**Evidence table (key questions 2–4)**

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| Study ID | Study and Sample Characteristics | CDSS/KMS Test Intervention | Comparator(s) | Results | Comments/  Quality/ Applicability |
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| **Alper, White, and Ge, 2005**  #9344 | **Geographical location:**  U.S., Israel, Lebanon, Pakistan  **Study dates:**  January 20, 2004–June 23, 2004  **General setting:** NR  **Specific setting:** NR  **Study design:**  RCT, crossover  **Unit of randomization:**  System query  **Duration of intervention:**  3 months  **Sample type(s) (with N randomized for each):**  Individual HCPs:  - MDs [family medicine, internal medicine, pediatrics, women’s health]: 60 randomized, 52 included  - MDs: 49  - NP: 3  - Clinician system queries: 780; 698 | **Authors’ basic description of system:**  DynaMed is a database of synthesized evidence. Authors investigated whether primary care clinicians would answer more clinical questions, change clinical decision making, and alter search time using DynaMed in addition to their usual information sources.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Other; answering specific clinician questions  *b) Relationship to point of care:*  - Synchronous  - Asynchronous  **Decision support:**  *Response requirement:*  Mandatory response | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: Total number of questions answered/asked (%)—  With DynaMed: 263 of 347 (75.8)  Without DynaMed: 250 of 351 (71.2)  Number of questions for which the answer changed decisionmaking/total asked (%)—  With DynaMed: 224 of 347 (64.6)  Without DynaMed: 209 of 351 (23.4)  Questions for which the participant did not find an answer when the answer would have changed decisionmaking (%)—  With DynaMed: 68 (19.6)  Without DynaMed: 82 (23.4) | **General comments:**  Participants could still use their usual information sources  **Quality assessment:**  Overall rating: Fair  Comments:  Baseline issues—participants recruited, not compelled to participate  **Applicability/ generalizability:**  Participants recruited voluntarily  Intervention was not locally developed  The study did not use patient-centered outcomes |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
|  | **User level of expertise/ proficiency:** NR | **Information delivery:**  *a) Delivery format:*  Online access  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N |  | **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: Median time searching (n = 695 questions), minutes—  With DynaMed: 4.95  Without DynaMed: 4.98  Median time to find answers (n = 510 questions), minutes—  With DynaMed: 4.78  Without DynaMed: 4.89  Median time for unsuccessful searches (n = 185 questions), minutes—  With DynaMed: 5.23  Without DynaMed: 5.1  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Answered more questions (n = 46 [%])—  With DynaMed: 23 (50)  Without DynaMed: 13 (28.3)  Difference: 10 (21.7), P = 0.05  Found more answers that changed clinical decisionmaking (n = 46 [%])—  With DynaMed: 25 (54.3)  Without DynaMed: 13 (28.3)  Difference: 8 (17.4), P = 0.01  Had better overall impact on decisionmaking (n = 46 [%])—  With DynaMed: 28 (60.9)  Without DynaMed: 15 (32.6)  Difference: 3 (6.5), P = 0.007  Spent less time searching (n = 46 [%])—  With DynaMed: 22 (47.8)  Without DynaMed: 23 (50)  Difference: 1 (2.2), P = 0.59  Found answers faster (n = 42 [%])—  With DynaMed: 20 (47.6)  Without DynaMed: 22 (52.4), P = 0.64  Stopped unsuccessful searches earlier (n = 28 [%])—  With DynaMed: 16 (57.1)  Without DynaMed: 12 (42.7), P = 0.69  - HCP Use:NR  - Implementation of CDSS/KMS: NR |  |
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| **Ansari, Shlipak, Heidenreich, et al., 2003**  #4529 | **Geographical location:**  San Francisco, CA  **Study dates:**  February 1, 2000–April 16, 2001  **General setting:**  VA  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 169  **User level of expertise/ proficiency:**  System users were physicians using the CDSS for the first time during this intervention phase | **Authors’ basic description of system:**  We conducted a randomized trial to determine whether two intervention strategies, a nurse facilitator, and a combination of patient-specific computer reminders and patient letters could improve the utilization of beta blockers in appropriate, stable outpatients with CHF compared with an aggressive provider education program alone.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  3 groups:  1) Provider education only (control)  2) Nurse facilitator  3) Provider and patient notification via CDSS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Hospitalizations and ER visits of study patients during followup (# [%])  P = 0.81  Control (n = 51): 25 (49)  Nurse Facilitator (n = 54): 23 (43)  CDSS Notification (n = 64): 29 (45)  Hospitalizations for CHF:  Control (n = 51): 5(10%)  Nurse Facilitator (n = 54): 5 (9%)  CDSS Notification (n = 64): 9(14%)  P = 0.66  Median hospitalizations or ER visits per patient:  Control (n = 51): 1(2%)  Nurse Facilitator (n = 54): 2 (4%)  CDSS Notification (n = 64): 1(2%)  P = 0.14  - Mortality: Deaths of study patients during followup (# [%]) P = 0.05—  Control (n = 51): 7 (14)  Nurse Facilitator (n = 54): 5 (9)  CDSS Notification (n = 64): 1 (2)  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  *-* Recommended treatment ordered/prescribed: Patients initiated or uptitrated on beta blockers (# [%]) P < 0.001—  Control (n = 51): 14 (27)  Nurse Facilitator (n = 54): 36 (67)  CDSS Notification (n = 64): 10 (16)  Patients at target beta blocker doses at end of study (# [%]) P < 0.001—  Control (n = 51): 5 (10)  Nurse Facilitator (n = 54): 23 (43)  CDSS Notification (n = 64): 1 (2)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Setting was VA hospital  Study used patient centered outcomes |
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| **Apkon, Mattera, Lin, et al., 2005**  #3126 | **Geographical location:**  Fort Knox, KY  Mayport, FL  **Study dates:**  Patient screening: 4/22/2004–12/31/2002  **General setting:**  Community; 2 military treatment facilities dealing with ambulatory practice  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  NR  **Sample type(s) (with N randomized for each):**  Patients: 1902 (936 intervention [I], 966 control [C])  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Problem-knowledge couplers, a decision support tool that used structured questions based on patient’s chief complaint to elicit information from the patient and the provider. That information is linked to a proprietary database of medical knowledge that generates suggestions for appropriate patient care strategies.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  -Diagnosis  - Chronic disease management  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  I: 722 of 2074 (34.8%)  C: 603 of 1983 (30.4%); p = 0.03  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: For acute/chronic disease management—  I: 83 of 300 (27.7%)  C: 92 of 282 (32.6%); p = 0.26  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:**  Patient satisfaction (mean values):  Speed, efficiency, and courtesy during visit—  I: 4.17  C: 4.19  P= .23  Health care provider—  I: 4.40  C: 4.37  P=.82  Personal issues—  I: 4.24  C: 4.27  P=NA  Overall visit assessment –  I:4.27  C: 4.30  P= 0.74  **5) Impact on economic outcomes:**  **-** Cost: Coupler patients used more laboratory and pharmacy resources than usual care patients (logarithmic mean difference $71). Multivariable analysis using logarithmic cost as the outcome showed a significant main effect of treatment, with coupler patients using a logarithmic mean difference of $46 more than usual care patients.  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Strongest level of perceived satisfaction related to information quality—75% agreed that the system provided high-quality information  83% disagreed or strongly disagreed that the problem-knowledge couplers involved acceptable amounts of time  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Providers cared for both intervention and control patients; a historical control and a concurrent control clinic were also used for comparison  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Evaluated among patients seen at ambulatory care practices that were part of the military health system; patient characteristics and needs may be different from general population |
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| **Bates, Kuperman, Rittenberg, et al., 1999**  #6103 | **Geographical location:**  Boston, MA  **Study dates:**  June 28, 1994–October 30, 1994  **General setting:**  Academic  **Specific setting:**  Inpatient – non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  4 months  **Sample type(s) (with N randomized for each):**  Patients: 11,586  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized reminders at the time a test was ordered that appeared to be redundant.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Number of tests performed when reminder was triggered by a test \*—  Intervention: 117 (27%)  Control: 257 (51%) (P < 0.001)  \* In this context, the reminder is for a redundant test, and a lower rate of test orders is an indicator of the effectiveness of the reminder  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Charge savings identified as a result of canceling redundant tests = $35,000 (0.15% of the annual laboratory budget)  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Tests ordered using written instructions and tests ordered as part of an order set were outside the purview of the intervention  As a result, only 44% of the tests performed had an associated computer order; further, 50% of the tests with a computer order were not screened for redundancy because they were ordered as part of an order set  **Applicability/ generalizability:**  Conducted in an academic tertiary care institution  Designed to evaluated only a limited number of tests |
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| **Bell, Grundmeier, Localio, et al., 2010**  #13008 | **Geographical location:**  Philadelphia, PA  **Study dates:**  Dec 1, 2005–Apr 15, 2008  **General setting:**  - Academic (4 urban practices)  - Community (8 suburban practices)  Academic as well as community practices affiliated with the Children’s Hospital of Philadelphia Pediatric Research Consortium (CHOP), a primary care practice-based research network  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  2.4 years  **Sample type(s) (with N randomized for each):**  Clinics/practices/hospitals: 12  **User level of expertise/ proficiency:**  Practicing primary care physicians trained in the use of the CDSS | **Authors’ basic description of system:**  Clinical decision support tool embedded in an electronic health record (EHR) to improve clinician adherence to National Asthma Education and Prevention Program (NAEPP) guidelines.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow:Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations:N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment:Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning:Y  **-** Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process:Y (developed and validated by a multidisciplinary team at Children’s Hospital of Philadelphia Pediatric Research Consortium)  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Spirometry performed:  Urban Practices—  I: 24% (147 of 604)  C: 22% (150 of 690)  P = 0.04  Suburban practices—  I: 14% (67 of 464)  C: 1% (2 of 185)  P = 0.003  - Recommended treatment ordered/prescribed: Recommended controller medication prescribed:  Urban Practices—  I: 78% (943 of 1205)  C: 80% (1068 of 1328); P = 0.006  Suburban practices—  I: 74% (682 of 926)  C: 51% (209 of 409); P = not significant  Asthma Care Plan (ACP) filed under treatment outcome:  Urban practices—  I: 63% (763/1205)  C: 68% (903/1328)  P not significant  Suburban practices—  I: 53% (491/926)  C: 36% (148/409)  P = 0.03  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Intervention and characteristics of study population well described  Valid outcome measures; baseline differences between intervention and controls also determined during stages of study named pre-education and education  **Applicability/ generalizability:**  Study population includes those served by an academic urban practice as well as primary practices serving mainly suburban population |
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| **Bertoni, Bonds, Chen, et al., 2009**  #501 | **Geographical location:**  Winston-Salem, NC  **Study dates:**  June 1, 2001–May 31, 2003 (baseline)  May 1, 2004–Apr 30, 2006 (followup)  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinic  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  Clinics/practices/ hospitals: N = 66 (34 JNC-7 intervention, 32 ATP III intervention)    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized decision support system (CDSS) that calculates the Framingham risk score (FRS) and delivers recommendations.  Recommendations for lipid screening and management were based on the National Cholesterol Education Program Adult Treatment Panel (ATP III) guidelines (Intervention) or on JNC guidelines (Control).  **Source/origin of system:**  Locally developed  CDSS based on ATP III guidelines dissemination and available on the National Heart Lung and Blood Institute ATP III website that was modified to include additional information on therapy to lower lipid levels (LLT).  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Standalone system (PDA-based)  *b) Delivery mode:*  User-initiated (“pull”) (response to user-entered data)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning:Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  **-** CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  In the control CDSS, recommendations were based on the Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Proportion of patients screened  Intervention: 49.0% (n = 1811)  [baseline 43.6%; (n = 2216)]  Control: 50.8% (n = 2010)  [baseline 40.1% (n = 2841)]  Net change -5.3%; P=0.22  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Appropriate Management—  Intervention: 72.3% (n = 709)  [baseline 73.4%, (n = 842)]  Control: 68.9.3% (n = 771)  [baseline 79.7% (n = 855)]  Net change +9.7%; 95% CI, 2.8%-16.6%; P < 0.01  Appropriate prescription of LLT—  Intervention: 24.8% (n = 190)  [baseline 38.8%; (n = 216)]  Control: 24.1% (n = 200)  [baseline 45.3% (n = 205)]  Net change +7.2%; P = 0.37  Inappropriate prescription of LLT –  Intervention: 3.9% (n = 519)  [baseline 6.6%; (n = 626)]  Control: 6.4% (n = 571)  [baseline 4.2% (n = 650)]  Net change -4.9%; P = 0.01  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Intervention is a standalone PDA that was not integrated into electronic medical record. Provider use of PDA decreased during the latter half of the intervention particularly if they had adopted electronic health records.  **Quality assessment:**  Overall rating: Good  Comments:  Intervention not blinded; outcome assessors blind to assignment of intervention/control  **Applicability/ generalizability:**  Practices included were those that were community and not affiliated with the medical school or a residency program |
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| **Bird, McPhee, Jenkins, et al., 1990**  #7221  **Comparison 1 of 3** | **Geographical location:**  San Francisco, CA  **Study dates:**  1984−1987  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group, 2 x 3 factorial design  **Unit of randomization:**  Clinician  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > Training MDs: residents in internal medicine (N = 62; 21 cancer screening reminders, 20 audit with feedback, 21 no physician education)  **User level of expertise/ proficiency:**  Computer was used to generate recommendations that were printed out and provided to the physician. As such, interaction with the computer-based system was limited and user level of expertise/proficiency may not be relevant. | **Authors’ basic description of system:**  Cancer screening reminder intervention provided residents with up-to-date records of their patient’s screening status at the time of each practice visit.    **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement (no response required for the recommendation as such; however, residents were asked to note on the reminder form whether they performed or ordered any screening test during the patient visit)  -**Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Cancer screening reminders  2 x 3 factorial design: Patient education (present or absent) by:  - Cancer screening reminders  versus  - Audit with feedback  versus  - No physician intervention  Total of 6 groups, but results reported only for 5 of the 6 possible cells in the 2 x 3 factorial design; primary outcome of cost of intervention reported for single interventions only:  Cancer screening with and without patient education  Audit with feedback with and without patient education  No physician intervention, by inference, with only the patient education group | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Total cost of implementation—  Cancer screening reminders: $5820  Per patient: $12.93  Labor cost: Cancer screening reminders (by inference, n = 21)—  Total cost: $12,222  Prorated cost: $5820  No tests of significance reported  - Cost-effectiveness: Implementation cost—  Cost per additional test: $18.19  # of tests promoted per $1000 expenditure: 55  **6) Impact on HCP use and implementation:**  - HCP acceptance: Residents’ use of the reminders also indicated general acceptance of the intervention. Residents made notations on 2397 (70%) of 3441 reminders for completed patient appointments; they returned 793 (23%) without notations and failed to return 251 (7%).  - HCP satisfaction:  Most of the residents were also enthusiastic; 14 of 21 residents found the reminders very useful/helpful  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  This was a secondary (feasibility) analysis of a previously published study: McPhee SJ, Bird JA, Jenkins C, Fordham D. Promoting cancer screening: a randomized, controlled trial of three interventions. Arch Intern Med 1989; 149:1866.  Patient education intervention only addressed screening for breast cancer among women, while intervention arms had screening strategies with broader focus (including other cancers and male patients)  **Quality assessment:**  Overall rating: Poor  Comments: Methods used for randomization and allocation concealment not adequately described  Small sample size (~10 per cell in 2 x 3 factorial design)  Inadequate reporting of methods and results  Potential for multiple confounders  **Applicability/ generalizability:**  Technical features of the intervention may be outdated by the standards of current information technology  Assessed among residents in an academic teaching hospital  Units of costs in 1984–1987 dollars |
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| **Bird, McPhee, Jenkins, et al., 1990**  #7221  **Comparison 2 of 3** | **Geographical location:**  San Francisco, CA  **Study dates:**  1984−1987  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group, 2 x 3 factorial design  **Unit of randomization:**  Clinician  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > Training MDs: residents in internal medicine (N = 62; 21 cancer screening reminders, 20 audit with feedback, 21 no physician education)  **User level of expertise/ proficiency:**  Computer was used to generate recommendations that were printed out and provided to the physician. As such, interaction with the computer-based system was limited and user level of expertise/proficiency may not be relevant. | **Authors’ basic description of system:**  Cancer screening reminder intervention provided residents with up-to-date records of their patient’s screening status at the time of each practice visit.    **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement (no response required for the recommendation as such; however, residents were asked to note on the reminder form whether they performed or ordered any screening test during the patient visit)  -**Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Audit with feedback  2 x 3 factorial design: Patient education (present or absent) by:  - Cancer screening reminders  versus  - Audit with feedback  versus  - No physician intervention  Total of 6 groups, but results reported only for 5 of the 6 possible cells in the 2 x 3 factorial design; primary outcome of cost of intervention reported for single interventions only:  Cancer screening with and without patient education  Audit with feedback with and without patient education  No physician intervention, by inference, with only the patient education group | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Total cost of implementation—  Audit with feedback: $4488  Per patient: $9.63  Labor cost: Audit with feedback (by inference, n = 20)—  Total cost: $8976  Prorated cost: $4488  - Cost-effectiveness: Implementation cost—  Cost per additional test: $50.40  # of tests promoted per $1000 expenditure: 20  **6) Impact on HCP use and implementation:** NR | **General comments:**  This was a secondary (feasibility) analysis of a previously published study: McPhee SJ, Bird JA, Jenkins C, Fordham D. Promoting cancer screening: a randomized, controlled trial of three interventions. Arch Intern Med 1989; 149:1866.  Patient education intervention only addressed screening for breast cancer among women, while intervention arms had screening strategies with broader focus (including other cancers and male patients)  **Quality assessment:**  Overall rating: Poor  Comments: Methods used for randomization and allocation concealment not adequately described  Small sample size (~10 per cell in 2 x 3 factorial design)  Inadequate reporting of methods and results  Potential for multiple confounders  **Applicability/ generalizability:**  Technical features of the intervention may be outdated by the standards of current information technology  Assessed among residents in an academic teaching hospital  Units of costs in 1984–1987 dollars |
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| **Bird, McPhee, Jenkins, et al., 1990**  #7221  **Comparison 3 of 3** | **Geographical location:**  San Francisco, CA  **Study dates:**  1984−1987  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group, 2 x 3 factorial design  **Unit of randomization:**  Clinician  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > Training MDs: residents in internal medicine (N = 62; 21 cancer screening reminders, 20 audit with feedback, 21 no physician education)  **User level of expertise/ proficiency:**  Computer was used to generate recommendations that were printed out and provided to the physician. As such, interaction with the computer-based system was limited and user level of expertise/proficiency may not be relevant. | **Authors’ basic description of system:**  Cancer screening reminder intervention provided residents with up-to-date records of their patient’s screening status at the time of each practice visit.    **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement (no response required for the recommendation as such; however, residents were asked to note on the reminder form whether they performed or ordered any screening test during the patient visit)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Patient education  2 x 3 factorial design: Patient education (present or absent) by:  - Cancer screening reminders  versus  - Audit with feedback  versus  - No physician intervention  Total of 6 groups, but results reported only for 5 of the 6 possible cells in the 2 x 3 factorial design; primary outcome of cost of intervention reported for single interventions only:  Cancer screening with and without patient education  Audit with feedback with and without patient education  No physician intervention, by inference, with only the patient education group | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Total cost of implementation—  Patient education: $1280  Per patient: $ 3.11  Labor cost: Patient education (by inference, n = 10)—  Total cost: $3967  Prorated cost: $1280  No tests of significance reported    - Cost-effectiveness: Implementation cost—  Cost per additional test: $51.20  # of tests promoted per $1000 expenditure: 20  **6) Impact on HCP use and implementation:** NR | **General comments:**  This was a secondary (feasibility) analysis of a previously published study: McPhee SJ, Bird JA, Jenkins C, Fordham D. Promoting cancer screening: a randomized, controlled trial of three interventions. Arch Intern Med 1989; 149:1866.  Patient education intervention only addressed screening for breast cancer among women, while intervention arms had screening strategies with broader focus (including other cancers and male patients)  **Quality assessment:**  Overall rating: Poor  Comments: Methods used for randomization and allocation concealment not adequately described  Small sample size (~10 per cell in 2 x 3 factorial design)  Inadequate reporting of methods and results  Potential for multiple confounders  **Applicability/ generalizability:**  Technical features of the intervention may be outdated by the standards of current information technology  Assessed among residents in an academic teaching hospital  Units of costs in 1984–1987 dollars |
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| **Bosworth, Olsen, Dudley, et al., 2009**  #560  **AND**  **Bosworth, Olsen, Goldstein, et al., 2005**  #3481 | **Geographical location:**  Durham, NC  **Study dates:**  March 2002–April 2005  **General setting:**  VA  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  2-level (PCP and patient) RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  Individual HCPs:  >Training MDs  > MDs: 23 general internists  - PAs/NPs: 7  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  CDSS system used special features of the VA’s computerized medical record and provided patient-specific recommendations about hypertension decision support delivered at the point of care during each patient visit.    **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  2-level cluster RCT:  1) PCPs receiving intervention (n = 17)  2) PCPs not receiving intervention (n = 15)  3) Patients receiving usual care  4) Patients receiving bimonthly tailored nurse-delivered behavioral telephone intervention to improve hypertension treatment | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: Percentage of visits during which HCPs interacted with the system—  57% of the visits when the system displayed the decision support system  - Implementation of CDSS/KMS: NR | **General comments:**  Primary outcome was the proportion of patients who achieved blood pressure control over 24-month intervention period  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Long followup period;  high retention rate; less than 3% dropped out; intervention evaluated in a veteran patient population (98% male, 40% African American) |
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| **Bourgeois, Linder, Johnson, et al., 2010,**  #14341 | Geographical location:  12 sites in Boston, MA  Study dates:  October 2006–April 2007  General setting:  Community  Specific setting:  - Outpatient  - Chronic and acute  Study design:  RCT, cluster randomization  Unit of randomization:  - Clinic or team  Duration of intervention:  6 months  Sample type(s) (with N randomized for each):  - Clinics/practices/ hospitals: 12  - Individual HCPs: 146  User level of expertise/ proficiency:  Intervention clinics were given 3 months to familiarize with the CDSS. In-person training session on use of ARI-IT | **Authors’ basic description of system:**  Interactive, computerized, guideline-driven (“smart form”) template to assist clinicians in antibiotic prescribing for acute respiratory illness (ARI).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Lab test ordering  - Disease management (chronic and acute)  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Antimicrobial prescriptions (percentage of total visits)—  I = 5929/14934 (39.7%)  C = 2303/5007 (46%)  P = 0.844  Macrolide prescriptions (percentage of total visits)—  I = 1408/14934 (9.4%)  C = 290/5007 (5.8%)  P < 0.0001  Antimicrobial prescriptions for viral illnesses (%)—  I = 1526/14934 (17.9%)  C = 408/5007 (15.7%)  P = 0.129  Macrolide prescription for viral illnesses (%)—  I = 336/14934 (4%)  C = 93/5007 (3.6%)  P = 0.484  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: CDSS used during 419 of 14,934 visits, accounting for 2.8% of all visits. CDSS used by 32 of112 (29%) intervention clinic clinicians.  - Implementation of CDSS/KMS: NR  - Other: Clinicians who used the ARI-IT form reported that the features of greatest benefit and appeal included features that were most likely to improve efficiency, including (1) the note creation feature, (2) the automatically generated, weight-based, printable prescriptions, (3) patient handouts, and (4) excuse forms.  Clinicians also identified a number of frustrations with the form, including (1) the overly detailed list of symptoms, (2) the need to add specific details in the physical exam (particularly appearance of tympanic membranes) and review of systems, (3) the need to immediately identify the patient’s diagnoses as qualifying as an ARI diagnosis in order to launch the form, (4) the need to complete the entire template during the patient visit in order to save the visit note. | **General comments:**  None  Quality assessment:  Overall rating:  Fair  Comments:  Valid outcome measures  No details on randomization, concealment, or blinding provided  More clinics, clinicians, and patients included in the intervention group  **Applicability/ generalizability:**  Locally developed system by Partners Healthcare  Low adoption rate among clinicians prevent accurate assessment for generalizability |
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| **Brier, Gaweda, Dailey et al., 2010**  #14348 | Geographical location:  Louisville, KY  Study dates:  December 2006–July 2007  General setting: NR  Specific setting: NR  Study design:  RCT, parallel group  Unit of randomization:  Patient  Duration of intervention:  8 months  Sample type(s) (with N randomized for each):  Patients: 60  User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  Anemia management using model predictive control (MPC) recommends EPO dosing.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  Not clearly described  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N    *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity:  Hospitalization events:  Intervention = 53  Control = 47  - Mortality: 6 in intervention group; Two of the deaths were cardiovascular in nature; study mortality rate was below the facility rate  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Proportion 11.0 to 12.0 g/dl—  Control = 42/112 (37%)  Intervention = 34/92 (37%)  Proportion > 13.0 and < 9.0 g/dl—  Control = 30/112 (27%)  Intervention = 15/92 (16%)  Mean absolute difference from 11.5 g/dl—  Control = 1.14 ± 1.18  Intervention = 0.96 ± 0.70  P < 0.001 (difference in variance)  AUC—  Control = 3.38 ± 2.69  Intervention = 2.86 ± 1.46  P = 0.025 (difference in variance)  Number of dose changes—  Control = 3.9 ± 1.6  Intervention = 4.8 ± 2.2  Total EPO dose (1000U)—  Control = 97.6 ± 66.1  Intervention = 129.3 ± 170.8  P = 0.005 (difference in variance)  Total Iron dose (mg)—  Control = 1133 ± 1212  Intervention = 1496 ± 1573  P = 0.261 (difference in variance)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  Quality assessment:  Overall rating: Fair  Comments:  Dropout = 7 of 60 (> 10%)  Small sample size  **Applicability/ generalizability:**  Wide age gap patient inclusion (18 to 80)  Locally developed system with proprietary software and unknown parameters (neural network)  Possibly veteran population |
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| **Burack, Gimotty, George, et al., 1994**  #6957  **AND**  **Burack and Gimotty, 1997**  #6473 | **Geographical location:**  Detroit, MI  **Study dates:**  May 1, 1989–Sep 1, 1991  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  Patients:  Year 1: 2725  Year 2: 1225  **User level of expertise/ proficiency:** NA; paper-based reminders | **Authors’ basic description of system:**  Computer-generated mammography reminder form for physicians, a mammography appointment postcard reminder for women, and an appointment rescheduling system for women who were unable to complete a scheduled mammography appointment.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  No CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  Screening for mammography among women aged 40 and over measured as annual completed mammography rates—  Year 1 (n = 2,725)  I: 53%  C: 41%  Year 2 (n = 1,225)  I: 44%  C: 28%  (adjusted OR = 1.84; 95% CI 1.40 to 2.40)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Strategies to address barriers to screening such as elimination of out-of-pocket mammography expenses to patients and physician and staff orientation were implemented in both experiment as well as control groups  **Quality assessment:**  Overall rating: Good  Comments: Study population, baseline characteristics well-described  **Applicability/ generalizability:**  Intervention implemented in the community setting in three health care organizations serving urban, predominantly Medicaid-eligible population  Not a real-time system; recommendations generated offline by a dedicated research team using information from several sources such as medical chart review, site administration data, and mammography facility records to generate reminders |
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| **Burack, Gimotty, George, et al., 1998**  #6292 | **Geographical location:**  Detroit, MI,  **Study dates:**  March 1993–April 1994  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 5801  **User level of expertise/ proficiency:** NA; paper-based reminders | **Authors’ basic description of system:**  The computer-based reminder system generated pap smear reminders for both patients and physicians. The reminders were generated off-site. Physician reminder was a brightly colored reminder placed in the patient medical record while the patient reminder was a letter mailed to the patient.  Eligible women were assigned to receive either physician reminder, patient reminder, or a combination of both; the control group participants were not assigned to receive any reminders.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence:  Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  No CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  Pap smear completion:  Intervention—  Physician and patient reminders:  32%; OR = 1.23; n = 960  Physician reminders alone  29%; OR = 1.05; n = 960  Patient reminders alone  29%; OR = 1.07; n = 964  Control—  No reminders:  28%; (n = 964)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:** None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Intervention implemented in the community setting at three sites of an HMO serving an urban, predominantly Medicaid-eligible population  Not a real-time system;  recommendations were generated offline  Additional organizational resources to scan records and generate recommendations |
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| **Burack, Gimotty, Simon, et al., 2003**  #4609 | **Geographical location:**  Detroit, MI  **Study dates:**  Jan 1994–Feb 1995  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 2471  **User level of expertise/ proficiency:** NA;  paper- based reminders | **Authors’ basic description of system:**  Combined pap smear and mammography reminder; reminders included both a mailed letter to the patient and a medical record prompt placed in the patient’s medical chart.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence:  Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  Comparator was a mammography-only reminder; similar to the intervention, the control group included both a mailed letter to the patient and a medical record prompt with the only difference being that it addressed mammography alone. | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Pap smear completion—  Intervention: 30%  Control: 23%; p = 0.007  Adjusted OR = 1.39, 95% CI 1.08 to 1.63  Mammography completion—  Intervention: 38.9%  Control:39.7;  Adjusted OR = 0.94 95% CI (0.78, 1.14)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Intervention implemented in the community setting at three sites of an HMO serving an urban, predominantly Medicaid-eligible population  Not a real-time system;  recommendations were generated offline  Additional organizational resources to scan records and generate recommendations |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Cannon and Allen, 2000**  #5781 | **Geographical location:**  Salt Lake City, UT  **Study dates:**  Jan 5, 1998–Oct 7, 1998  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  Patients: 78  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The computer system, called CaseWalker, reminded clinicians when guideline-recommended screening for mood disorder was due, ensured the fidelity of the diagnosis of major depressive disorder to criteria of DSM-IV, and generated a progress note.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Standalone system  [The CDSS program ran on the same computer that was used for processing EHRs but was not integrated into the workflow of the EHR system.]  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: NR  - CDSS accompanied by conventional education: N | **Comparator(s):**  No CDSS or KMS;  manual reminder  Manual reminder was a paper checklist that was inserted into the assessment section of the paper medical record of each patient assigned to the control arm. The paper checklist presented the diagnostic criteria used in the intervention in a paper form in exactly the same order. | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: percentage of patients screened for mood disorder—  I: 86.5%  C: 61%; p = 0.008  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair    Comments:  Small team of health care providers (clinical psychologist, registered nurse, social worker and addiction therapist) evaluated subjects in both arms of the study  Potential for contamination across study arms as 4 HCPs administered care to all the subjects in the study.  **Applicability/ generalizability:**  Small sample of highly select group of patients attending an outpatient clinic at a VA Health Center staffed with 4 HCPs that were part of the Posttraumatic Stress Disorder (PTSD) clinical team; limited generalizability to other settings |
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| **Cavalcanti, Silva, Pereira, et al., 2009**  #216  **Comparison 1 of 2** | **Geographical location:**  Brazil; multicenter trial in 5 ICUs at 5 different Brazilian institutions  **Study dates:**  May 4, 2005–Dec 4, 2006  **General setting:**  - Academic  - Community  (3 ICUs associated with teaching hospitals and 2 associated with nonteaching hospitals)  **Specific setting:**  Inpatient – ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  Patients: 168 (56 CAIP, 58 Leuven protocol, 54 conventional)  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Interventions were computer-assisted insulin protocol (CAIP), with continuous intravenous insulin infusion maintaining BG between 100 and 130 mg/dL.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy, insulin therapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:* NR  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:* NR  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  Comparator 1: Leuven protocol with continuous insulin infusion maintaining BG between 80 and 110 mg/dL | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Incidence of at least 1 episode of hypoglycemia—  CAIP: 21.4% ( n = 24)  Leuven: 41.4% (n = 24); p = 0.04  Percentage of hypoglycemic episodes per patient—  CAIP: 0.43  Leuven: 0.55; p = 0.04  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Computer-generated random numbers; centralized randomization using a Web site that assured concealment of the allocation list; no blinding of patients or investigators; insufficient and ambiguous reporting of methods  **Applicability/ generalizability:**  Study carried out at multiple ICUs across Brazil; patients had longer ICU stay and greater frequency of hypoglycemia compared to studies in other settings |
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| **Cavalcanti, Silva, Pereira, et al., 2009**  #216  **Comparison 2 of 2** | **Geographical location:**  Brazil; multicenter trial in 5 ICUs at 5 different Brazilian institutions  **Study dates:**  May 4, 2005–Dec 4, 2006  **General setting:**  - Academic  - Community  (3 ICUs associated with teaching hospitals and 2 associated with nonteaching hospitals)  **Specific setting:**  Inpatient – ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  Patients: 168 (56 CAIP, 58 Leuven protocol, 54 conventional)  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer-assisted insulin protocol (CAIP), with continuous intravenous insulin infusion maintaining BG between 100 and 130 mg/dL.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy, insulin therapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:* NR  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:* NR  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y/  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Comparator 2: Usual care; conventional treatment was subcutaneous insulin administration according to a sliding scale if glucose > 150 mg/dL | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Patients with incidence of at least 1 episode of hypoglycemia—  CAIP: 21.4% (n = 24)  Usual care: 3.8% (n = 2); p = 0.006  Percentage of hypoglycemic episodes per patient—  CAIP: 0.43  Usual: 0.03; p = 0.007  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Computer-generated random numbers; centralized randomization using a Web site that assured concealment of the allocation list; no blinding of patients or investigators; insufficient and ambiguous reporting of methods  **Applicability/ generalizability:**  Study carried out at multiple ICUs across Brazil; patients had longer ICU stay and greater frequency of hypoglycemia compared to studies in other settings |
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| **Chambers, Balaban, Carlson, et al., 1989**    #15368 | Geographical location:  Philadelphia, PA  Study dates:  Nov 1, 1986–April 30, 1987  General setting:  Academic  Specific setting:  Outpatient  Study design:  RCT, parallel group  Unit of randomization:  Patient  Duration of intervention:  6 months  Sample type(s) (with N randomized for each):  Patients 1262  User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  A microcomputer reminder system prompting physicians to schedule periodic mammographic screenings for patients.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  *-* Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Up-to-date (at beginning of intervention period)—  Control = 88 of 623 (14/.%)  Intervention = 87 of 639 (13.6%)  P = 0.793  Brought up-to-date (of those who start or who became due)—  Control = 68 of 523 (12.1%)  Intervention = 111 of 580 (19.1%)  P = 0.001  Up-to-date (at the end of the intervention period)—  Control =128 of 623 (20.6%)  Intervention = 170 of 639 (26.6%)  P = 0.011  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  Quality assessment:  Overall rating: Good  **Applicability/ generalizability:**  A single site study located in an academic medical center  Relatively older study involving computerized reminder that requires a print out in paper form  Not a diverse patient population |
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| **Christakis, Zimmerman, Wright, et al., 2001**  #5448 | **Geographical location:**  Seattle, WA  **Study dates:**  - Baseline: March–September  - Intervention: October–May  (years NR)  **General setting:**  Academic  **Specific setting:** Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  8 months  **Sample type(s) (38):**  Individual HCPs:  > Training MDs: 29  > MDs: 7  > NPs: 2    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A point-of-care evidence-based message system presenting real-time evidence to providers based on their prescribing practice for otitis media.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration:Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescription of antibiotics for otitis media that were for < 10 days (change in mean outcome before vs after)—  I: 44.43% (standard error 4.24%)  C: 10.48% (standard error 5.25%)  Treatment of acute otitis media without antibiotics (change in mean outcome before vs after)—  I: -4.33%  C: -16.81%  P < 0.01  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Small sample size; possibility of diffusion of evidence between the experimental and control groups  Outcomes expressed as change in individual provider behavior; seasonal factors may have introduced trends in prescribing behavior since the baseline period was during summer, and the intervention was during fall and winter months  **Quality assessment:**  Overall rating: Fair  Comments:  Randomized using electronic random number generator; potential for diffusion of evidence between experimental and control arms  **Applicability/ generalizability:**  Intervention carried out in a resident teaching clinic of a large, academic hospital |
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| **Cleveringa, Gorter, van den Donk, et al., 2008**  #831  **AND**  **Cleveringa, Welsing, van den Donk, et al., 2010**  #11 | **Geographical location:**  Primary care practices (55) throughout Netherlands  **Study dates:**  March 2005–August 2007  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Clinics/practices: 55  - Patients: 3391  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Diabetes care protocol (DCP) characterized by delegation of routine tasks in diabetes care to a practice nurse, software that supports diabetes management, medical decisions and benchmarking.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N/  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Intervention patients incurred higher total costs (€1415, $1,967; P = NS)  - Cost-effectiveness: Incremental cost per quality-adjusted year = € 38,243, $27,808 per QALY gained  Calculated using a modified probabilistic diabetes model for Netherlands; model simulates the natural history of type 2 diabetes and calculates costs and QALYs for Dutch type 2 diabetic patients  “In the long run, DCP is more costly and leads to only slightly more health than current care, although it does result in significantly lower CHD costs.”  **6) Impact on HCP use and implementation:** NR | **General comments:**  Details of the intervention are provided in a separate article; Cleveringa FGW, Gorter KG et al. (2007)  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Large, unselected primary care population receiving diabetes care at primary care practices across various locations in Netherlands; race/ethnicity is primarily Caucasian population |
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| **Co, Johnson, Poon, et al., 2010,**  #14409 | Geographical location:  12 sites in Massachusetts, USA  Study dates:  December 2006 –July 2007  General setting:  Community  Specific setting:  - Outpatient  - Chronic  Study design:  RCT, cluster randomization  Unit of randomization:  Clinic or team  Duration of intervention:  6 months  Sample type(s) (with N randomized for each):  - Patients: 412  - Clinics/practices/ hospitals: 12  - Individual HCPs:  > MDs [pediatricians]:  79  User level of expertise/ proficiency:  Physicians have 6 weeks to get accustomed to the new CDSS features. They were given instructions through presentations at practice meetings and detailed email. | **Authors’ basic description of system:**  EHR reminders and templates in pediatric primary care to assess ADHD.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: ~~Y~~  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Adherence to guidelines for recommended interval of followup:  Patients with any visit at which ADHD was discussed—  Control = 111 (53.9%)  Intervention = 146 (70.9%)  P =0.04  Patients with non-well child visit during which ADHD was discussed—  Control = 69(33.5%)  Intervention = 90 (43.7%)  P = 0.27  Patients with a well-child visit at which ADHD was discussed—  Control = 46 (22.3%)  Intervention = 59(28.2%)  P = 0.33  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction:  Satisfaction score with reminders and structured diagnosis and reminder template—  Intervention = 4.3  Control = 3.3  P = 0.01  - HCP use: NR  - Implementation of CDSS/KMS: The number of times a reminder appeared for a patient was not associated with increased likelihood of having a visit at which ADHD symptoms and treatments were discussed (P = 0.68)  - Other: Physician focus groups revealed barriers for optimal use of the decision support tool, including (1) forgetting the templates were avail-able, (2) preferring to use templates that they created themselves, and (3) finding the templates difficult to use efficiently.  They suggested that their template use may have been higher if (1) their availability within the long list of available templates was better highlighted, (2) they were introduced before having developed their own templates, and (3) the templates were simplified. | **General comments:**  None  Quality assessment:  Overall rating: Fair  Comments:  No details provided on randomization process, blinding or concealment  **Applicability/ generalizability:**  Included children age 5 to 18 years—no distinction made in the analysis between young (age 5 to 12 years) and older children (age 13 to 18 years)  All sites used the Partners Healthcare medical record |
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| **Cobos, Vilaseca, Asenjo, et al., 2005**  #11817 | **Geographical location:**  Barcelona, Spain  **Study dates:**  March 1999–April 2002  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 2221  - Clinics/practices/ hospitals: 44  **User level of expertise/ proficiency:** All practices had electronic health records; expertise with the specific computer module used in the intervention not specified | **Authors’ basic description of system:**  Clinical decision support system based on the recommendations of the European Society of Cardiology and other societies for hypercholesterolemia management.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: NR  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Use of lipid lowering drugs—  Intervention: 40.8% (n = 427)  Usual Care: 59.1% (n = 677)  Odds ratio: (95% CI) 0.37 (0.26, 0.52)  P = 0.0001  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Treatment cost per patient—  Intervention: € 178  Control: € 237 ;  Difference = € 59 (95%CI 34,83; p < 0.0001)  Total costs per patient—  Intervention: € 223  Control: € 283  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: CDSS recommendations for lipid management were accepted in 71.3% of patient visits  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Loss to followup high (25%) in both arms of the study; unblinded, pragmatic trial  **Applicability/ generalizability:**  Evaluated in 44 practices in Spain that were part of the public health system and were known to be using electronic health records; patient characteristics likely to be representative of public health clinics in Spain |
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| **Davis, Wright, Chalmers, et al., 2007**  #2021 | **Geographical location:**  Seattle, WA  **Study dates:**  Nov 1999–Dec 2003  **General setting:**  - Academic  - Community  Intervention carried out at 2 sites: academic pediatric care center and pediatric clinic in the community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinicians  **Duration of intervention:**  50 months at site 1 (academic primary care center) and 18 months at the site 2 (clinic in the community)  **Sample type(s) (44):**  Individual HCPs: 44  - Training MDs: 29  - MDs: 15  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  An evidence-based system that presented real-time evidence to providers based on prescribing practices for common pediatric conditions (acute otitis media, allergic rhinitis, sinusitis, constipation, pharyngitis, croup, urticaria and bronchiolitis).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Percentage of prescriptions in accordance with evidence—  At baseline:  I: 38%  C: 39%  At conclusion of study period:  I: 42%  C: 40%  Adjusted difference between the intervention and control groups: 8% (95% CI 1%, 15%)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  36 providers based at the academic training facility and 8 providers based in a primary care clinic in the community  Main outcome measure was change in prescribing behavior over the course of the trial  **Quality assessment:**  Overall rating: Fair  Comments:  Randomization using computer generated random numbers  **Applicability/ generalizability:**  Study participants were primarily English speaking, fairly well educated and were in an urban and semiurban setting  Intervention was implemented at a large academic training facility and a community-based clinic staffed by recent graduates of the academic center |
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| **Del Fiol, Haug, Cimino, et al., 2008**  #938 | **Geographical location:**  Utah and Idaho  **Study dates:**  5/2007–11/2007  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > MDs: 90  - Infobutton sessions: 3729  **User level of expertise/ proficiency:**  Study clinicians had to have conducted 10 or more medication infobutton sessions; infobuttons have been implemented in the EMR since September 2001 for the laboratory results, problem list, and medication-ordering modules | **Authors’ basic description of system:**  Infobuttons are decision support tools that provide links within electronic medical record systems to relevant content in online information resources.  Two studies assessed the effectiveness of two versions of the medication order entry infobuttons—one that provided context-specific topic links and the other that provided general content through nonspecific links.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Other: To answer clinicians’ questions at the point of care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS:  1) Intervention group: Clinicians had access to topic links  2) Control group: Clinicians had access to nonspecific links | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: Subjects reported a high positive clinical impact (i.e., decision enhancement or knowledge update) in 62% of the sessions  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: Time spent seeking information (median session duration) —  Intervention: 35.5 seconds  Control: 43 seconds, p = 0.008  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Postsurvey study (n = 25 participants, with a total of 115 (9.9%) individual responses)—  The information-seeking success rate was equally high in both groups. In the control group, 59 (89%) of the responses indicated that the information being sought was found compared to 41 (84%) in the intervention group, p = 0.9.  - HCP use: Median number of infobutton sessions—  Intervention: 22  Control: 17.5, p = 0.21  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Inadequate description of study population, incomplete and ambiguous reporting of findings, nonblinded participants, low response rate with followup survey  **Applicability/ generalizability:**  Well-established health IT infrastructure and history of being an early adopter of health IT  Locally developed system  No patient-centered outcomes |
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| **Demakis, Beauchamp, Cull, et al., 2000**  #5631 | **Geographical location:**  12 VA medical centers, US  **Study dates:**  1/31/1995–6/30/1996  **General setting:**  VA medical centers  **Specific setting:**  Outpatient (primary care), mostly for chronic care.  **Study design:**  RCT, parallel group  **Unit of randomization:**  Firms or team system and half-day blocks of residents    **Duration of intervention:**  17 months  **Sample type(s) (with N randomized for each):**  - Patients: During the course of the study, the residents cared for 18,700 unique patients, and 12,989 of these patients were eligible for at least 1 of the investigated SOCs  - Individual HCPs:  > Training MDs, residents: 299 initially randomized, 275 residents completed the study  **User level of expertise/ proficiency:**  Intervention subjects received an introduction to the reminder system that consisted of an education session that lasted 1 to 2 hours and included a demonstration of how the reminder system worked | **Authors’ basic description of system:**  Computerized system to remind physicians to provide appropriate care for 13 standards of care (SOCs).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Chronic disease management  - Preventive care  - Immunization  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Visit-specific adherence rate to all SOCs, # (% adherent)—  Intervention: 12,759 (17.9%)  Control: 14,013 (12.2%)  OR 1.57; 95% CI: 1.45,1.71, P-value: <0.001  Significantly higher adherence rates were found for 9 of the 13 SOCs examined individually  General adherence rate to all SOC, # (% adherent)—  Intervention: 19,373 (58.8%)  Control: 20,575 (53.5%)  OR 1.24; 95% CI: 1.08,1.42, p = 0.002  General adherence rate to pneumococcal vaccination—  Intervention: 1759 (12.7%)  Control: 1688 (4.3%)  OR 3.26; 95% CI: 2.09,5.09, p < 0.001  Significantly higher adherence rates were found for 5 of the 13 SOC examined individually  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  VA study; locally developed system; no patient-centered outcomes |
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| **Dexter, Perkins, Overhage, et al., 2001**  #5255 | **Geographical location:**  Indianapolis, IN  **Study dates:**  5/1/1997–10/31/1998  **General setting:**  Academic (urban public teaching hospital)  **Specific setting:**  Inpatient – non-ICU; mostly acute care  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  - Patients: 6371  - Inpatient teams: 8 (4 in the intervention group, 4 in the control group)  - Individual HCPs:  > MDs: 202  - Hospitalizations: 10,065  **User level of expertise/ proficiency:**  The study hospital already had computer-generated reminder systems | **Authors’ basic description of system:**  During the order-entry process, the system provided clinical-decision support to physicians and medical students by means of rule-based reminders, which were call care rules regarding the use of: (1) pneumococcal vaccination, (2) influenza vaccination, (3) aspirin for cardiovascular disease, and (4) prophylactic subcutaneous heparin.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Immunization  - Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage of hospitalizations during which therapy was ordered for an eligible patient—  Pneumococcal vaccine:  Intervention: 35.8%  Control: 0.8% (p < 0.001)  Influenza vaccine:  Intervention: 51.4%  Control: 1.0% (p < 0.001)  Subcutaneous heparin:  Intervention: 32.2%  Control: 18.9% (p < 0.001)  Aspirin at discharge:  Intervention: 36.4%  Control: 27.6% (p < 0.001)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Academic setting; locally developed system; site has a well-established health IT infrastructure and historically an early adopter of health IT |
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| **Dexter, Perkins, Maharry, et al., 2004**  #3730 | **Geographical location:**  Indianapolis, IN  **Study dates:**  11/1/199 –12/31/1999  **General setting:**  Academic  **Specific setting:**  Inpatient —non-ICU  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  General medical physician teams  **Duration of intervention:**  14 months  **Sample type(s) (with N randomized for each):**  - Patients: 3777  - Physician teams: 8  - Individual HCPs:  > Training MDs: 212  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized physician standing orders for influenza and pneumococcal vaccines were compared with computerized reminders to determine the impact on inpatient vaccination rates.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Immunization  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  1) Intervention: Computerized physician standing orders  2) Control: Computerized physician reminders | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Vaccine administration:  Influenza vaccinations, # (%)—  Reminder: 137 of 463 (30%)  Standing order: 163 of 385 (42%)  p < 0.001  Pneumococcal vaccinations, # (%)—  Reminder: 132/423 (31%)  Standing order: 209/406 (51%)  p < 0.001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Academic setting; no patient-centered outcomes  Site has a well-established health IT infrastructure and was an early adopter of health IT |
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| **Downs, Turner, Bryans, et al., 2006**  #2818 | **Geographical location:**  - Central Scotland  - London, England  **Study dates:**  1999–2002  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  General practices  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 13,068 registered patients  - Practices: 36 workshops, 10 control  **User level of expertise/ proficiency:** NR; practices had to be using EMIS or GPASS software for patient records | **Authors’ basic description of system:**  The decision support software was written inside the existing electronic medical record software and produced prompts for the investigation and management of dementia.  **Source/origin of system:**  Commercially available (EMIS or GPASS software for patient records)  **Content:**  *a) Objective(s):*  - Diagnosis  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  1) Electronic CD tutorial  2) Decision support software (DSS)  3) Small group workshops at the study practices  4) Control (no intervention) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Difference in # of patients aged ≥ 75 diagnosed with dementia before and after intervention (n = 280), with p-value compared to control—  Tutorial: 6.55 (p = 0.02)  DSS: 1.80 (p = 0.18)  Workshop: 7.31 (p = 0.01)  DSS (p = 0.01) and practice-based workshops (p = 0.01) both significantly improved rates of detection compared with control. There were no significant differences by intervention in the measures of concordance with guidelines.  The number of people identified as having dementia after the interventions represents 31% of all cases diagnosed in the practice-based workshops arm, 20% in the electronic tutorial arm, 30% in the DSS arm, and 11% in the control arm  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Study conducted in Scotland and England  Study practices part of a nationalized healthcare system  Commercially available system |
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| **Dykes, Carroll, Hurley, et al., 2010**  #15221 | **Geographical location:**  4 sites, Boston, Massachusetts, USA  **Study dates:**  January 1, 2009 to June 30, 2009  **General setting:**  - Academic  - Community  **Specific setting:**  Inpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 10264  - Clinics/practices/ hospitals: 8 units  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Fall prevention tool kit (FPTK) using health information technology (HIT) assesses fall risk and provides reminders to care providers.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  - Online access  - Paper-based  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** **NR**  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Adherence to protocol through assessment of Morse Falls Scale completion—  Control: 81%  Intervention: 94%  For all patients:  Baseline fall rate per 1000 patient days—  Control: 5.56  Intervention: 5.85  P = 0.61  Number of patients with falls per total number of patients—  Control: 87 of 5104  Intervention: 67 of 5160  P = 0.02  Total number of falls—  Control: 89  Intervention: 71  Number of repeat falls—  Control: 2  Intervention: 4  P = 0.46  Fall rate (95% CI) per 1000 patient-days—  Control: 4.64 (3.86 to 5.57)  Intervention: 3.48 (2.83 to 4.28)  P = 0.04  Fall rate (95% CI) per 1000 patient-days adjusted for site, sex, race, insurance, age—  Control: 4.18 (3.45 to 5.06)  Intervention: 3.15 (2.54 to 3.90)  P = 0.04  For patients aged < 65 years:  Baseline fall rate per 1000 patient days—  Control: 4.93  Intervention: 4.73  P = 0.81  Number of patients with falls per total number of patients—  Control: 36 of 2595  Intervention: 33 of 2405  P = 0.72  For patients aged ≥ 65 years:  Baseline fall rate per 1000 patient days—  Control: 5.22  Intervention: 5.97  P = 0.34  Number of patients with falls per total number of patients:  Control: 51 of 2509  Intervention: 34 of 2755  P = 0.004  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Fall prevention tool kit outputs were printed for 93.2% of patients.  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Specific details of the CDSS unclear  **Quality assessment:**  Overall rating: Fair  Comments:  No details provided on randomization process, blinding or concealment  Interventions not blinded  **Applicability/ generalizability:**  Studies were conducted in academic and community medical centers  All 4 sites used a single health care system, i.e. Partners Healthcare system  Multi-intervention makes it harder to assess the effectiveness of individual intervention leading to potential bias |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Eccles, McColl, Steen, et al., 2002**  #2  **Comparison 1 of 2** | **Geographical location:**  60 sites in Northeast England  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic disease management  **Study design:**  Before and after pragmatic cluster; pragmatic cluster randomized controlled trial using a 2 x 2 incomplete block design  **Unit of randomization:**  General practice  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  General practices: 62  **User level of expertise/ proficiency:**  Intervention practices were invited to send two members to a one-day workshop on using the system (training materials were supplied) | **Authors’ basic description of system:**  The system anticipated clinicians’ requirements by using information contained within a patient’s computerized record to trigger the guideline and present patient scenarios.  **Source/origin of system:**  Commercially available, adapted for this study’s purposes  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  1) Computerized guidelines for the management of asthma (with control patients for the management of angina)  2) Computerized guidelines for the management of angina (with control patients for the management of asthma) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Process of care for patients with asthma based on clinical records before and after introduction of computerized decision support system—  Number (%) of patients consulting before and after intervention period:  Intervention n = 1200  Control n = 1163  OR (95% CI)  Lung function assessed: All patients  I: 516 (43); 511 (43)  C: 492 (42); 517 (45)  OR: 0.94 (0.67 to 1.33)  Compliance checked: All patients  I: 426 (36); 442 (37)  C: 446 (38); 471 (41)  OR: 0.82 (0.58 to 1.15)  Inhaler technique assessed: All patients  I: 203 (17); 224 (19)  C: 234 (20); 262 (23)  OR: 0.8 (0.5 to 1.28)  Asthma education, action plan, or both: All patients  I: 79 (7); 60 (5)  C: 108 (9); 78 (7)  OR: 0.84 (0.4 to 1.74)  Smoking status known: All patients  I: 285 (24); 370 (32)  C: 305 (26); 367 (32)  OR: 0.97 (0.65 to 1.45)  Smoking cessation advice or nicotine replacement therapy: All patients  I: 57 (5); 81 (7)  C: 68 (6); 103 (9)  OR: 0.75 (0.45 to 1.26)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: “Levels of use of the software were low.”  - Implementation of CDSS/KMS: NR | **General comments:**  Authors note that the lack of effect associated with the DSS was probably due to low levels of use of the software.  **Quality assessment:**  Overall rating: Fair  Comments: Unblinded, outcomes assessment not validated, comparator introduces bias  **Applicability/ generalizability:**  Comparator (the same DSS but for a different condition) may bias the estimate in the direction of no difference  Study conducted in England  Study practices were chosen because their computer systems were extensively used |
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| **Eccles, McColl, Steen, et al., 2002**  #2  **Comparison 2 of 2** | **Geographical location:**  60 sites in Northeast England  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic disease management  **Study design:**  Before and after pragmatic cluster; pragmatic cluster randomized controlled trial using a 2 x 2 incomplete block design  **Unit of randomization:**  General practice  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  General practices: 62  **User level of expertise/ proficiency:**  Intervention practices were invited to send two members to a one-day workshop on using the system (training materials were supplied) | **Authors’ basic description of system:**  The system anticipated clinicians’ requirements by using information contained within a patient’s computerized record to trigger the guideline and present patient scenarios.  **Source/origin of system:**  Commercially available, adapted for this study’s purposes  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  1) Computerized guidelines for the management of asthma (with control patients for the management of angina)  2) Computerized guidelines for the management of angina (with control patients for the management of asthma) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Process of care for patients with angina based on clinical records before and after introduction of computerized decision support system  Number (%) of patients consulting before and after intervention period  Intervention n = 1117  Control n = 1218  OR (95% CI)  Blood pressure recorded: All patients  I: 859 (77); 889(80)  C: 935 (77); 969 (80)  OR: 1.01 (0.74 to 1.39)  Exercise recorded or advised: All patients  I: 99 (9); 113 (10)  C: 156 (13); 153 (13)  OR: 0.91 (0.55 to 1.50)  Weight recorded or advised: All patients  I: 253 (23); 282 (26)  C: 288 (24); 362 (30)  OR: 0.86 (0.54 to 1.35)  Smoking status known: All patients  I:222 (20); 243 (22)  C: 261 (22); 378 (32)  OR: 0.68 (0.42 to 1.11)  Smoking education given: All patients  I: 33 (3); 47 (4)  C: 41 (3); 48 (4)  OR: 1.08 (0.86 to 1.77)  12 lead electrocardiogram recorded: All patients  I: 162 (15); 154 (14)  C: 197 (16); 164 (14)  OR: 1.01 (0.68 to 1.52)  Exercise electrocardiogram recorded: All patients  I: 46 (4); 28 (3)  C: 46 (4); 30 (3)  OR: 1.01 (0.56 to 1.80)  Haemoglobin concentration recorded: All patients  I: 322 (29); 371 (33)  C: 355 (29); 400 (33)  OR: 1.01 (0.72 to 1.42)  Thyroid function recorded: All patients  I:192 (17); 214 (19)  C: 215 (18); 264 (22)  OR: 0.83 (0.62 to 1.12)  Cholesterol or other lipid concentrations recorded: All patients  I:395 (35); 482 (43)  C: 427 (35); 574 (47)  OR: 0.85 (0.65 to 1.12)  Blood glucose or HbA1c concentrations recorded: All patients  I: 221 (20); 300 (27)  C: 267 (22); 334 (27)  OR: 0.96 (0.67 to 1.39)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: “Levels of use of the software were low.”  - Implementation of CDSS/KMS: NR | **General comments:**  Authors note that the lack of effect associated with the DSS was probably due to low levels of use of the software.  **Quality assessment:**  Overall rating:Fair  Comments: Unblinded, outcomes assessment not validated, comparator introduces bias  **Applicability/ generalizability:**  Comparator (the same DSS but for a different condition) may bias the estimate in the direction of no difference  Study conducted in England  Study practices were chosen because their computer systems were extensively used |
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| **Emery, Morris, Goodchild, et al., 2007**  #1851 | **Geographical location:**  East Anglia, UK  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Practice  **Duration of intervention:**  12 months minimum  **Sample type(s) (with N randomized for each):**  Clinics: 45  **User level of expertise/ proficiency:**  Each intervention practice selected a clinician to serve as the “lead clinician,” and they received a 90-minute interactive training session to learn about the GRAIDS software | **Authors’ basic description of system:**  The GRAIDS software links a user-friendly pedigree-drawing tool to patient-specific management advice regarding a family history of breast/ovarian and colorectal cancer.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Other: referral for genetic counseling  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:* Not clearly described  *b) Delivery mode:* NR  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Cant’ tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  1) Intervention 1: Adaptive subgroup, with opportunity for practice to assess and resolve problems using the software  2) Intervention 2: Fixed subgroup, with no opportunity to assess and resolve problems using software  3) Comparison: “Best practice” (practitioners attended a 45-minute educational session on cancer genetics and received a copy of regional guidelines) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study or referral ordered: Practice referral rate, mean (SD) per 10,000 patients registered patients per year—  Intervention (n = 23): 6.2 (3.1)  Control (n = 22): 3.2 (2.8)  Mean difference: 3.0 referrals; 95% CI: 1.2, 4.8; p = 0.001  Referrals from GRAIDS practices were more likely to be consistent with referral guidelines (OR 5.2; 95% CI: 1.7, 15.8; p = 0.006)  Patients referred from GRAIDS practices had lower cancer worry scores at the point of referral (p = 0.02)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: The intervention increased GPs’ confidence in managing familial cancer  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Lead clinicians’ confidence in managing people with a family history of cancer increased significantly after training, and this increase was maintained at 12 months.  Their attitudes toward the software were generally positive, such that it was felt to be simple, easy, beneficial and cost-effective and these positive attitudes remained at 12 months. However, there was some reduction over time, in agreement with the statement that the software enhanced consultations (mean score 2.1 [0.8] post-training; 3.0 [1.7] at 12 months; mean change 0.8 95% CI 0.1 to 1.6; p = 0.04; n = 26) and persistent agreement that it would prolong consultations (mean score 2.5 [1.2] post training; mean score 2.3 [1.2] at 12 months).  Median consultation time with the lead clinician was 28 min.  - HCP use: Software used with patients 219 times, mean use of 8.27 per 10,000 registered patients per year (intervention only)  Software use at 12 months per 10,000 registered patients per year, mean, [SD]  Intervention 1 (adaptive practices): 8.8 [4.1]  Intervention 2 (fixed practices): 7.8 [4.7]  Mean difference 0.9; 95% CI (-2.8,  -4.8); p value = 0.60  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Incomplete and ambiguous reporting throughout  **Applicability/ generalizability:**  Study conducted in England  Unclear how DSS was integrated into practice  Commercially available system |
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| **Etchells, Adhikari, Cheung , et al., 2010**  #14484 | **Geographical location:**  Toronto, Ontario, Canada  **Study dates:**  February to May 2006  **General setting:**  Academic  **Specific setting:**  Inpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Other: critical abnormal results  **Duration of intervention:**  4 months  **Sample type(s) (with N randomized for each):**  - Patients: 108  - Events: 165 critical values  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Automated system for paging critical laboratory values from the laboratory information system directly to physician.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Alphanumeric pager  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: Median physician response time (IQR)—  Primary analysis: comparison of critical values with measurable response time (n = 165):  Intervention = 16 min (IQR 2–141)  Control = 39.5 min (IQR 7–104.5)  P = 0.33  Secondary analysis: comparison of critical values with documented time of order (n = 141):  Intervention = 12 min (IQR 1–124)  Control = 36 min (IQR 5–97)  P = 0.20  Secondary analysis: Comparison of critical values, using imputed data for missing values (n = 226):  Intervention = 30 min (IQR 2–155)  Control = 43 min (IQR 5–132)  P = 0.67  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  High dropout rate/exclusions  Learning bias  **Applicability/ generalizability:**  Single study conducted in an academic medical center  Short study duration  Residents were the targeted system users, and total number of subjects not disclosed |
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| **Feldstein, Elmer, Smith, et al., 2006**  #2858  **Comparison 1 of 2** | **Geographical location:**  Pacific Northwest, US  **Study dates:**  1999  **General setting:**  Community (nonprofit HMO)  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 327  - Clinics/practices/ hospitals: 15  - Individual HCPs:  > MDs: 159  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Patient-specific clinical guideline advice to the primary care provider delivered by electronic medical record (EMR) message versus electronic reminder to the provider plus an educational letter mailed to the patient.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  EMR reminders to physicians plus letter to patients  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  1) Usual care  2) EMR reminders to physician plus letter sent to patients  3) EMR reminders to physicians | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: See below.  - Recommended treatment ordered/prescribed: At 6 months, provider reminder resulted in 51.5% of patients receiving BMD measurement or osteoporosis medication. Provider reminder plus patient education resulted in 43.1%. Usual care resulted in 5.9% (p < 0.001). The effect of provider advice combined with patient education was not significantly different from provider advice alone (p = 0.88).  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT infrastructure and history of being an early adopter of health IT  Locally developed system  No patient-centered outcomes |
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| **Feldstein, Elmer, Smith, et al., 2006**  #2858  **Comparison 2 of 2** | **Geographical location:**  Pacific Northwest, US  **Study dates:**  1999  **General setting:**  Community (nonprofit HMO)  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 327  - Clinics/practices/ hospitals: 15  - Individual HCPs:  > MDs: 159  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Patient-specific clinical guideline advice to the primary care provider delivered by electronic medical record (EMR) message versus electronic reminder to the provider plus an educational letter mailed to the patient.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  EMR reminders only  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  1) Usual care  2) EMR reminders to physician plus letter sent to patients  3) EMR reminders to physicians | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: See below.  - Recommended treatment ordered/prescribed: At 6 months, provider reminder resulted in 51.5% of patients receiving BMD measurement or osteoporosis medication. Provider reminder plus patient education resulted in 43.1%. Usual care resulted in 5.9% (p < 0.001). The effect of provider advice combined with patient education was not significantly different from provider advice alone (p = 0.88).  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT infrastructure and history of being an early adopter of health IT  Locally developed system  No patient-centered outcomes |
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| **Feldstein, Smith, Perrin, et al., 2006**  #2502 | **Geographical location:**  NR  **Study dates:**  9/6/2004–12/20/2004  **General setting:** NR  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Primary care clinic  **Duration of intervention:**  14 weeks  **Sample type(s) (with N randomized for each):**  - Patients: 961  - Clinics: 15 (4 usual care, 4 EMR, 3 automated voice messages, 4 pharmacy team)  - Individual HCPs:  > MDs: 200  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The EMR intervention consisted of a patient-specific electronic message to the PCP from the chair of the patient safety committee. The message referenced internal and external guideline resources, recommended specific tests, and provided a sample letter that the PCP could send to the patient to request that he or she go to the laboratory.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS:  1) Usual care (UC)  2) EMR messages to PCP  3) Automated voice messages (AVM) to patients  4) Pharmacy team outreach | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: By day 9 (immediately before the second reminder)—  34 (14.3%) of 237 patients in the UC group, 61 (31.1%) of 196 patients in the EMR group, 117 (43.8%) of 267 patients in the AVM group, and 184 (70.5%) of 261 patients in the pharmacy team outreach group had completed all monitoring (p < 0.001)  All differences among arms were statistically significant at p < 0.05  At 25 days (approximately 2 weeks after the second reminder)—  EMR group: 95 (48.5%) of 196  AVM group: 177 (66.3%) of 267  Pharmacy team group: 214 (82.0%) of 261  UC: 53 (22.4%) of 237  All differences among arms were statistically significant at P < 0.05  Hazard ratios for completing laboratory monitoring compared with usual care—  EMR: 2.5 (95% CI: 1.8-3.5)  P value: <0.01  AVM: 4.1 (95% CI: 3.0-5.6)  P value: <0.01  Pharmacy team: 6.7 (95% CI: 4.9-9.0)  P value: <0.01  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:**  Patient satisfaction: The qualitative interviews found that all 3 interventions were acceptable to PCPs and patients.  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT infrastructure and EMR used since 1996  Locally developed system  Multiple relevant comparisons |
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| **Field, Rochon, Lee, et al., 2009**  #341 | **Geographical location:**  Canada  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Long-term facility  **Study design:**  RCT, parallel group  **Unit of randomization:**  Long-stay units  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Patients: 833  - Long-stay units: 22  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  We developed a CDSS built on a commercially purchased CPOE system that provided specific dose recommendations for long-term care residents with renal insufficiency.  The CDSS included 4 types of alerts: (1) alerts recommending maximum total daily dose of the medication, (2) alerts  recommending maximum frequency of administration, (3) alerts recommending that the medication be avoided, and  (4) alerts notifying prescribers that no creatinine clearance could be calculated for this resident because of missing  serum creatinine test results or weight .  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: RR (95% CI) for the alerts and overall, compared to control:  Dose: 0.95 (0.83, 1.1)  Frequency: 2.4 (1.4, 4.4)  Avoid: 2.6 (1.4, 5.0)  Missing info: 1.8 (1.1, 3.4)  Overall: 1.2 (1.0, 1.4)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Canadian study  Modified, commercially available system  Longstanding use of EHR and CPOE, and participants had prior experience with the CDSS |
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| **Fihn, McDonell, Vermes, et al., 1994**  #6979 | **Geographical location:**  5 sites in US  **Study dates:** NR  **General setting:**  Academic (2 university clinics and 3 VA clinics)  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 849 randomized, 19 withdrew; 620 with at least one visit where a recommendation was generated and a subsequent followup visit was completed  - Clinics: 5  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer-generated recommendations for scheduling next anticoagulation clinic visit.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Other: scheduling next clinic visit  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Not clearly described  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: NR  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: After adjusting for intensity of anticoagulation, the risks of bleeding and thromboembolic complications in the intervention group were not significantly different from those in the control group (RR = 1.1 [95% CI = 0.5, 2.3] and 2.1 [95% CI = 0.5, 8.4], respectively)  Three intervention patients and three control patients experienced a second complication during the study.  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Followup interval (weeks, mean ± SD)—  Intervention (n = 301)  Recommended: 5.5 ± 2.1  Scheduled: 4.4 ± 1.8  Actual: 4.4 ± 1.8  Control (n =3 19)  Recommended: 5.2 ±2.2  Scheduled: 3.5 ± 1.4  Actual: 4.1 ± 1.8  P < 0.05  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Number of visits with recommendation (n = 2472)—  Number of modifications (%)  Total: 992 (40)  Longer than recommended: 99 (10)  Shorter than recommended: 893 (90)  Mean length of modification (weeks)—  Longer than recommended: 2.2  Shorter than recommended: 3.5  Reason for modification (%)—  Scheduling convenience: 131 (13)  Interval not acceptable: 807 (81)  Other: 54 (5)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments: Inadequate reporting throughout; no intention-to-treat analysis  **Applicability/ generalizability:**  Insufficient reporting to determine generalizability of clinics; locally developed CDSS |
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| **Fiks, Hunter, Localio, et al., 2009**  #360 | **Geographical location:**  20 sites in the US from the Pediatric Research Consortium, a multistate, hospital-owned, primary care practice–based research  **Study dates:**  10/1/200–3/31/2007  **General setting:**  Academic and community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Pediatric practice  **Duration of intervention:**  - 6 months  **Sample type(s) (with N randomized for each):**  - Patients: 11,919  - Practices: 20  - Clinic visits: 23,418  **User level of expertise/ proficiency:**  All practices had previously implemented the ambulatory EHR EpicCare, and intervention sites received a presentation on how to use the system; physicians also received a copy of the presentation | **Authors’ basic description of system:**  Influenza vaccine alerts.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Immunization  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Captured opportunities for vaccination increased 3.8% from 12.7% to 16.3% at control practices and 4.8% from 14.4% to 19.2% at intervention sites, a difference of 1% (95% CI: -2.4% to 4.9%)  With standardization for selected covariates, overall rates of captured opportunities increased from 14.4% to 18.6% at intervention sites and from 12.7% to 16.3% at control sites, a 0.3% (95% CI: -1.9 to 2.5%) greater improvement  Rates of up-to-date influenza vaccination increased from 44.2% to 48.2% at control sites and from 45.0% to 53.0% at intervention sites, a 4.0% (95% CI: 1.3% to 9.1%) greater but not statistically significant improvement  With standardization for selected covariates, up-to-date vaccination rates increased similarly by 3.4% (95% CI:-1.4% to 9.1%), a statistically nonsignificant improvement  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Statistical analysis plan does not appear to differentiate between primary and secondary outcomes or to account for multiple tests. Authors’ conclusions don’t appear to be fully supported by the findings.  **Applicability/ generalizability:**  Primary care practice based research network;  commercially available system; no patient-centered outcomes |
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| **Filippi, Sabatini, Badioli, et al., 2003**  #4586 | **Geographical location:**  Italy  **Study dates:**  5/1/200 –11/30/2001  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 15,343 (7,313 control, 8,030 intervention)  - Individual HCPs:  > MDs, GPs: 300    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Electronic reminders to physicians for antiplatelet drug prescribing in diabetic patients.  **Source/origin of system:** NR  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Patients with antiplatelet drug prescription at the end of the followup—  Control: 2,242 (30.7%)  Intervention: 3,012 (37.5%)  (OR 1.99; 95% CI: 1.79, 2.22)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: Data showed that 128 of 150 GPs activated the electronic prompt  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Insufficient reporting on randomization, allocation concealment, outcomes assessment, blinding  **Applicability/ generalizability:**  Study conducted in Italy |
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| **Fitzmaurice, Hobbs, Murray, et al., 2000**  #5655 | **Geographical location:**  12 sites in Birmingham, England  **Study dates:**  02/1995–02/1996  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  Other RCT: 12 primary care practices randomized; patients also randomized, with 2 control groups (intrapractice and interpractice controls)  **Unit of randomization:**  - Clinic  - Patient  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Patients: 367  - Clinics: 12  **User level of expertise/ proficiency:**  Intervention clinicians received an afternoon session on practical instruction in the use of the CDSS and NPT and one on-site visit was provided | **Authors’ basic description of system:**  A novel, complete care package comprising near-patient testing (NPT) and CDSS for oral anticoagulation monitoring within nurse-led primary care clinics.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:* NR  *b) Delivery mode:* NR  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  1) Near-patient testing for INR along with CDSS  2) Two sets of control patients: (a) patients randomized to no intervention within intervention practices and (b) patients in practices allocated to no intervention | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Time spent in the INR range showed significant improvement for patients in the intervention group (p = 0.008)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: The intervention cost, on average, was approximately $160 per patient per year more than for controls  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments: Insufficient and ambiguous reporting of methods, atypical (and not clearly justified) selection of controls  **Applicability/ generalizability:**  Study conducted in England; multifaceted intervention; uncertain generalizability |
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| **Flanagan, Doebbeling, Dawson, et al., 1999**  #6163 | **Geographical location:**  Iowa  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, crossover  **Unit of randomization:**  Clinician  **Duration of intervention:**  10 months  **Sample type(s) (with N randomized for each):**  - Patients: NR  - Individual HCPs:  > MDs: 30  > Trainee MDs: 55  **User level of expertise/ proficiency:**  Nursing staff received 2 hours of training, and resident and staff physicians received 1 hour of training; both groups also received assistance during the first month of use | **Authors’ basic description of system:**  Online immunization reminders.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Immunization  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Online access  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Compliance with guidelines was improved significantly for tetanus and for hepatitis B in several analyses. No such effects were found for pneumococcal, measles, or influenza vaccines.  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: Those sessions involving physicians in the reminder arm were less likely to involve an order for a vaccine (p value < 0.0005, RR 0.73, 95% CI 0.60, 0.88) | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments: Inadequate and ambiguous reporting of methods and results; inappropriate analytical methods  **Applicability/ generalizability:**  Locally developed system  Crossover design, 5 months in each arm, in the course of a single year, without regard to flu season  Academic setting was a single institution |
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| **Flottorp, Oxman, Havelsrud, et al., 2002**  #4933 | **Geographical location:**  Norway  **Study dates:**  1/1/2000–1/31/2001  Intervention: 5/2000–1/2001  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  General practices  **Duration of intervention:**  7 to 8 months  **Sample type(s) (with N randomized for each):**  Practices: 142  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The Mediata software also included an interactive decision support application and a tool to collect additional data from pop-up screens that were triggered when a diagnosis code for a sore throat or urinary tract infection was entered into a patient’s record.  The main components of the tailored interventions were patient educational material, computer based decision support and reminders, an increase in the fee for telephone consultations, and interactive courses for general practitioners and practice assistants.  **Source/origin of system:**  Commercially available    **Content:**  *a) Objective(s):*  Acute disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:* NR  **Information delivery:**  *a) Delivery format:* NR  *b) Delivery mode:* NR  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: NR  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  Practices randomized to DSS for sore throat vs UTI | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Use of laboratory testing—  “The absolute reduction in the proportion of consultations for urinary tract infection where a laboratory test was ordered for urinary tract infections was 5.1% greater in the intervention group. No significant differences were found between the groups for use of laboratory tests for sore throat.”  - Recommended treatment ordered/prescribed: Use of antibiotics—  “The absolute reduction in the proportion of consultations where antibiotics were prescribed for sore throat was 3.0% greater in the intervention group. For patients with urinary tract infection there was little change in the proportion of consultations where antibiotics were prescribed in both the intervention group (-0.2%) and the control group (0.2%).”  - Impact on user knowledge: NR  From the text: “Passively delivered, complex interventions targeted at identified barriers to change had little effect in changing practice.”  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments: Inadequate reporting throughout; nonvalidated outcome assessments  **Applicability/ generalizability:**  Study conducted in Norway; multifaceted intervention with short followup period; very little information provided on CDSS |
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| **Fordham, McPhee, Bird, et al., 1990**  #7227  **AND**  **McPhee, Bird, Jenkins, et al., 1989**  #7279 | **Geographical location:**  San Francisco, CA  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  - Patients  - Training MDs: 62  **User level of expertise/ proficiency:**  Faculty oriented each resident to the reminders, explained their purpose, and demonstrated how to use them | **Authors’ basic description of system:**  A reminder was generated for each patient encounter; reminders displayed the list of appropriate cancer screening procedures (based on the patient’s age and sex), the recommended testing intervals, the last performances date, the due date for each test, and the patient’s “due” status.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS  3 arms:  1) Cancer screening reminders  2) Audit with feedback  3) No intervention (control) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  Cancer screening reminders—  FOBT b coefficient 19.0 (p = 0.002)  Rectal b coefficient 22.6 (p < 0.001)  Sigmoidoscopy b coefficient 31.3 (p = 0.002)  Pap smear b coefficient 34.8 (p = 0.122)  Pelvic exam b coefficient 20.5 (p = 0.004)  Breast exam b coefficient 24.3 (p = 0.001)  Mammogram b coefficient 15.7 (p = 0.040)  Audit with feedback—  FOBT b coefficient 12.3 (p = 0.048)  Rectal b coefficient 14.0 (p = 0.020)  Sigmoidoscopy b coefficient -1.2 (p = 0.899)  Pap smear b coefficient 29.5 (p = 0.198)  Pelvic exam b coefficient 10.4 (p = 0.140)  Breast exam b coefficient 25.3 (p = 0.001)  Mammogram b coefficient 20.6 (p = 0.008)  Patient education—  Breast exam b coefficient 2.3 (p = 0.679)  Mammogram b coefficient 16.7 (p = 0.009)  Constant—  FOBT b coefficient 54.7 (p<0.001)  Rectal b coefficient 40.7 (p<0.001)  Sigmoidoscopy b coefficient 21.8 (p = 0.009)  Pap smear b coefficient 108.5 (p<0.001)  Pelvic exam b coefficient 26.5 (p = 0.01)  Breast exam b coefficient 37.9 (p = 0.001)  Mammogram b coefficient 34.3 (p<0.001)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Not blinded; contamination; loss of followup for graduating residents  **Applicability/ generalizability:**  One academic residency program  Paper-based medical record system in 1990 |
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| **Fortuna, Zhang, Ross-Degnan, et al., 2009**  #265  **Comparison 1 of 2** | **Geographical location:**  14 sites in Massachusetts  **Study dates:**  3/11/2007–3/10/2008  **General setting:**  - Academic  - Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic sites  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Clinic sites: 14  - Individual HCPs:  > Clinicians, internal medicine including MDs, NPs, and PAs: 257  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized prescription alerts embedded in an EHR to reduce the prescribing of heavily marketed hypnotic medications in the ambulatory setting.    **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Alerts only group  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  1) Computerized alerts only  2) Computerized alerts plus physician-led educational sessions  3) Control—neither alerts nor educational sessions | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescriptions for heavily marketed medications—  Control group:  Intervention period RR (95% CI): 1.27 (1.05, 1.54)  Intervention period adjusted RR (95% CI): 1.31 (1.08, 1.60)  Ratio of RR (95% CI): 1.0  Alert group:  Intervention period RR (95% CI): 0.99 (0.84, 1.17)  Intervention period adjusted RR (95% CI): 0.97 (0.82, 1.14)  Ratio of RR (95% CI): 0.74 (0.57, 0.96)  Alert + Education group:  Intervention period RR (95% CI): 1.03 (0.89, 1.21)  Intervention period adjusted RR (95% CI): 0.98 (0.83, 1.17)  Ratio of RR (95% CI): 0.74 (0.58, 0.97)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  Postimplementation survey (89 clinicians eligible, 51 responded) (% agree)—  - HCP acceptance: Alerts changed my prescribing decision(s): 11 (23%) (95% CI: 12 to 37%)  - HCP satisfaction: Alerts did not interfere with workflow: 35 (70%) (95% CI: 55 to 82%)  Alerts prompted me to spend more time discussing alternative treatments with my patient(s): 24 (47%) (95% CI: 33 to 62%)  Alerts provided useful evidence to support prescribing decisions: 43 (88%) (95% CI: 75 to 95%)  Alerts provided useful patient education materials regarding insomnia: 40 (83%) (95% CI: 70 to 93%)  Alerts increased my awareness of hypnotic medication costs: 35 (71%) (95% CI: 57 to 83%)  - HCP use: 89 of 257 internal medicine clinicians included in the study received at least one alert  - Implementation of CDSS/KMS: NR | **General comments:**  Authors concluded that computerized decision support is an effective tool to reduce the prescribing of heavily marketed hypnotic medications in ambulatory settings  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Commercially available system with locally developed modifications  Desired outcome was reduction in number of prescriptions  Sites have used an Epic EHR for all ambulatory patient encounters since 1997 |
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| **Fortuna, Zhang, Ross-Degnan, et al., 2009**  #265  **Comparison 2 of 2** | **Geographical location:**  14 sites in Massachusetts  **Study dates:**  3/11/2007–3/10/2008  **General setting:**  - Academic  - Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic sites  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Clinic sites: 14  - Individual HCPs:  > Clinicians, internal medicine including MDs, NPs, and PAs: 257  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized prescription alerts embedded in an EHR to reduce the prescribing of heavily marketed hypnotic medications in the ambulatory setting.    **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Alerts plus educational sessions  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  1) Computerized alerts only  2) Computerized alerts plus physician-led educational sessions  3) Control—neither alerts nor educational sessions | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescriptions for heavily marketed medications—  Control group:  Intervention period RR (95% CI): 1.27 (1.05, 1.54)  Intervention period adjusted RR (95% CI): 1.31 (1.08, 1.60)  Ratio of RR (95% CI): 1.0  Alert group:  Intervention period RR (95% CI): 0.99 (0.84, 1.17)  Intervention period adjusted RR (95% CI): 0.97 (0.82, 1.14)  Ratio of RR (95% CI): 0.74 (0.57, 0.96)  Alert + Education group:  Intervention period RR (95% CI): 1.03 (0.89, 1.21)  Intervention period adjusted RR (95% CI): 0.98 (0.83, 1.17)  Ratio of RR (95% CI): 0.74 (0.58, 0.97)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  Postimplementation survey (89 clinicians eligible, 51 responded) (% agree)—  - HCP acceptance: Alerts changed my prescribing decision(s): 11 (23%) (95% CI: 12 to 37%)  - HCP satisfaction: Alerts did not interfere with workflow: 35 (70%) (95% CI: 55 to 82%)  Alerts prompted me to spend more time discussing alternative treatments with my patient(s): 24 (47%) (95% CI: 33 to 62%)  Alerts provided useful evidence to support prescribing decisions: 43 (88%) (95% CI: 75 to 95%)  Alerts provided useful patient education materials regarding insomnia: 40 (83%) (95% CI: 70 to 93%)  Alerts increased my awareness of hypnotic medication costs: 35 (71%) (95% CI: 57 to 83%)  - HCP use: 89 of 257 internal medicine clinicians included in the study received at least one alert  - Implementation of CDSS/KMS:NR | **General comments:**  Authors concluded that computerized decision support is an effective tool to reduce the prescribing of heavily marketed hypnotic medications in ambulatory settings  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Commercially available system with locally developed modifications  Desired outcome was reduction in number of prescriptions  Sites have used an Epic EHR for all ambulatory patient encounters since 1997 |
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| **Frame, Zimmer, Werth, et al., 1994**  #6941 | **Geographical location:**  Dansville, NY  **Study dates:**  1991–1992  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  Patients: 1665  **User level of expertise/ proficiency:**  2-hour provider instruction session was conducted by PI to teach providers how to use the computer-based system and the manual system | **Authors’ basic description of system:**  A computer-based health maintenance tracking system that generates annual provider and patient reminders to all patients.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Initiating discussion with patient  - Preventive care  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:*  Allowed providers to specify or cancel sending patient reminders; including dates; protocols were modifiable without the assistance of programmers | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Estimated operating costs of operating the intervention for the generation of 1,000 patient and provider reminders—  Patient reminders: $545.03  Provider reminders: $234.73  Cost of maintaining the computer system and generating patient and provider reminders—  Per patient: $0.78  Billings—  C: (n = 837)  Preintervention 1990: $48,150  Intervention 1991: $55,823  Intervention 1992: $57,014  I (n = 829):  Preintervention 1991: $54,834  Intervention 1991: $58, 201  Intervention 1992: $57,604  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Among active (n = 1324) and inactive patients (n = 145), overall mean baseline compliance for all 11 procedures was 52%  Change in overall provider compliance for initially active patients (n = 1324)—  C = 3.3%  I = 13.5%  P < 0.001  Change in overall provider compliance for initially inactive patients (n = 145)—  C = 13.5%  I = 27.1%  P = 0.02  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Provider compliance for individual procedures (11) available in article  Multiple interventions; provider reminders and patient reminders  Outcome for patient adherence was not reported  **Quality assessment:**  Overall rating: Fair  Comments:  Blinding and concealing methods not clearly described; baseline characteristics unknown; no followup data  **Applicability/ generalizability:**  Computer application, HTRAK, was built using legacy systems  Rural and lower-middle class population |
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| **Frank, Litt, and Beilby, 2004**  #4200 | **Geographical location:**  South Australia, Australia  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Acute and chronic  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 10,507 (I = 5,118,C = 5,389)  - Individual HCPs:  > MDs, 10 GPs  **User level of expertise/ proficiency:**  GPs had used computer medical records for 8 years | **Authors’ basic description of system:**  Opportunistic electronic reminders for preventive care in general practice.  **Source/origin of system:** NR  **Content:**  *a) Objective(s):*  - Immunization  - Preventive care  *b) Relationship to point of care:* NR  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:* NR  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Opportunities taken for preventive activity; relative changes (RC) in preventive activity performed (95% CI)—  Tetanus immunization:  C = 222 of 15,089 (1.5%)  I = 333 of 11,947 (2.8%)  RC = 1.89 (1.59, 2.25)  Recording of allergies:  C = 682 of 13,713 (5.0%)  I = 991 of 10,991 (9.0%)  RC = 1.81(1.63, 2.02)  Pneumococcal immunization:  C = 39 of 2370 (1.6%)  I = 58 of 2079 (2.8%)  RC = 1.70 (1.10,2.62)  Recording of weight:  C = 567 of 11,592 (4.9%)  I = 654 of 10,476 (6.2%)  RC = 1.28 (1.13, 1.44)  Measles, mumps, and rubella immunization:  C = 43 of 523 (8.2%)  I = 46 of 446 (10.3%)  RC = 1.25 (0.82, 1.93)  Smoking status:  C = 171 of 9407 (1.8%)  I = 181 of 8908 (2.0%)  RC = 1.12 (0.90, 1.39)  Cervical smear:  C = 348 of 4833 (7.2%)  I = 343 of 4387 (7.8%)  RC = 1.09 (0.91, 1.29)  Blood pressure:  C = 666 of 4404 (15.1%)  I = 677 of 4370 (15.5%)  RC = 1.02 (0.90, 1.16)  Diabetes screening:  C = 47 of 1900 (2.5%)  I = 45 of 1858 (2.4%)  RC = 0.98 (0.65, 1.48)  Influenza immunization:  C = 248 of 912 (27.2%)  I =245 of 935 (26.2%)  RC = 0.96 (0.78, 1.18)  Lipid screening:  C = 215 of 7929 (2.7%)  I = 176 of 7268 (2.4%)  RC = 0.89 (0.73, 1.09)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Possible concealment issues because GPs were not blinded; no followup  **Applicability/ generalizability:**  The use of Royal Australian College of General Practitioners’ Guidelines |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Fretheim, Aaserud, Oxman, 2006**  #2688  **AND**  **Fretheim, Oxman, Havelsrud, et al., 2006**  #2689 | **Geographical location:**  Oslo, Norway  Tromso, Norway  **Study dates:**  May 2002–Dec 2003  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients:  > Choice of antihypertensive drug  (1,968 + 2,184 = 4,152)  > Achievement of treatment goals (17,123 + 16,593 = 33,716)  > Started on medication for hypertension and/or hypercholesterolemia (3,316 + 2,863 = 6,179)  - Clinics/practices/ hospitals: 146 practices (C = 73, I = 73)  - Individual HCPs:  > MDs: 501 (257 intervention, 244 control)    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized reminders present the physicians with performance of risk estimation and choice of drugs after being triggered by elevated blood pressure or low density lipoprotein in patients.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y  *e) Other:*  Supplementary materials for patients were available for print out | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Cardiovascular risk assessment done—  C = 112 of 768 (14.6%)  I = 147 of 854 (17.2%)  ICC = 0.39  RR (95% CI) = 1.04 (0.60, 1.71)  P = 0.90  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescribing of thiazides for hypertension—  C = 218 of 1968 (11.1%)  I = 378 of 2184 (17.3%)  ICC = 0.087  RR (95% CI) = 1.94 (1.49, 2,49)  P < 0.001  Secondary outcomes: Prescribing of thiazides and beta blockers—  C = 632 of 1968 (32.1%)  I = 889 of 2184 (40.7%)  ICC = 0.073  RR (95% CI) = 1.41 (1.27, 1.56)  P < 0.001  Prescribing of angiotensin II receptor blockers and alpha blockers—  C = 945 of 1968 (48.0%)  I = 876 of 2184 (40.1%)  ICC = 0.084  RR (95% CI) = 1.21(1.101.30)  P < 0.001  Treatment goals achieved—  C = 6,056 of 16,593 (36.5%)  I = 5,502 of 17,123 (32.0%)  ICC = 0.026  RR (95% CI) = 0.98(0.93, 1.02)  P = 0.33  Secondary outcomes: Treatment goal achieved among diabetes patients—  C = 994 of 2950 (33.7%)  I = 905 of 2875 (31.5%)  ICC = 0.028  RR (95% CI) = 0.96 (0.87,1.06)  P = 0.46  Treatment goal for hypertension achieved—  C = 3,310 of 10,564 (31.3%)  I = 3,073 of 11,308 (27.2%)  ICC = 0.032  RR (95% CI) = 1.00 (0.95, 1.06)  P = 0.89  Treatment goal for cholesterol achieved—  C = 3,770 of 7711 (48.9%)  I = 3,545 of 7815 (45.4%)  ICC = 0.040  RR (95% CI) = 0.97 (0.91, 1.02)  P = 0.23  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Net annual cost (cost minimization) in study population = $53,395  Net annual savings in a national program after 2 years = $761,998; per practice = $540  - Cost-effectiveness: The cost effectiveness of the intervention was estimated as the cost per additional patient being started on thiazides  Net annual cost (cost minimization) in study population per practice = $454; cost-effectiveness = $183  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Investigators assessing outcomes and conducting analyses were blinded  Block randomization with software allocation  Multifaceted intervention that included educational outreach, audit and feedback, and computerized reminders—not possible to say which component contributed to the overall effectiveness of the intervention  This was a multifaceted intervention that included a comparison with baseline data captured 1 year prior to the intervention  **Applicability/ generalizability:**  Guidelines for antihypertensive and cholesterol-lowering drugs for the prevention of cardiovascular disease may vary in other countries.  Study conducted in Norway  Practices had to use one of two EHR systems that were compatible with the intervention software |
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| **Gill, Chen, Glutting, et al., 2009**  #181 | **Geographical location:**  35 sites in US  **Study dates:**  Nov 1, 2005–Oct 31, 2006  **General setting:**  - Academic  - Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 64,150  - Clinics/practices/ hospitals: 25 offices  - Individual HCPs:  > Training MDs and  > MDs in general internal medicine, family medicine, general practice: 105  **User level of expertise/ proficiency:**  Physicians used centricity EMR for at least 1 year before intervention | **Authors’ basic description of system:**  EMR-based intervention for lipid management in a network of primary care practices. This intervention integrated nationally recognized guidelines (specifically the ATP-III guidelines) into the EMR and included prompts at the point of care.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Lab test ordering  - Chronic disease management  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:*  Supplementary materials (reporting tools, access to guidelines, Web sites for patient or physician education, document counseling) | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Proportion of patients tested adequately for hyperlipidemia—  Univariate analysis:  High risk  I = 81.2  C = 77.9  Moderate risk  I = 89.8  C = 89.9  Low risk  I = 63.0  C = 65.2  The likelihood of lipid testing increased significantly from baseline to end point for all groups except for the high-risk control group.  Multivariate analysis:  High risk (n = 2,081) OR = 15.00 (P < 0.05)  Moderate risk (n = 1286) OR = 1.47  Low risk (n = 14,384) OR = 0.97  - Recommended diagnostic study ordered/completed: NR  - Recommended treatment ordered/prescribed: Proportion of high-risk patients who were prescribed lipid-lowering medications—  Univariate analysis:  I = 70.1  C = 62.8  Multivariate analysis:  High risk (n = 663) OR = 0.05  Proportion of patients whose most recent low-density lipoprotein cholesterol was at goal (< 100 for high risk, < 130 for moderate risk, < 160 for low risk)—  Univariate analysis:  High risk  I = 53.3  C = 56.1  Moderate risk  I = 64.7  C = 68.5  Low risk  I = 87.9  C = 90.9  The proportion of patients at lipid goal in creased significantly for all groups except the moderate-risk intervention group.  The proportion of high-risk patients on medication if not at goal increased significantly for both the intervention and control groups.  Multivariate analysis:  High risk (n = 4043) OR = 1.17  Moderate risk (n = 2383) OR = 0.29  Low risk (n = 1955) OR = 1.74  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  Moderate baseline differences in provider and patient characteristics  Blinding and concealment methods unknown  No followup  Randomization by block  Several authors consulted for, or were employed by, the EHR vendor  Included a comparison with baseline data captured 1 year prior to the intervention  **Applicability/ generalizability:**  Geographic location of clinics unknown  Physician practices were recruited through a consortium of offices that used a specific outpatient EHR  Included resident physicians |
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| **Gilutz, Novack, Shvartzman, et al., 2009**  #745 | **Geographical location:**  Israel  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  6 to 36 months  **Sample type(s) (with N randomized for each):**  - Patients: 7448  - Clinics/practices/ hospitals: 112 clinics  - Individual HCPs:  > MDs:  I = 204 GPs  C = NR  > Nurses  I = 396  C = NR  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The CDSS was programmed to automatically detect patients with coronary artery disease (CAD) and to evaluate the availability of an updated lipoprotein profile and treatment with lipid-lowering drugs. The program produced automatic computer-generated monitoring and treatment recommendations.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Chronic disease management  - Preventive care  *b) Relationship to point of care:*  Not clearly described  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:*  Data integration from hospital discharge diagnosis database, laboratory database, and Clalit Health Services central pharmacy database | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: All cardiovascular-related rehospitalization (major and nonmajor cardiac effects) and all-cause mortality during the first year—  C = 59.2%  I = 57.1%  P < 0.03  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Appropriate lipoprotein monitoring (n = 7448)—  I = 54.8%  C = 48.7%  P < 0.001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Medication initiation recommended for patients with LDL levels above 110 mg/dL—  I = 59.1%  C = 53.7%  P < 0.003  Patient compliance with statin treatment—  N = 28% of patients taking clinically meaningful dose of lipid-lowering drugs  < 25% of expected number of pills: 47%  25 to 49% of expected pills: 17%  50 to 75% of expected pills: 8%  > 75% of expected pills: 28%  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  CDSS intervention not clearly described  **Quality assessment:**  Overall rating: Poor  Comments:  More patients with MI (P = 0.004) and percutaneous coronary intervention (P = 0.019) in the intervention arm  All-cause mortality data stated but not reported  Blinding and concealment not reported  Only followup data is presented  **Applicability/ generalizability:**  Locally developed CDSS implemented in multiple clinics  Study conducted in Israel  6-month followup period |
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| **Goud, de Keizer, ter Riet, et al., 2009**  #490 | **Geographical location:**  21 sites in Netherlands  **Study dates:**  January 2005–July 2006  **General setting:**  - Academic  - Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Other outpatient centers  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 2787  - Clinics/practices/ hospitals: 21  **User level of expertise/ proficiency:**  All multidisciplinary cardiac rehabilitation teams received a standardized training course, designed by the investigators, during which both the control and intervention  versions of CARDSS were demonstrated to  all teams | **Authors’ basic description of system:**  CARDSS assists in formulating  a patient specific rehabilitation program by providing computerized decision support: it automatically shows whether each of the four treatments is recommended by the guidelines, on the basis of the patient’s needs assessment data. On request, CARDSS provides the rationale behind its recommendations and links to relevant research evidence.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Chronic disease management  - Preventive care  *b) Relationship to point of care:*  - Synchronous  - Asynchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Paper-based  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Concordance with guideline recommendations:  Exercise—  C: 933 of 1102 (84.7%)  I: 1,508 of 1629 (92.6%)  Adjusted difference 3.5 (95% CI: 0.1 to 5.2)  Concordance with the guideline for exercise therapy was higher in the control group than had been estimated in the sample size calculation, but it was much lower than estimated for the relaxation and lifestyle change therapy.  The adjusted difference between the control arm and intervention arm in undertreatment was 42.8% (95% confidence interval 1.1% to 68.0%) for relaxation therapy and 25.8% (14.9% to 33.6%) for education therapy, in favor of the intervention arm. There was found a significant difference for overtreatment with exercise therapy.  In the intervention arm, lack of sufficient facilities was another important reason for nonconcordance with recommendations about lifestyle change (160 of 686) and relaxation therapy (68 of 651)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: In the intervention arm, patients’ refusal was reported as the main reason for nonconcordance with recommendations for exercise (77 of 121), education (127 of 199), relaxation (407 of 651), and lifestyle change (381 of 686)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Unknown followup data  **Applicability/ generalizability:**  Multicenter trials only took place in Netherlands  Participants received incentives such as reimbursement of the purchasing costs of CARDSS, free training, and helpdesk services |
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| **Graumlich, Novotny, Nace, et al., 2009A**  #347  **AND**  **Graumlich, Novotny, Nace, et al., 2009B**  #218 | **Geographical location:**  Central Illinois  **Study dates:**  Nov 2004–Jan 2007  **General setting:**  Academic  **Specific setting:**  Inpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  26 months  **Sample type(s) (with N randomized for each):**  - Patients: 631  - Individual HCPs:  > Training MDs [internal medicine]:  Postgraduate year 1: 41  Postgraduate years 2 to 4: 17  > MDs [internal medicine]: 12    **User level of expertise/ proficiency:**  Physicians assigned to discharge software completed additional training via multimedia demonstration with one-on-one coaching as needed | **Authors’ basic description of system:**  The CPOE application included basic levels of clinical decision support to facilitate communication at the time of hospital discharge to patients, retail pharmacists, and community physicians.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Other—discharge planning  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  Not clearly described  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:* Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:*  System did not perform error checking to warn about pending tests, drug-drug interactions, therapeutic duplications, or missing items (e.g., immunizations, drugs, education) | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Readmitted within 6 months (Control = 315, Intervention = 316)—  Control: 119 (37.8%)  Intervention: 117 (37.0%)  P value: 0.897  Parameter estimate without cluster correction intervention coefficient (95% CI) = -0.005 (-0.076 to 0.067)  P value: 0.894 (adjusted)  Parameter estimate with cluster correction intervention coefficient (95% CI) = -0.005 (-0.074 to 0.065)  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: Adverse event within 1 month—  Control: 23 (7.3%)  Intervention: 23 (7.3%)  P value: 0.886 (95% CI: -0.037 to 0.043)  P value: 0.884 (95% CI: -0.037 to 0.043) (adjusted)  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: Effort for discharge planning—  Mean (SD)  Control: 7.9 (2.1)  Intervention: 6.5 (1.9)  Difference (95% CI) = 1.4 (0.3 to 2.4)  P value: 0.011  **4) Impact on relationship-centered outcomes:**  - Patient satisfaction: Patient perception of discharge preparedness—  Mean (SD)  Control: 17.2 (4.0)  Intervention: 17.7 (4.1)  P value: 0.040 (95% CI: 0.006 to 0.288)  P value: 0.042 (95% CI: 0.005 to 0.289) (adjusted)  \* When patient perception of discharge preparedness was the dependent variable, then physician level of training had a nonsignificant coefficient  (P > 0.219)  Patient satisfaction with medication information score—  Mean (SD)  Control: 12.1 (4.6)  Intervention: 12.3 (4.8)  P value: 0.587 (95% CI: -0.987 to 0.544)  P value: 0.567 (95% CI: -0.937 to 0.513) (adjusted)  \* Physician level of training was  nonsignificant in models of patient satisfaction with medication information (P > 0.068)  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Physician satisfaction—  Mean (SD)  Control: 7.9 (1.4)  Intervention: 7.4 (1.4)  P value: 0.129 (95% CI: -0.2 to 1.3)  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  CDSS was not integrated with EMR as intended, resulting in physicians having to enter patient data twice; this may have affected generalizability on physicians’ behavior.  Hospital had a standard medication reconciliation process in place  Academic setting |
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| **Greiver, Drummond, White, et al., 2005**  #9046 | **Geographical location:**  Toronto, Ontario, Canada  **Study dates:**  Mid Nov 2001–mid June 2002  **General setting:**  - Academic  - Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  - Patients: 65  - Individual HCPs:  > MDs: 17 (family medicine)  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  PDA software application assesses patient’s risk of angina, using Diamond-Forrester risk-stratification model, and suggests appropriate diagnostic management.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system (PDA)  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Test given appropriately—  Cardiac stress testing:  Control: 8 (28.6%)  Intervention: 18 (48.6%)  P value: (with 95% CI) = 0.28  (-11.54% to -51.4%)  Nuclear cardiology testing:  Control: 5 (45.5%)  Intervention: 17 (63%)  P value: (with 95% CI) = 0.4 (-13.9% to 48.9%)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: Increase use of cardiac stress testing due to PDA use (81% vs 50%) | **General comments:**  Experiment not adequately described  **Quality assessment:**  Overall rating: Poor  Comments:  Blinding and concealment not reported  Baseline characteristics not reported  Unknown randomization method  Unknown followup data  **Applicability/ generalizability:**  Small sample size  Many physicians belonged to a research network |
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| **Gurwitz, Field, Rochon, et al., 2008**  #840 | **Geographical location:**  - Connecticut, US  - Ontario, Canada  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Long-term facility  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Other—resident care units  **Duration of intervention:**  Site 1 – 1 year  Site 2 – 6 months  **Sample type(s) (with N randomized for each):**  - Patients: 1118  - Other: 29 resident care units  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized provider order entry with clinical decision support for preventing adverse drug events in long-term care.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y- Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: NR  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: All adverse drug events—  C = 340 (100%)  Rate/100 resident-years = 10.4  I = 411 (100%)  Rate/100 resident-years = 10.8  Rate ratio = 1.06  95% CI = 0.92 to 1.23  Preventable—  C = 126 (30.7%)  Rate/100 resident-years = 3.9  I = 152 (37.0%)  Rate/100 resident-years = 4.0  Rate ratio = 1.02  95% CI = 0.81 to 1.30  More severe—  C = 97 (28.5%)  Rate/100 resident-years = 3.0  I = 123 (30.0%)  Rate/100 resident-years = 3.2  Rate ratio = 1.07  95% CI = 0.82 to 1.40  Preventable more severe—  C = 58 (17.1%)  Rate/100 resident-years = 1.8  I = 79 (19.2%)  Rate/100 resident-years = 2.1  Rate ratio = 1.15  95% CI = 0.82 to 1.61  Less severe—  C = 24 3(71.5%)  Rate/100 resident-years = 7.5  I = 288 (70.1%)  Rate/100 resident-years = 7.6  Rate ratio = 1.06  95% CI = 0.89 to 1.26  Preventable less severe—  C = 68 (20.0%)  Rate/100 resident-years = 2.1  I = 73 (17.8%)  Rate/100 resident-years = 1.9  Rate ratio = 0.92  95% CI = 0.66 to 1.28  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Possible crossover contamination  Unknown followup cases  Only age as baseline characteristics  **Applicability/ generalizability:**  Baseline characteristics not reported  No comorbid conditions or chronic disease reported  Locally developed system implemented in two different geographic areas |
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| **Hamilton, Platt, Gauthier, et al., 2004**  #4244 | **Geographical location:**  7 sites in US and Canada  **Study dates:**  Feb 1, 1999–March 31, 2001  **General setting:**  Academic  **Specific setting:**  Inpatient–non-ICU  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Other—centers  **Duration of intervention:**  25 months  **Sample type(s) (with N randomized for each):**  - Patients: 4993  - Clinics/practices/ hospitals: 7  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The computer calculates the contraction frequency automatically from the obstetrical monitor that records the mother’s contractions and the baby’s heart rate, and the computer then displays a graph of the measured dilation, as well as a percentile comparison to the reference population using the mathematical model.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:* Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  Control: without reference range  Intervention: with reference range | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Apgar scores reported at 1 and 5 minute intervals after birth by categories 0-2, 3-4, 5-6, 7-8, 9-10; no significant differences reported between the control and intervention group (p value > 0.41 for all comparisons)  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: Primary outcome: rates of caesarian section (CS)—  Pretest-posttest analysis: CS fell from 1124 of 5753 (19.54%) in all eligible women in the year preceding the trial to 551 of 3234 (17.04%) (p = 0.004) by 6 months; and to 923 of 5554 (16.62%) by 12 months (p = 0.00006) | **General comments:**  How many centers within each of the hospitals?  **Quality assessment:**  Overall rating: Fair  Comments:  Blinding and concealment not clearly described  Baseline characteristics unknown  **Applicability/ generalizability:**  Reliability and ranges of the model |
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| **Harpole, Khorasani, Fiskio, et al., 1997**  #6439 | **Geographical location:**  Boston, MA  **Study dates:**  - Phase 1: Aug 1–Sept 30, 1995  - Phase 2: Nov 10, 1995–March 21, 1996  **General setting:**  Academic  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  \* Unclear if ICU or non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Orders  **Duration of intervention:**  (Nonrandomized) Phase 2: 19 weeks  **Sample type(s) (with N randomized for each):**  - Patients: 491 (Phase 2)  - Individual HCPs:  > Training MDs  > MDs: 127 (85 medicine physicians, 42 surgical physicians)  > Nurses: 109  - Other: 864 films  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Real-time critiquing about the appropriateness of abdominal radiographs (KUB) during the use of POE system by physicians.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Other—radiograph ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Control: Phase 1 critique message  2) Intervention: amended evidence-based critique message | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: No differences in the rate of cancellation of low-yield films, change to suggested view(s), or results of low-yield films between the two randomized groups; no statistical test or details reported for these differences  Phase 2 results:  N (95% CI)  KUB receiving ≥1 critique = 385 of 864 (45% ± 3%)  Low-yield KUB cancelled = 10 of 283 (4% ± 2%)  KUB orders changed to suggested views = 96 of 176 (55% ± 7%)  Findings of films for Phase 2 only—  Positive:  Low-yield films = 12 of 255 (5%)  Non–low-yield films = 101 of 514 (20%)  Equivocal:  Low-yield films = 55 of 25 (24%)  Non–low-yield films = 165 of 514(32%)  Negative:  Low-yield films = 188 of 255 (73%)  Non–low-yield films = 248 of 514 (48%)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Annual charge savings of $6,000 of a potential $98,500—based on 4% cancellation of low-yield film orders and 40% adherence to the critique to change from two KUB views to one. Data from Phase 2. Does not make a distinction between control and intervention.  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Response to critique by provider type; does not make a distinction between Phase 1 or Phase 2 and control and intervention  Medicine:  No of KUBs ordered receiving low-yield critique = 189 of 337 (56%)  No of KUBs ordered receiving alternate-view critique = 120 of 337 (36%)  No of low-yield KUBs cancelled = 9 of 189 (5%)  No of KUB orders changed to suggested views = 75 of 120 (63%)  Surgery:  No of KUBs ordered receiving low-yield critique = 205 of 466 (44%)  No of KUBs ordered receiving alternate-view critique = 85 of 466 (18%)  No of low-yield KUBs cancelled = 3 of 205 (1%)  No of KUB orders changed to suggested views = 26 of 85 (31%)  Nursing:  No of KUBs ordered receiving low-yield critique = 131 of 231 (57%)  No of KUBs ordered receiving alternate-view critique = 69 of 231 (30%)  No of low-yield KUBs cancelled = 8 of 131 (6%)  No of KUB orders changed to suggested views = 33 of 69 (48%)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **Exclusion reasons (if appropriate):**  Phase 2 data (randomized) merged; no acceptable comparator  **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Possible learning or Hawthorn effect due to the two phases  Fairly similar baselines  Blinding and concealment not reported  **Applicability/ generalizability:**  Study was conducted at Brigham and Women’s Hospital (academic medical center) |
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| **Heidenreich, Gholami, Sahay, et al., 2007**  #1968 | **Geographical location:**  Palo Alto, CA  **Study dates:**  May 2001–Nov 2005  **General setting:**  Academic  **Specific setting:**  - Inpatient–non-ICU  - Outpatient  - Chronic  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  4.5 years  **Sample type(s) (with N randomized for each):**  Patients: 1546  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Effect of reminder attached to the echocardiography report on use of beta blockers for patients with reduced left ventricular ejection fraction.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Hospitalization—  One-year survival free of heart failure hospitalization was 77%  Reminders had no measurable effect on survival free of hospitalization for heart failure  Hazard ratio = 0.99  95% CI = 0.83 to 1.18  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescription for beta blocker at 9 months—  I: 74%, 458 of 621,  C: 66%, 428 of 650, p = 0.002  Prescription for beta blocker on formulary:  I: 42%  C: 37%  P = 0.048  Beta blocker prescriptions for inpatients:  I: 75%  C: 64%  Beta blocker prescriptions for outpatients:  I: 73%  C: 67%  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Majority of providers thought that the intervention should be continued (35 of 41; 50 providers in total, 41 participated in the survey)  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  No description of features associated with clinician-system interaction  Control group also experienced increase in beta blocker use over time (55% in 2001 versus 68% in 2004)  **Quality assessment:**  Overall rating: Good  Comments:  No significant baseline differences between control and intervention; adequate allocation concealment; computerized randomization;  adequate intervention period (4.5 yr)  **Applicability/ generalizability:**  Implemented in a system (VA) where the infrastructure and familiarity with electronic medical records (EHR) and CDSS is extensive  Study population was predominantly male and White |
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| **Hetlevik, Holmen, and Kruger, 1999**  #6099  **AND**  **Hetlevik, Holmen, Kruger, et al., 1998**  #6201 | **Geographical location:**  Norway  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  - Patients: 2239  - Clinics/practices/ hospitals: 29  - Individual HCPs:  > MDs: 53  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  CDSS was implemented as an external computer program, accessible from the main computerized record system. The CDSS guided the doctors in diagnostics, history taking, physical examination, additional test taking and treatment.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Percentage of doctors who reported changes in their treatment strategies as a result of CDSS—  Some change = 54% (n = 13)  No change = 38% (n = 9)  Large change = 0  Did not know = 0  - HCP satisfaction: NR  - HCP use: Percentage of patients in which CDSS was used either partly or totally in treatment = 12% (104)  - Implementation of CDSS/KMS: NR | **General comments:**  Main outcome measures were changes in doctor’s behavior, measured by registration of recommended variables in the Norwegian clinical guidelines. Other outcomes were related to impact on HCP use and implementation  **Quality assessment:**  Overall rating: Fair |
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| **Hetlevik, Holmen, Kruger, et al., 2000**  #5862 | **Geographical location:**  Norway  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  - Patients: 2239  - Clinics/practices/ hospitals: 29  - Individual HCPs:  > MDs: 53  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  CDSS was implemented as an external computer program, accessible from the main computerized record system. The CDSS guided the doctors in diagnostics, history taking, physical examination, additional test taking and treatment.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow:Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR    **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Percentage of doctors who reported changes in their treatment strategies as a result of CDSS—  Some change = 54% (n = 13)  No change = 38% (n = 9)  Large change = 0  Did not know = 0  - HCP satisfaction: NR  - HCP use: Percentage of patients in which CDSS was used either partly or totally in treatment = 12% (104)  - Implementation of CDSS/KMS: NR | **General comments:**  Main outcome measures were changes in doctor’s behavior, measured by registration of recommended variables in the Norwegian clinical guidelines. Other outcomes were related to impact on HCP use and implementation  **Quality assessment:**  Overall rating: Fair  **Applicability/ generalizability:**  20 of 24 GPs judged the recommended procedures to be too time consuming |
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| **Hicks, Sequist, Ayanian, et al., 2008**  #1343 | **Geographical location:**  14 sites in MA  **Study dates:**  July 1, 2003–February 1, 2005  **General setting:**  - Academic  - Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  - Patients: 2027  - Clinics: 14  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Integrated patient-specific electronic clinical reminder system for management of diabetes and coronary artery disease. In addition to the CDSS reminders, the study also included a nurse practitioner protocol.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Guideline adherent medication prescribing—  I: 7%,  C: 5%, p < 0.0001  Prescribing Joint National Committee adherent drug class within 1 week of visit  Adjusted odds ratio 1.32 (1.09 to 1.61)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Racially diverse sample of primary care patients at hospital and community care clinics associated with a large urban academic medical center where use of electronic medical records was the norm  Intervention integrated into existing EHR and into the workflow without the need for additional input from physician |
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| **Hobbs, Delaney, Carson, et al., 1996**  #6704 | **Geographical location:**  Birmingham, UK  **Study dates:**  January–October 2002  **General setting:**  Not clearly described  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  Clinics/practices/ hospitals: 25 (I = 21, C = 4)  **User level of expertise/ proficiency:**  Practices with previous experience of DSS were excluded  Staff attended a university training session (“Recruitment of the practices,” page 134); no further information available | **Authors’ basic description of system:**  Primed is a rule-based system that guides hyperlipidemia decisions in general practice.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:* Hypertext functioned as an educational tool | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Mean rate of lipid testing was 4.4 tests/1000 population/month. No differences between practices during pre and post usage.  Increase in the number of patients receiving a full lipid profile and decrease in those having only partial investigation (χ2 = 49.5, df = 3, P < 0.05)  Data did not show distinction between control and intervention  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: Practitioner knowledge of lipid disorders = 24 to 41.7%  No distinction between control and intervention practices  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Cost of lipid-lowering drugs = £49/1000 patients/month  SD = £31.70 (£4.53 – 140.81/1000 patients/month)  No difference between control and intervention period  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: Referrals—  Pre: 3 from control, 17 from intervention  Post: 6 from control, 22 from intervention  55% decrease in expected referrals  Analysis of usage (n = 14)  Mean patients = 12 (range 0 to 47)  Working days = 12 of 130 (range 2 to 91) for 50% of practices  50% of practices used the module less than 8 times (min 6, max of 41 and mean of 15)  Data did not report distinction between control and intervention  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  Uneven experimental group  8 of 25 dropped out (1 dispute, 1 lost data, 3 failed to record data, 3 lost data due to upgrades)  Blinding and concealment not described  Outcome data were not adequately reported  Learning bias (Discussion section, paragraph 2)  **Applicability/ generalizability:**  CDSS was built using legacy system; 6 months of intervention |
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| **Holbrook, Thabane, Keshavjee, et al., 2009**  #299 | **Geographical location:**  Ontario, Canada  **Study dates:**  Late 2002–End of 2003  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Patient  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 511 (I = 253, C = 258)  - Individual HCPs:  > MDs: 43  > PAs/NPs: 3 NPs    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The CDSS is a web-based diabetes tracker of the Computerization of Medical Practices for the Enhancement of Therapeutic Effectiveness Study II, providing both physicians and patients updated tracker information and most recent laboratory results.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Chronic disease management  - Initiating discussion with patient  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Online access  *b) Delivery mode:*  Not clearly described  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Total process composite score [maximum = 10] (SD)—  Intervention (n = 253)  Before: 5.19 (2.14)  After: 6.52 (2.30)  Control (n = 258)  Before: 5.19 (2.16)  After: 5.25 (2.52)  Mean difference 95% CI 1.27 (0.79 to 1.75), P < 0.001  Patients with improvement for total composite score, n (%)—  Intervention: 156 (61.7)  Control: 110 (42.6)  Difference 19.1% P < 0.001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: Knowledge of diabetes target had improved = 16 of 33 (48%)  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:**  - Patient satisfaction: Intervention patients were more optimistic than those in the control group in terms of their daily productivity and ease of management of their diabetes, their relationship with their respective primary care providers, and the quality of their diabetes care.  192 (75.9%) of the intervention patients were as satisfied or more satisfied with their care since starting to use the tracker system.  There were no statistically significant changes in quality-of-life measures, SF-12 and Diabetes-39.  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Unable to retrieve supplemental data  **Quality assessment:**  Overall rating: Fair  Comments:  Used allocation concealment  Computer generated randomization  Outcome assessors were blinded to each patient’s intervention status  No information whether patients or physicians were blinded  Attrition rate:  I = 29 of 253  C = 37 of 258  > 10%  Fairly similar baseline  **Applicability/ generalizability:**  Short intervention period (6 months)  Use of surrogate outcomes  Participants were already using an EMR in practice |
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| **Holt, Thorogood, Griffiths, et al., 2010**  #14579  **AND**  **Holt, Thorogood, Griffiths, et al., 2006** | Geographical location:  19 practices in the West Midlands UK area  Study dates:  September 2006-September 2008  General setting:  Community  Specific setting:  Outpatient  Study design:  RCT, parallel group  Unit of randomization:  Patient  Duration of intervention:  24 months  Sample type(s) (with N randomized for each):  - Clinics/practices/ hospitals: 19  - Patients: 38,147  User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  A cardiovascular risk assessment tool to improve the identification of at-risk patients.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Diagnosis  - Preventive care  *b) Relationship to point of care:*  - Synchronous  - Asynchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:* Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Incidence of cardiovascular events—  Rate ratio = 0.96, 95% CI = 0.85 to 1.10, P = 0.59  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR  **Other (clinical and process outcomes):**  Incidence of cardiovascular events: rate ratio = 0.96, 95% CI = 0.85 to 1.10, P = 0.59 | **General comments:**  Definition of cardiovascular event:  - A new diagnosis of cardiovascular disease (i.e., entry onto the Coronary Heart Disease [CHD] Register or Stroke/Transient Ischaemic Attack [TIA] Register)  - A new stroke or TIA (whether or not already on the Stroke/TIA Register)  - A new myocardial infarction (whether or not already on the CHD Register)  - Sudden death from cardiovascular disease  Quality assessment:  Overall rating: Fair  Comments:  Baseline characteristics of study population not described; blinding and concealment methods not reported  **Applicability/ generalizability:**  Multicenter primary care practices across various locations and regions in UK; cannot determine the impact of the intervention for specific types of cardiovascular events  Unable to determine the impact of CDSS due to changes in the wording of the screen alerts |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Judge, Field, DeFlorio, et al., 2006**  #2625 | **Geographical location:**  Worcester, MA  **Study dates:**  March 2002–March 2003  **General setting:**  Academic  **Specific setting:**  Long-term care facility  **Study design:**  RCT, parallel group  **Unit of randomization:**  Resident care units of a long-term care facility  **Duration of intervention:**  12 months  **Sample type(s) (with N randomize**  Clinics/practices/ hospitals: 7 resident care units  **User level of expertise/ proficiency:**  High | **Authors’ basic description of system:**  Computer-based clinical decision support system for the long-term care setting based on evidence derived from observational studies of preventable adverse drug events, consensus recommendations for the appropriate use of medications in geriatric patients, and known high-risk drug-drug interactions.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance:  Intervention:  Number of alerts = 1982 (%); appropriate action taken = 31% (n = 606)  Control:  Number of alerts = 1861 (%); appropriate action taken = 28% (n = 513)  Relative risk = 1.1 , 95% CI (1.00,1.2)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Primary outcome was the effect of a prescription-related alert on physician behavior measured in terms of proportion of alerts that were followed by appropriate action in the intervention and control units  **Quality assessment:**  Overall rating: Fair  **Applicability/ generalizability:**  Implemented in resident care facilities of a large academic hospital and incorporated into a CPOE system that had been in use for at least 4 years |
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| **Kenealy, Arroll, and Petrie, 2005**  #3200  **Comparison 1 of 3** | **Geographical location:**  Auckland, New Zealand  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  2 months  **Sample type(s) (with N randomized for each):**  > MDs: 107 family practitioners  > Practices: 66  **User level of expertise/ proficiency:**  Family practitioners were instructed on using computer reminder as well as patient reminder form | **Authors’ basic description of system:**  Two versions of reminders for diabetes screening were evaluated: (1) computerized reminders for physicians that flashed only for patients eligible for screening and (2) patient reminders using a diabetes risk self-assessment sheet.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS  1) Usual care  2) Patient reminder  3) Computerized reminder | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage of eligible screened for diabetes (total = 19,187 patients; eligible for screening = 5628 patients)  I: Computerized reminder: 31.8%  C: Usual Care: 15.5%  Odds ratio 2.55, 95% CI 1.68, 3.88  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Short duration (2 months)  **Quality assessment:**  Overall rating: Good  Comments:  Methods used for randomization were adequate  **Applicability/ generalizability:**  Implemented in a community-based, primary care practice setting in which the vast majority of the family practitioners used the same commercially available EHR software  Additional stipulation was that the HCPs receive the laboratory glucose results electronically, which a vast majority of them did |
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| **Kenealy, Arroll, and Petrie, 2005**  #3200  **Comparison 2 of 3** | **Geographical location:**  Auckland, New Zealand  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  2 months  **Sample type(s) (with N randomized for each):**  - MDs: 107 family practitioners  - Practices: 66  **User level of expertise/ proficiency:**  Family practitioners were instructed on using computer reminder as well as patient reminder form | **Authors’ basic description of system:**  Two versions of reminders for diabetes screening were evaluated: (1) computerized reminders for physicians that flashed only for patients eligible for screening and (2) patient reminders using a diabetes risk self-assessment sheet.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  1) Usual care  2) Patient reminder  3) Computerized reminder  Patient reminder was a diabetes self-assessment form that was filled out by the patient prior to the visit and given to the doctor during the visit | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage of eligible screened for diabetes (total = 19,187 patients; eligible for screening = 5628 patients)—  I: Computerized reminder: 31.8%  C: Patient reminder: 23.9%  Odds ratio 1.49, 95% CI 1.07, 2.07  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Methods used for randomization were adequate  **Applicability/ generalizability:**  Implemented in a community-based, primary care practice setting in which the vast majority of the family practitioners used the same commercially available EHR software  Additional stipulation was that the HCPs receive the laboratory glucose results electronically, which a vast majority of them did |
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| **Kenealy, Arroll, and Petrie, 2005**  #3200  **Comparison 3 of 3** | **Geographical location:**  Auckland, New Zealand  **Study dates:** NR  **General setting:**  -Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  2 months  **Sample type(s) (with N randomized for each):**  - MDs: 107 family practitioners  - Practices: 66  **User level of expertise/ proficiency:**  Family practitioners were instructed on using computer reminder as well as patient reminder form | **Authors’ basic description of system:**  Two versions of reminders for diabetes screening were evaluated: (1) computerized reminders for physicians that flashed only for patients eligible for screening and (2) patient reminders using a diabetes risk self-assessment sheet.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  - User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  1) Usual care  2) Patient reminder  3) Computerized reminder | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage of eligible screened for diabetes (total = 19,187patients; eligible for screening = 5628 patients)  I: Computerized reminder: 31.8%  C: Computerized reminder + patient reminder: 23.7%  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Methods used for randomization were adequate  **Applicability/ generalizability:**  Implemented in a community-based, primary care practice setting in which the vast majority of the family practitioners used the same commercially available EHR software  Additional stipulation was that the HCPs receive the laboratory glucose results electronically, which a vast majority of them did |
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| **Khan, Maclean, and Littenberg, 2010**  #14627  **AND**  **Maclean, Gagnon, Callas, et al., 2009** | Geographical location:  38 practices in Vermont and 26 in NY  Study dates:  Observed for at least 24 months  General setting:  Community  Specific setting:  Outpatient  Study design:  RCT, cluster randomization  Unit of randomization:  Clinic or team  Duration of intervention: NR  Sample type(s) (with N randomized for each):  - Patients: 7412  - Clinics/practices/ hospitals: 64  - Individual HCPs: 132  > MDs: family medicine: 65  - Internists: 35  - NPs: 18  - PAs: 14  User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  Decision support system designed to help primary care providers and their diabetes patients achieve guideline-based treatment targets.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: All subjects: Inpatient length of stay (days) —  Control: 1.1  Intervention: 0.99  P = 0.01  Seniors (age 65 years and up): Inpatient length of stays (days)—  Control: 1.44  Intervention: 1.22  P = 0.002  Age < 65 years: Inpatient length of stay (days)—  Control: 0.84  Intervention: 0.79  P < 0.25  Men: Inpatient length of stay (days)—  Control: 1.10  Intervention: 0.94  P = 0.03  Women: Inpatient length of stay (days)—  Control: 1.10  Intervention: 1.05  P = 0.15  - Morbidity: All subjects: Number of inpatient admissions (hospitalization)—  Control: 0.20  Intervention: 0.17  P = 0.01  All subjects: Number of emergency department visits—  Control: 0.36  Intervention: 0.27  P < 0.0001  Seniors (age 65 years and up): Number of inpatient admissions—  Control: 0.27  Intervention: 0.21  P =0.001  Seniors (age 65 years and up): Number of emergency department visits­—  Control: 0.36  Intervention: 0.21  P < 0.001  Age < 65 years: Number of inpatient admissions—  Control: 0.15  Intervention: 0.13  P < 0.31  Age < 65 years: Number of emergency department visits—  Control: 0.37  Intervention: 0.33  P < 0.11  Men: Number of inpatient admissions—  Control: 0.21  Intervention: 0.17  P = 0.02  Men: Number of emergency department visits—  Control: 0.36  Intervention: 0.23  P < 0.0001  Women: Number of inpatient admissions—  Control: 0.20  Intervention: 0.17  P = 0.15  Women: Number of emergency department visits—  Control: 0.37  Intervention: 0.30  P = 0.01  - Mortality: NR  - Validated measure of HRQOL or functional status: Functional status (n = 672)—  SF-12 Physical (0-100)  Control: 40.6  Intervention: 40.8  Unadjusted effect=+0.2  Adjusted effect = +0.2 (95% CI  −0.9 to +1.3)  P = 0.68  SF-12 Mental (0-100)  Control: 50.5  Intervention: 50.7  Unadjusted effect=+0.3  Adjusted effect=−0.4 (95% CI  −1.6 to +0.8)  P = 0.50  Quality of life at followup survey (n = 658)—  Audit of diabetes dependent  quality of dife (ADDQOL) (−9 to  +9)  Control: −1.4  Intervention: −1.2  Unadjusted effect: +0.23  Adjusted effect: +0.12 (95% CI −0.04 to +0.28)  P = 0.13  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Guideline-appropriate testing for A1C—  Control: 55%  Intervention: 56%  Unadjusted OR = 1.06  Adjusted OR = 1.17 (95% CI 0.80 to 1.72)  P = 0.43  Guideline-appropriate testing for  lipids—  Control: 71%  Intervention: 74%  Unadjusted OR = 1.17  Adjusted OR = 1.39 (95%CI 1.07, 1.80)  P = 0.012  Guideline-appropriate testing for  creatinine—  Control: 80%  Intervention: 84%  Unadjusted OR = 1.26  Adjusted OR= 1.40 (95% CI 1.06 to 1.84  P = 0.018  Guideline-appropriate testing for  urine protein:—  Control: 32%  Intervention: 40%  Unadjusted OR = 1.41  Adjusted OR = 1.74 (95% CI 1.13 to 1.69)  P = 0.012)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: All subjects: Inpatient charges—  Control: $3480.14  Intervention: $3113.19  P = 0.02  All subjects: Emergency department charges —  Control: $414.30  Intervention: $303.51  P < 0.0001  Seniors (age 65 years and up): Inpatient charges—  Control: 4264.36  Intervention: $3699.26  P = 0.004  Seniors (age 65 years and up): Emergency department charges—  Control: $443.27  Intervention: $270.45  P < 0.0001  Age < 65 years: Inpatient charges—  Control: $2869.84  Intervention: $2572.14  P = 0.30  Age < 65 years: Emergency department charges—  Control: $391.76  Intervention: $334.03  P = 0.07  Men: Inpatient charges—  Control: $3712.22  Intervention: $3098.26  P = 0.03  Men: Emergency department charges—  Control: $410.91  Intervention: $299.18  P < 0.0001  Women: Inpatient charges —  Control: $3265.12  Intervention: $3128.00  P = 0.21  Women: Emergency department charges—  Control: $417.45  Intervention: $307.80  P < 0.009  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  Quality assessment:  Overall rating: Good  **Applicability/ generalizability:**  Locally developed intervention evaluated in a multisite trial across two states; some baseline differences between the control and intervention group |
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| **Kline, Zeitouni, Hernandez-Nino, et al., 2009**  #381 | **Geographical location:**  Charlotte, NC  **Study dates:**  Oct 17, 2005–Sep 18, 2007  **General setting:**  Academic  **Specific setting:**  - Emergency department  - Acute  Patients with chest pain admitted to the emergency department  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  Patients: 400  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer-based method to estimate the pretest probability of acute coronary syndrome using the method of attribute matching that produces a point estimate of pretest probability by obtaining 8 predictor variables from a patient undergoing evaluation for a possible acute coronary syndrome.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: Median length of stay—  Control: 11.4 hours  Intervention: 9.2 hours  (95% CI for difference = -2.9, 7.6 hours; P = 0.36)  - Morbidity: Admit/hospitalization—  Control: N = 185  Intervention: N = 184  Significant cardiovascular diagnosis (n = 71): n (% of subgroup, % of group)—  Control = 13 (36%, 7%)  Intervention = 9 (26%, 5%)  No significant cardiovascular diagnosis (n = 298) : n (% of subgroup, % of group)—  Control = 20 (13%, 11%)  Intervention = 10 (7%, 5%)  P=0.059  Readmission within 7 days—  Control = 20 of 185 (11%)  Intervention = 6 of 184 (4%)  95% CI = 2.5% to 13.2%  P=0.001  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:**  - Patient satisfaction: Satisfaction with clinician explanation of the problem—  Control: 38%  Intervention: 49%  (95% CI for the difference = 0.9% to 21.0%)  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Randomization adequate (computer- generated randomization sequence); assessors blind to group assignment  **Applicability/ generalizability:**  Urban emergency department population known to have a high rate of cocaine use  Full-time research coordinator required to gather the clinical variables and input them into the computerized interface to generate the pretest probability |
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| **Krall, Traunweiser, and Towery, 2004**  #4293 | **Geographical location:**  Portland, OR  **Study dates:**  Jan 15–Feb 16, 2000  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  1 month  **Sample type(s) (with N randomized for each):**  - Patients: 10,972  - Individual HCPs:  > MDs/DOs (family practice and internal medicine): 73  > PAs/NPs: 27  > Nurses    **User level of expertise/ proficiency:**  Comprehensive EMR since 1994 | **Authors’ basic description of system:**  Low-dose aspirin therapy alert that notified the clinician at the point of care using offline data analysis instead of event monitoring.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y (clinician needed 2 extra clicks to complete recommended aspirin order)  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N  *e) Other:*  Two clicks were required for the clinicians to complete the recommended aspirin order | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Documentation of aspirin use for patients within the first month—  Intervention: 54.3% (315 of 580)  Control: 25.8% (128 of 496)  (p < 0.001, OR 3.3)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Short-term intervention—1 month  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Early adopter of CDSS;  short study duration (1 month) |
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| **Kucher, Koo, Quiroz, et al., 2005**  #3517 | **Geographical location:**  Boston, MA  **Study dates:**  9/2000–1/2004  **General setting:**  Academic  **Specific setting:**  Inpatient medical and surgical services  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  40 months  **Sample type(s) (with N randomized for each):**  Patients: 2506  **User level of expertise/ proficiency:**  Users already using CPOE/EHR | **Authors’ basic description of system:**  A computer program linked to the patient database to identify consecutive hospitalized patients at risk for deep-vein thrombosis among high-risk hospitalized patients.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care—ordering DVT prophylactic measures  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  Design: eligible patients randomized to have alerts generated for their providers versus no such alerts | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Clinically diagnosed DVT or PE at 90 days occurred in 61 patients in the intervention group (4.9%) compared with 103 patients (8.2%) in the control group. The Kaplan-Meier estimates of the likelihood of freedom from DVT or PE at 90 days were 94.1% (95% CI: 92.5 to 95.4%) and 90.6% (95% CI: 88.7 to 92.2%), respectively (p < 0.001)  30-day outcomes—  DVT:  Intervention: 3.3%  Control: 5.7%, p = 0.004  PE:  Intervention: 0.8%  Control: 1.7%, p = 0.05  - Mortality: Death at 90 days—  Intervention: 22.5%  Control: 22.3%, p = 0.74  Death at 30 days—  Intervention: 13.9%  Control: 12.5%, p = 0.56  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Prophylactic measures ordered—  Intervention: 421 of 1255 patients (33.5%)  Control: 182 of 1251 (14.5%)  p < 0.001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Well-designed study with adequate intervention and followup periods  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Early adopter of CDDS  Locally developed system  Use of relevant, valid, and reproducible patient-centered outcomes |
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| **Kuperman, Teich, Tanasijevic, et al., 1999**  #5941 | **Geographical location:**  Boston, MA  **Study dates:**  12/1/1994–1/31/1995 and 9/1/1995–10/30/1995  **General setting:**  Academic  **Specific setting:**  Inpatient–non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  4 months  **Sample type(s) (with N randomized for each):**  Alerts: 192  **User level of expertise/ proficiency:**  Clinical alerting system that had been in use since June 1994 | **Authors’ basic description of system:**  A computer system to detect critical conditions and automatically notify the responsible physician via the hospital’s paging system.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Other—action in response to a critical laboratory value  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  - Mandatory response  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Other—pager  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N (action required)  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: NR  - Mortality:  Control: 13 of 98 (13.3% per patient)  Intervention: 7 of 94 (7.4% per patient), p = 0.19  - Validated measure of HRQOL or functional status: NR  - Adverse events: Adverse events among alerting situations (including death)—  Control: 27 of 98 (28% per patient)  Intervention: 31 of 94 (33% per patient), p = 0.41  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Time until treatment ordered (in hours)—  Intervention (n = 94):  Median (IQR): 1.0 (0.2-2.6)  Mean (SD): 4.1 (12.1)  Control (n = 98):  Median (IQR): 1.6 (0.6-4.2)  Mean (SD): 4.6 (9.1)  p = 0.003  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Academic setting  Early adopter of DCSS  Locally developed system |
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| **Lee, Chen, Currie, et al., 2009**  #312 | **Geographical location:**  New York, NY  **Study dates:**  1/1/2006–8/31/2006  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  8 months  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > Training Nurses (acute and family): 29  - Other: 1874 patient encounters  **User level of expertise/ proficiency:**  Participants received user training including basic use of personal digital assistant and clinical log system and overview of decision support features for obesity management and smoking cessation | **Authors’ basic description of system:**  A personal digital assistant–based log with and without obesity decision support features.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  Not clearly described  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS (no CDSS for obesity, but CDSS for smoking cessation) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed:  Obesity-related diagnoses—  Intervention: 91 of 807 (11.3%)  Control: 10 of 997 (1%)  (p < 0.001)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  **Overall rating: Fair**  Comments: Nonblinded participants and outcome assessors; ambiguous reporting of methods  **Applicability/ generalizability:**  Student nurses as participants  Standalone PDA CDSS  No patient-centered outcomes |
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| **Linder, Rigotti, Schneider, et al., 2009**  #488 | **Geographical location:**  Boston, MA  **Study dates:** 12/19/06–9/30/07  **General setting:**  Academically-affiliated community practices  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Practice  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  - Patients: 12,207 smokers of 132,630 patients for 315,962 visits  - Practices: 26  - Individual HCPs:  > Clinicians: 521 (314 control, 207 intervention)  **User level of expertise/ proficiency:**  Clinicians received an introductory email, one practice visit by an investigator, and periodic emails to encourage use | **Authors’ basic description of system:**  In intervention practices, clinicians received 3 enhancements to the EMR:  (1) First, two smoking status icons were added. If smoking status was not documented in the EMR (e.g., not present in the problem list), a black icon of a cigarette and a question requested the clinician to update this status. If the EMR recognized the patient as a smoker, a scarlet icon appeared to guide the clinician to the Tobacco Smart Form.  (2) Second, for smokers clinicians received various tobacco treatment reminders.  (3) Third, the Tobacco Smart Form provided documentation-based clinical decision support. In particular, an order set facilitated the ordering of smoking cessation medications, documenting of cessation-related actions, and referrals to smoking cessation counselors who would then attempt to follow up with the patients.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Pharmacotherapy  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)    **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  - System-initiated (“push”)  - User-initiated (“pull”)  (icons were available to users, who then needed to take action in order to fully initiate the process)    **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y (reminders, Yes; form, Can’t tell)  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescribed medication—  Intervention: 2.0%  Control: 2.0%  p = 0.40  Referred to smoking cessation counseling—  Intervention: 4.5%  Control: 0.4%  p < 0.001  Documentation of smoking status increased—  Intervention: 37 to 54%  Control: 35 to 46% in the (p < 0.001)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: 44% (90 of 207) of intervention clinicians used the Tobacco Smart Form at least once  - Implementation of CDSS/KMS: NR | **General comments:**  Apparent increase in smoking cessation rates might be due to improved documentation. Even though the study was positive, the absolute magnitude of the impact of the intervention was relatively modest.  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  The practices had used an EMR for a number of years previously    Included residents  Portions of the intervention have been implemented into other EHRs |
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| **Litzelman, Dittus, Miller, et al., 1993**  #7057 | **Geographical location:**  Indianapolis, IN  **Study dates:**  May 1–Oct 31, 1989  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Other—half-day practice session  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 5,407  - Individual HCPs:  > MDs: 176; 31 internal medicine, 145 residents  I = 92 (15 faculty + 77 residents)  C = 84 (16 faculty + 68 residents)  - Other—32 practice sessions (I = 16, C = 16)  **User level of expertise/ proficiency:**  Computerized reminder system had been used for 14 years (1975–1989) | **Authors’ basic description of system:**  Computerized reminder system containing more than 1400 physician-authored rules to review information stored in the patients’ electronic records. Computerized reminder system reviewed the records of all patients prior to scheduled visits to the general medicine practice and printed indicated tests in the “orders” section of each patient’s outpatient encounter form.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  - Synchronous  **Decision support:**  *Response requirement:*  - Justification for not complying  - Mandatory response (nurse/clerk will return incomplete form)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  (guideline design involved 35 faculty)  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:* Contains summary of the patient’s recent study test results | **Comparator(s):**  Another CDSS/KMS  1) CDSS prints out patient-specific data for each reminder with explanation  2) The comparator is the same CDSS with modifications for the 3 prevention tests targeted for the study; FOBT, mammography, and pap test | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: All tests—  All physicians:  I = 46%  C = 38%  P **=** 0.002  Residents only:  I = 47%  C = 37%  P = 0.0004  Faculty only:  I = 42%  C = 44%  P = 0.72  FOBT—  All physicians:  I = 61%  C = 49%  P = 0.0007  Residents only:  I = 63%  C = 46%  P < 0.0001  Faculty only:  I = 57%  C = 58%  P = 0.81  Mammography—  All physicians:  I = 54%  C = 47%  P = 0.036  Residents only:  I = 55%  C = 45%  P = 0.013  Faculty only:  I = 50%  C = 51%  P = 0.87  Pap testing—  All physicians:  I = 21%  C = 18%  P = 0.20  Residents only:  I = 22%  C = 18%  P = 0.136  Faculty only:  I = 17%  C = 18%  P = 0.77  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Intervention physicians complied with target reminders for cancer screening protocols for mammography, pap smear, and fecal occult blood testing more often than control physicians (46% vs 38%, P = 0.002)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Randomization by block (half-day practice sessions); possible contamination between physicians during change over  New physicians may be added to the session  Different practicing patterns between faculty and residents  **Applicability/ generalizability:**  Regenstrief Medical Record System locally developed  Experiment conducted in an academic environment; population may be less generalizable to the community  Form of delivery in paper may no longer apply |
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| **Lo, Matheny, Seger, et al., 2009**  **#748** | **Geographical location:**  Boston, MA  **Study dates:**  7/21/03–1/20/04  **General setting:**  - Community  - Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 2765  - Clinics: 22  - Individual HCPs: 366 (191 control, 175 intervention)  - Events: 3673  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  In an effort to avoid overloading physicians with alerts, a system for stratifying alerts into three tiers, with noninterruptive alerts falling into the category of least likely and least severe consequences was developed (with comment from physician and pharmacist expert panels).  This study was limited to noninterruptive alerts. When the physician used the EMR to order a medication, the system was queried for the relevant lab tests. If such tests were not found, a notification was displayed in real time on the screen.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering    *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care (usual care included access to the EMR, but without the alerts) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Proportion of laboratory tests that were appropriately ordered within 14 days of the visit—  Intervention: 41% (689 of 1685)  Control: 39% (771 of 1988)  OR 1.048, CI 0.753 to 1.457, p = 0.782  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Quite likely the reason that this study was negative was that providers had to take the trouble to use a paper ordering system, rather than automatic order entry  **Quality assessment:**  Overall rating: Good  Comments: The primary analysis was via logistic regression, which was necessary to control for baseline differences between the groups  **Applicability/ generalizability:**  These practices had used an EMR for a number of years; included residents |
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| **Lobach and Hammond, 1994**  #7001 | **Geographical location:**  Durham, NC  **Study dates:** 9/93–2/94  **General setting:**  Academic  **Specific setting:**  Outpatient, chronic disease management  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 497  - Clinics/practices/ hospitals  - Individual HCPs:  > Training MDs: 10  > MDs: 20  - Events 1265  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A collaboratively developed guideline for outpatient diabetes management consisting of eight elements (e.g., Hgb1AC every 6 months) that were pulled from the EMR.  At each encounter, the eight elements were listed, plus the date that each was last performed and a recommended followup date (this date could include “due now”).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Lab test ordering  - Chronic disease management  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:*  Providers could enter data elements that were not automatically captured by the EMR (e.g., foot exams, laboratory tests performed elsewhere) | **Comparator(s):**  Usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Provider compliance scores—  Intervention: 32.0%  Control: 15.6%  P = 0.02  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  The clinical meaning of the primary outcome variable is uncertain  **Quality assessment:**  Overall rating: Good  Comments: Compliance was assessed using chart audit  It was not clear precisely how the physician-level compliance scores, which were reported as percent compliance, were calculated  Each encounter generated 8 potential elements, not all of which required immediate attention; did the authors take the percent compliance out of those actions that were recommended as immediate?  **Applicability/ generalizability:**  The idea could be used elsewhere, but the implementation was dependent on the peculiarities of this particular EMR  Guideline recommendations based on the American Diabetes Association  Single clinic |
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| **Locatelli, Covic, Macdougall, et al., 2009**  #220 | **Geographical location:**  53 centers in 8 European countries (Bulgaria, Croatia, Germany, Italy, Latvia, Poland, Romania and Serbia, Montenegro)  **Study dates:** Enrollment was completed in 9/2005  **General setting:**  - Academic  - Community  **Specific setting:**  - Outpatient (nephrology care centers)  - Chronic care  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Center  **Duration of intervention:**  6 to 8 months  **Sample type(s) (with N randomized for each):**  - Patients: 599  - Clinics: 53  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  This is a central database, plus a CDS system that uses the response to data collection prompts to generate guideline-based recommendations customized for each patient, with arguments for and against the option.  **Source/origin of system:** NR    **Content:**  *a) Objective(s):*  Chronic disease management (primary, the description of the system was too sketchy to determine whether the system had other objectives)  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  Can’t tell  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Proportion of adherence to the guideline-based reminders—  Intervention patients: 40%  Control: 48%  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  This paper is extremely sketchy regarding the details of the intervention and somewhat sketchy about how the statistical analyses were performed  **Quality assessment:**  Overall rating: Fair  Comments:  Details about the intervention were uncertain.  No blinding  Uncertain how patients with missing values were analyzed  The funding sponsor identified the selection of centers and was responsible for data collection and data management  Interpretation of data was performed with close collaboration  between the steering committee and the sponsor  **Applicability/ generalizability:** These clinics are unlikely to reflect practice in the US; recommendations were based on the European Best Practices Guidelines |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Manotti, Moia, Palareti, et al., 2001**  #5240 | **Geographical location:**  5 sites in Italy  **Study dates:**  1996–1998  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  Patients: 345 in induction phase (145 intervention, 190 control), and 916 in maintenance phase (458 intervention, 458 maintenance)  **User level of expertise/ proficiency:**  High; these are experienced anticoagulation providers that already use a computerized anticoagulation management system | **Authors’ basic description of system:**  The environment is a standalone computerized system for managing anticoagulation. The intervention group adds a computer-aided dosing module that proposes the next dose and the next followup interval. Final decision about the prescription and the schedule of followup appointments was left to the physician, who was free to accept or to modify the computer suggestion.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  2 study arms:  1) Group C: Computer-aided dosing  2) Group M: Manual dosing by physician | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Patients in Group C spent significantly more time within the therapeutic range than patients in Group M (71.2% vs 68.2%). There was also a significant difference in the percentage of time spent within the therapeutic range for each of the drug groups. All these differences were highly significant (p < 0.001) at the statistical level.  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  This study is assessing only a tiny component of CDS but one that is nevertheless important for the practice of anticoagulation  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:** Although outside the US, these results could likely be generalized to any anticoagulation clinic that is organized around an EMR |
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| **Marco, Sedano, Bermudez, et al., 2003**  #4674 | **Geographical location:**  Santander, Spain  **Study dates:**  12/98–8/99  **General setting:**  Academic  **Specific setting:**  Outpatient (anticoagulation unit of a university hospital)  **Study design:**  RCT, crossover  **Unit of randomization:**  Patient  **Duration of intervention:**  20 weeks  **Sample type(s) (with N randomized for each):**  Patients: 1882  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The software was used in parallel with traditional management; the software proposes a dose and the next visit time, but these recommendations are reviewed by the provider before action is taken.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: The computer matched the traditional dosing, achieving a small but statistically significant greater efficacy in maintaining patients within the INR target range.  The percentage of INR determinations over 5.5 was very low in both groups. Results validated the computerized acenocoumarol dosing in the center, achieving at least similar levels of effectiveness and safety compared with traditional dosage by medical staff.  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  The design was a crossover but analyzed as parallel groups; contamination seems quite likely  **Quality assessment:**  Overall rating: Fair  Comments:  The intervention was not well described, and contamination was likely  **Applicability/ generalizability:**  Single site  Study conducted in Spain |
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| **Martens, van der Aa, Panis, et al., 2006**  #3066  **AND**  **Martens, van der Weijden, Severens, et al., 2007**  #1633 | **Geographical location:**  Netherlands  **Study dates:** 10/03–4/04  **General setting:**  - Academic  - Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team (practice)  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Practices: 23  - Individual HCPs:  > MDs: 53 general practitioners  **User level of expertise/ proficiency:**  Physicians received individual instruction when the system was installed in the practice | **Authors’ basic description of system:**  This is a real-time automated reminder system that contains reminders regarding alternative type of drug, other doses, alternative drug administration, specific indication, other duration of prescribing, not prescribing, referring to a specialist. It uses if-then logic derived from guidelines and is activated whenever the physician enters a prescription in the computerized prescriptions module that is not consistent with guidelines.  Not explicitly stated whether the reminders could be ignored, or how well the system was integrated with the existing EMR.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: No differences between groups were found for indicators and volumes related to recommendations advocating certain drugs  Although there was a tendency toward clinically relevant results for prescription volumes that were supposed to drop, the difference in sum score between the groups was not significant.  For antibiotic prescriptions that were supposed to drop, the sum score for the intervention group was 28.2 (95% CI: 20.8 to 44.5) prescriptions per 1000 patients per GP, while this was 39.7 (95% CI: 29.7 to 64.1) for the control group.  Cholesterol sum score prescriptions per 1000 patients per GP: All nonsignificant  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Halfway during the intervention year, a written questionnaire was sent to a specially selected sample of GPs asking about their experiences with and opinion on the feasibility of working with the clinical reminder system. From that, it was asserted that respondents valued the guidelines that were used as the basis for the reminders, accepted the content in part because of their input into the development process, and appreciated that reminders were only generated when prescription was outside the guidelines.  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Lots of providers and practices were ultimately excluded    Study was underpowered  **Applicability/ generalizability:**  A somewhat awkward and probably poorly integrated intervention, tested outside the US  Physicians were already experienced users of an EHR  Prescribing guidelines were set by a regional multidisciplinary committee of opinion leaders (pharmacists, GPs, hospital staff) and prevailing EBM |
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| **Matheny, Sequist, Seger, et al., 2008**  #1157 | **Geographical location:**  Boston, MA  **Study dates:** 1/1/04–6/30/04  **General setting:**  - Academic  - Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 1922  - Clinics: 20  - MDs: 303  - Other: 2507 clinic visits  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  In clinics that already use an EMR, the intervention appended reminders for potassium, creatinine, liver function, thyroid function, and therapeutic drug levels for appropriate medications (10 total reminders) to the main patient summary screen when lab testing associated with chronic medication use was late.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N- Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS (usual care includes a general EMR) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Rates of appropriate laboratory monitoring within 14 days of an office visit ranged from 14% (therapeutic drug levels) to 64% (potassium monitoring with potassium-sparing diuretic use).    Reminders for appropriate laboratory monitoring had no impact on rates of receiving appropriate testing for creatinine, potassium, liver function, renal function, or therapeutic drug level monitoring.  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  The authors partially attribute the negative results to a ceiling effect, the passive nature of the reminders, and guideline overload  **Applicability/ generalizability:**  Participants were already experienced users of the EMR  Practices were part of a health system that has historically been an early adopter of health IT |
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| **Maviglia, Yoon, Bates, et al., 2006**  #3030 | **Geographical location:**  Boston, MA  **Study dates:** 1/8/03–1/7/04  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Clinics: 18  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The EMR at Partners was enhanced to include an infobutton that provides patient-specific and context-sensitive links to help providers efficiently research questions about the drugs that they prescribe. Two versions were of the infobutton application were evaluated, one that linked to information from Micromedex® and the other to information from SkolarMD®.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  One version of KnowledgeLink included links to information provided from Micromedex (KL/MDX) and the other version provided content from SkolarMD (KL/SKL) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Postuse survey—289 completed surveys returned from 89 distinct users (29% response rate); 83.8% of queries were successfully answered (86.0% for KL/MDX, 72.5% for KL/SKL, p = 0.1) and 14.9% of the time the queries caused providers to change their decision (15.2% KL/MDX, 13.7% KL/SKL, p = 0.7)  - HCP satisfaction: Poststudy survey—  72 of 389 returned (19%); 80% of providers rated the system overall as positively on scales of ease of use, relevance, speed ,and improvement in patient care, and 70% or more had positive impressions of the target reference, either Micromedex or SkolarMD  Poststudy survey—KL/MDX respondents tended to be more satisfied than their KL/SLK counterparts (87% versus 54%, p = 0.05); not so much in how often users reported that they could find answers to their questions but more related to how quickly and easily the answers could be found  - HCP use: Clinicians used KnowledgeLink on average 2.3 times per month; range, 0.1–100; median, 0.5 and during an average of 1.2% patient encounters  Usage was statistically significantly higher among those randomized to Micromedex compared to SkolarMD (median 0.56 versus 0.42 uses/month, p = 0.01)  - Implementation of CDSS/KMS: NR | **General comments:** Although framed as a RCT, and although one of the links was preferred to the other, the ultimate impact of this work is not in comparing the two links, but rather in demonstrating how well context-sensitive help was received  **Quality assessment:**  **Overall rating:** Good  **Applicability/ generalizability:**  Academic setting  Early adopters of CDSS |
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| **Mc Donald, 1976**  #7448 | **Geographical location:**  Indianapolis, IN  **Study dates:** NR  **General setting:**  Academic    **Specific setting:**  Outpatient    **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  8 month(s)  **Sample type(s) (with N randomized for each):**  - Patients: 226  - Visits: 601  **User level of expertise/ proficiency: NR** | **Authors’ basic description of system:**  The EMR normally produced a summary report and a patient encounter form (this paper form then being used for all ordering of tests, drugs, etc.). The intervention added a surveillance report, which reminded the provider about appropriate tests to order.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Lab test ordering  - Pharmacotherapy  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N- Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  The comparator is the base CDS package without the surveillance report | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  - Recommended clinical study ordered/completed: Clinician response to order a test when due to an obsolete value—  Intervention: 36% (144 of 390)  Control: 11% (45 of 402)  p < 0.00001  - Recommended treatment ordered/prescribed: Clinicians appropriately changed drug regimen—  Intervention: 28% (31 of 110)  Control: 13% (9 of 68)  p = 0.026  If including either a repeat of the index measurement or the suggested change in medication—  Intervention: 57% (63 of 110)  Control: 23% (16 of 68)  p < 0.0001  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  A classic study in the development of the field  **Applicability/ generalizability:**  Good applicability, with pertinent findings |
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| **McCowan, Neville, Ricketts, et al., 2001**  #5320 | **Geographical location:**  United Kingdom  **Study dates:**  Circa 2000  **General setting:**  Community  **Specific setting:**  Outpatient    **Study design:**  RCT, cluster  **Unit of randomization:**  Practice  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 477  - Practices: 46  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  This standalone system requires clinicians to input information during the clinic visit and then refers to a database in order to generate recommendations. It can also print self-management plans and educational materials for patients.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Hospital contacts for asthma—  Admissions  Control (n = 330): 4 (1%)  Intervention (n = 147): 0  OR = 0 (0 to 3.44)  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Acute prescribing (# of patients)—  Exacerbations of asthma:  Intervention: 8% (12 of 147)  Control; 17% (57 of 330)  OR 0.43 (0.21 to 0.85)  Received oral corticosteroids:  Intervention: 5% (7 of 147)  Control: 11% (35 of 330)  OR 0.42 (0.14 to 1.29)  Received emergency nebulisations:  Intervention: 1% (1 of 147)  Control: 5% (17 of 330) 0.13 (0.01 to 0.91)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: In response to a survey of intervention practices, clinicians said that the software increased consultation times slightly, that the data collection was reasonably comprehensive, and that the reminders were appropriate.  The software also had a risk prediction function that was not well received. Clinicians also reported that the printed management plans were of use and seemed to be of value to the patients.  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Only 17 of 46 practices completed the study, with greater dropout in the intervention group  **Applicability/ generalizability:**  A rudimentary standalone system tested outside the US |
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| **McDonald, Hui, Smith, et al., 1984**  #7411 | **Geographical location:**  Indianapolis, IN  **Study dates:** 1980  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Team  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  - Patients: 12,467  - Teams: 27  - Individual HCPs: 115 residents, 11 faculty members, 4 nurse-clinicians  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  On top of the existing EMR, intervention patients received computer-based reminders regarding testing and treatment. The reminders were based on information available the day before a scheduled clinic visit and were provided in printed form.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Immunization  - Pharmacotherapy  - Lab test ordering  - Chronic disease management  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  Same EMR but with reminders turned off | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Hospitalization—  Patients cared by study physicians eligible for pneumococcal or influenza vaccine had fewer hospitalizations and emergency room visits than control (p < 0.02)  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR    **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: The mean per-patient response rate for residents—  Intervention: 49%  Control: 29% for (P < 0.001)  The effect of the computer reminder messages on the residents’ response rate was significant (p < 0.0001). The effect of the resident’s team was not (p = 0.1, intraclass correlation = 0.1).  The response rate for the 11 faculty members who served as their own controls was 44% and 29% in the study and control states respectively (p < 0.01).  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: The attitude of the residents in the study groups about the computer system in general and the reminder messages in particular predicted their response rate, accounting for 15% of the variance (p < 0.001).  The degree to which residents read the reports (as shown by their initials) predicted their response to a similar degree, explaining 15% (p < 0.001) of the variance. These two predictive variables were correlated (r = 0.42, p < 0.001); physicians who were positive about the computer were more likely to read the reports and vice versa.  Among study residents, the physicians’ intentions predicted their behavior, explaining 33% of the variance in response rate across the various actions (p < 0.03, r2 = 0.33).  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Intervention included 1491 rules that could generate 751 unique reminder messages  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:** Good, despite the passage of time |
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| **McDonald, Hui, and Tierney, 1992**  #7115 | **Geographical location:**  Indianapolis, IN  **Study dates:**  Winters from 1978 to 1981  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  3 years  **Sample type(s) (with N randomized for each):**  Patients: 4555  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  On top of the EMR, computerized reminders regarding influenza vaccinations were appended.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Immunization  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  The comparator was the EMR but without the reminders regarding preventive care, specifically influenza vaccination | **1) Impact on clinical outcomes:**  The difference in linear trends between the patients in the intervention group (whose physicians received reminders) and those in the control group was significant for emergency room visits (P < 0.05), hospitalizations (P < 0.01), and blood gas determinations (P < 0.001).  - Length of stay: NR  - Morbidity: Hospitalization—  Winter months in years with access:  1978–1979 (N = 1000)  Control: 5.0%  Intervention: 6.6%  1979–1980 (N = 33,451)  Control: 9.3%  Intervention: 7.9%  1980–1981 (N = 71,075)  Control: 9.0%  Intervention: 6.2%  Nonwinter months in years with access:  1978–1979 (N = 1000)  Control: 10.9%  Intervention: 10.5%  1979–1980 (N = 33,451)  Control: 14.0%  Intervention: 17.1%  1980–1981 (N = 71,075)  Control: 14.9%  Intervention: 15.7%  Winter months in years without access:  1978–1979 (N = 1000)  Control: 3.2%  Intervention: 3.5%  1979–1980 (N = 33,451)  Control: 4.7%  Intervention: 6.4%  1980–1981 (N = 71,075)  Control: 4.4%  Intervention: 2.9%  Winter months (linear difference), P = < 0.01  Nonwinter months (constant difference), P = not significant  Winter (no fall visit) (linear difference), P = not significant  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  The cumulative incidence of influenza vaccination—  1978–1979:  Control: 17.4%  Intervention: 35.3%  1979–1980:  Control: 19.7%  Intervention: 34.5%  1980–1981:  Control: 25.5%  Intervention: 42.9%  (p < 0.001)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  This is a report of some of the results of a larger trial. This larger trial is dated but nevertheless well-known and fundamental to the development of the field.  **Quality assessment:**  Overall rating: Good.  **Applicability/ generalizability:**  Academic setting |
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| **McDowell, Newell, and Rosser, 1986**  #7366  **Comparison 1 of 3** | **Geographical location:**  6 sites in Ontario, Canada  **Study dates:**  Oct 23, 1984–Dec 31, 1984  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Family  **Duration of intervention:**  10 weeks  **Sample type(s) (with N randomized for each):**  - Patients: 1420  - Clinics/practices/ hospitals: 6  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The computerized medical record system identifies patients for whom preventive procedures are due and automatically generates reminders for them using three mechanisms: reminder by mailed letter, telephone reminder by nurse, personal reminder by physician.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Immunization  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Intervention 1 = Reminder by letter  2) Intervention 2 = Telephone reminder by nurse  3) Intervention 3 = Personal reminder by physician (CDSS)  Control 1 = Randomized control group  Control 2 = Control practices | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Rates of vaccination, n (%)—  Intervention 1: 84 of 239 (35.1%)  Control 1: 21 of 215 (9.8%)  Control 2: 17 of 444 (3.8%)  3 intervention groups differed from randomized control group (χ2 = 40.7, 1df, p < 0.001)  Difference among 3 intervention groups (χ2 = 11.1, 1df, p < 0.005)  Personal reminder by physician versus control (z = 3.4, p < 0.005)  Rates of vaccination for patients contacted who had not been vaccinated before the trial—  Intervention 1: 84 of 237 (35.4%)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: NR  - Cost-effectiveness: The cost of letter rises slowly as the physician’s salary increases. Telephone method is more cost-effective than letter if nurse is paid less than $16 per hour. Personal contact by physicians is more cost-effective than letter if physician’s salary is $50 per hour or less.  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Learning bias in physicians; vaccination rate in randomized controlled group was significantly higher than control practices  Baseline was measured based on individual patient instead of family  Blinding, randomization method, and concealment were not reported  **Applicability/ generalizability:**  Academic medical center  Short study duration  Varying cost in other institutions |
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| **McDowell, Newell, and Rosser, 1986**  #7366  **Comparison 2 of 3** | **Geographical location:**  6 sites in Ontario, Canada  **Study dates:**  Oct 23, 1984–Dec 31, 1984  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Family  **Duration of intervention:**  10 weeks  **Sample type(s) (with N randomized for each):**  - Patients: 1,420  - Clinics/practices/ hospitals: 6  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The computerized medical record system identifies patients for whom preventive procedures are due and automatically generates reminders for them using three mechanisms: reminder by mailed letter, telephone reminder by nurse, personal reminder by physician.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Immunization  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Intervention 1 = Reminder by letter  2) Intervention 2 = Telephone reminder by nurse  3) Intervention 3 = Personal reminder by physician (CDSS)  Control 1 = Randomized control group  Control 2 = Control practices | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Rates of vaccination, n (%)—  Intervention 2: 77 of 208 (37.0%)  Control 1: 21 of 215 (9.8%)  Control 2: 17 of 444 (3.8%)  3 intervention groups differed from randomized control group (χ2 = 40.7, 1df, p < 0.001)  Difference among 3 intervention groups (χ2 = 11.1, 1df, p < 0.005)  Personal reminder by physician vs control (z = 3.4, p < 0.005)  Rates of vaccination for patients contacted who had not been vaccinated before the trial—  Intervention 2: 77 of 177 (43.5%)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: NR  - Cost-effectiveness: The cost of letter rises slowly as the physician’s salary increases. Telephone method is more cost-effective than letter if nurse is paid less than $16 per hour. Personal contact by physicians is more cost-effective than letter if physician’s salary is $50 per hour or less.  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Learning bias in physicians; vaccination rate in randomized controlled group was significantly higher than control practices  Baseline was measured based on individual patient instead of family  Blinding, randomization method, and concealment were not reported  **Applicability/ generalizability:**  Academic medical center  Short study duration  Varying cost in other institutions |
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| **McDowell, Newell, and Rosser, 1986**  #7366  **Comparison 3 of 3** | **Geographical location:**  6 sites in Ontario, Canada  **Study dates:**  Oct 23, 1984–Dec 31, 1984  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Family  **Duration of intervention:**  10 weeks  **Sample type(s) (with N randomized for each):**  - Patients: 1,420  - Clinics/practices/ hospitals: 6  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The computerized medical record system identifies patients for whom preventive procedures are due and automatically generates reminders for them using three mechanisms: reminder by mailed letter, telephone reminder by nurse, personal reminder by physician.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Immunization  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Intervention 1 = Reminder by letter  2) Intervention 2 = Telephone reminder by nurse  3) Intervention 3 = Personal reminder by physician (CDSS)  Control 1 = Randomized control group  Control 2 = Control practices | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Rates of vaccination, n (%)—  Intervention 3: 46 of 201 (22.9%)  Control 1: 21 of 215 (9.8%)  Control 2: 17 of 444 (3.8%)  3 intervention groups differed from randomized control group (χ2 = 40.7, 1df, p < 0.001)  Difference among 3 intervention groups (χ2 = 11.1, 1df, p < 0.005)  Personal reminder by physician vs control (z = 3.4, p < 0.005)  Rates of vaccination for patients contacted who had not been vaccinated before the trial—  Intervention 3: 46 of 102 (45.1%)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: NR  - Cost-effectiveness: The cost of letter rises slowly as the physician’s salary increases. Telephone method is more cost-effective than letter if nurse is paid less than $16 per hour. Personal contact by physicians is more cost-effective than letter if physician’s salary is $50 per hour or less.  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Learning bias in physicians; vaccination rate in randomized controlled group was significantly higher than control practices  Baseline was measured based on individual patient instead of family  Blinding, randomization method, and concealment were not reported  **Applicability/ generalizability:**  Academic medical center  Short study duration  Varying cost in other institutions |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **McDowell, Newell, and Rosser, 1989A**  #7290 | **Geographical location:**  6 sites in Ottawa, Canada  **Study dates:**  1985  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel-group  **Unit of randomization:**  Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 1406  - Clinics: 4  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Center uses a computerized record. In the physician group, the computer printed a message to the physician to recommend cervical cancer screening; repeat reminders were generated for subsequent visits until a test was done.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N (not in physician reminder group)  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS  4 arms:  1) Physician reminder (n = 332)  2) Letter reminder (n = 367)  3) Telephone reminder (n = 377)  4) No intervention control (n = 330) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Pap smears for those due—  Physician reminder: 41 of 255 = 16.1%  Letter reminder: 76 of 293 = 25.9%  Telephone reminder: 60 of 300 = 20%  Control: 35 of 255 = 13.7%  Physician reminders added only 2.4% to the screening rate; telephone reminder added 6.3%, whereas the letter was the most effective, increasing the screening rate by 12.2%. The difference among the four random groups was statistically significant (p < 0.005). The results for the physician intervention, however, were not significantly better than those of randomized control (z = 0.62, NS).  Effectiveness of the reminders, contacted, # (%); screening done, # (%)—  Physician reminder: 94 of 255 (36.9); 41 (43.6%)  Letter reminder: 188 of 287 (65.5); 64 (34.0)  Telephone reminder: 124 of 291 (30.4); 54 (36.7)  Control: 101 of 255 (39.6); 35 (34.7%)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: NR  - Cost-effectiveness: Cost including staff and material costs—  Cost per screening gained was $11.75 for an MD salary of $60 per hour; $5.88 for an MD salary of $30 per hour  Letter reminder cost (including stationery, stamps, prepaid replies, 158 followup letters, and clerical staff to assemble the letters was $444.06  Telephone reminder cost was $196 to call 280 women (salary of $15 an hour);  Cost per screening gained was $11.26 for a nurse salary $10 per hour; $4.38 for a nurse salary $5 per hour  **6) Impact on HCP use and implementation:** NR | **General comments:**  4 arms but only one aimed at MD and one control  **Quality assessment:**  Overall rating: Fair  Comments:  Possible contamination, inadequate reporting of methods and results, inadequate statistical analysis  **Applicability/ generalizability:**  Multiple interventions aimed at patients and nurses; Canadian practices |
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| **McDowell, Newell, and Rosser, 1989B**  #7291 | **Geographical location:**  6 sites in Ottawa, Canada  **Study dates:**  March 1985–June 1986  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Other—family  **Duration of intervention:**  15 month(s)  **Sample type(s) (with N randomized for each):**  - Patients: 6167 families; 8298 patients  - Practices: 6  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer printed a “check blood pressure” note to MD at time of patient visit until a reading was recorded; the computer continued to generate reminders on subsequent visits.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N (not in physician reminder group)  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS  4 arms:  1) Physician reminder (n = 1423)  2) Letter reminder (n = 1508)  3) Telephone reminder (n = 1433)  4) No intervention control (n = 1371) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study completed: Blood pressure check—  Physician reminder: 325 of 1059 = 30.7%  Letter reminder: 391 of 1094 = 35.7%  Telephone reminder: 251 of 1042 = 24.1%  Control: 210 of 996 = 21.1%  Efficacy of reminders: Outcomes after reminder week—  Physician reminder: 173 of 294 = 65.5%  Letter reminder: 302 of 886 = 34.1%  Telephone reminder: 154 of 637 = 24.2%  Control: 130 of 305 = 42.6%  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: NR  - Cost-effectiveness: Cost per reading gained for physician reminder was $1.70 or $1.33 according to salary level  Cost per reading gained for letter reminder was $14.37  Cost per reading gained for telephone reminder was $31.27 or $22.47 according to salary level  **6) Impact on HCP use and implementation:** NR | **General comments:**  4 groups: only 1 aimed at physician and 1 control  Similar study but different outcome measures as McDowell, Newell, and Rosser, 1989A; possible contamination across these two studies  **Quality assessment:**  Overall rating: Fair  Comments:  Possible contamination, inadequate reporting of methods and results, inadequate statistical analysis  **Applicability/ generalizability:**  Multiple interventions aimed at patients and nurses; Canadian practices |
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| **McGregor, Weekes, Forrest, et al., 2006**  #2627 | **Geographical location:**  Baltimore, MD  **Study dates:**  May 10–August 3, 2004  **General setting:**  Academic  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  12 weeks  **Sample type(s) (with N randomized for each):**  Patients: 4507 patient admissions; 2237 to intervention and 2270 to control  **User level of expertise/ proficiency:**  High | **Authors’ basic description of system:**  PharmWatch decision support designed to assist in the management of antimicrobial utilization. Alerts were designed to detect scenarios of potentially inappropriate or inadequate antimicrobial use.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay:  Intervention: 3.84 (2.12 to 7.57)  Control: 3.99 (2.19 to 7.57)  p = 0.38  - Morbidity: NR  - Mortality:  Intervention: 73 of 2237 = 3.26%  Control: 67 of 2270 = 2.95%  p = 0.55  - Validated measure of HRQOL or functional status: NR  - Adverse events: Testing for C. difficile—  Intervention: 127 of 2237 = 5.7%  Control: 150 of 2270 = 6.6%  p = 0.21  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Team intervention—  Intervention: 359 of 1315 = 16%  Control: 180 of 1325 = 7.9%  - Impact on user knowledge: NR    **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: The antimicrobial management team spent an average of 4.1 person-hours per day making interventions on the control arm and 3.2 person-hours per day on the intervention arm. Thus, the team spent roughly one hour less each day intervening on the intervention arm than the control arm of the trial.  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Antimicrobials—  Intervention: $285,812  Control: $370,006  Cost savings of $84,194 (22.8%)  Cost of restricted antimicrobials—  Intervention: $131,660  Control: $191,948  Cost savings of $60,288 (31%)  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  CDSS aimed at antimicrobial team  **Quality assessment:**  Overall rating: Good  Comments:  Intervention was blinded  **Applicability/ generalizability:**  Randomized by even/odd # MRN  Would only work in large academic setting that has an antimicrobial team |
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| **McLaughlin, Hayes, and Kelleher, 2010**  #15296 | Geographical location:  6 clinics in the US  Study dates: NR  General setting: NR  Specific setting:  Outpatient  Study design:  RCT, cluster randomization  Unit of randomization:  Clinic or team  Duration of intervention: NR  Sample type(s) (with N randomized for each):  Patients: 176 patients with abnormal blood pressure  Clinics/practices/ hospitals: 6  Individual HCPs: 40  [Training MDs and attending MDs]  User level of expertise/ proficiency:  The PDA intervention was also explained to physicians working at these clinics to ensure their understanding and to make them aware the PDA receipt would be placed in their patients’ records at future visits. | **Authors’ basic description of system:**  PDA application to calculate a blood pressure (BP) percentile or percentile range for each BP value entered. If the BP was ≥ 95th percentile, then “AB” was displayed next to the value as an abnormal flag.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  -Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Group 1: Paper normative pediatric BP table affixed to the growth chart  Group 2: PDA  Group 3: Usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance:  Intervention compliance—  Group 1 (BP table)  Compliance: 18%  Noncompliance: 12%  Group 2 (PDA)  Compliance: 33%  Noncompliance: 26%  Group 3 (Usual care)  Compliance: 18%  P = 0.27  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  Quality assessment:  Overall rating: Poor  Comments:  4 clinics dropped from study.  Unknown number of pediatricians (from 40) left in the pool of clinicians accepted for randomization.  Missing outcome data; no discussion of randomization, blinding, or allocation concealment process  **Applicability/ generalizability:**  Multisite trial across pediatric clinics  Locally developed PDA application  Included residents, but exact number was unclear |
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| **Montgomery, Fahey, Peters, et al., 2000**  #5769  **Comparison 1 of 2** | **Geographical location:**  27 sites in Avon, UK  **Study dates:**  Sept 1996–Sept 1998  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 614  - Clinics/practices/ hospitals: 27  - Individual HCPs:  > MDs: 74 GP  > Practice nurse: 11  **User level of expertise/ proficiency:**  GPs and nurses were trained to use the computer-based CDSS by one of the authors | **Authors’ basic description of system:**  A computer-based CDSS was written for the two most commonly used practice computing systems (EMIS and AAH Meditel) so that it could be incorporated into routine clinical care. The system is identical to the New Zealand guidelines for the management of hypertension, except that absolute risk is presented numerically rather than pictorially.  The following patient information is required to ascertain absolute cardiovascular risk: sex, age, diabetes, smoking, blood pressure, cholesterol, body mass index, symptomatic cardiovascular disease, family history of ischaemic heart disease, and familial hypercholesterolaemia. The system then calculates the patient’s 5-year risk of a fatal or nonfatal cardiovascular event.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Diagnosis  - Pharmacotherapy  *b) Relationship to point of care:*  Not clearly described  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y/N/Can’t tell Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Intervention 1 = CDSS + cardiovascular risk chart  2) Intervention 2 = cardiovascular risk chart  Control = usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Number (%) of patients prescribed different numbers of cardiovascular drugs at baseline and 6-month followup—  0-1 classes of drugs:  Intervention 1 (n = 207): 81 (39)  Control (n = 137): 50 (37)  2 classes of drugs:  Intervention 1: 74 (36)  Control: 47 (34)  More than 3 classes of drugs:  Intervention 1: 52 (25)  Control: 40 (29)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Simple randomization using table random numbers.  GPs, nurses, and patients were not blinded  Greater than 10% attrition rate at 12-month followup  Outcomes not consistently reported  **Applicability/ generalizability:**  The use of New Zealand guidelines may affect adoption in other care providers  Only involved general practice  Only older patients involved in the study (60 to 80 years old) |
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| **Montgomery, Fahey, Peters, et al., 2000**  #5769  **Comparison 2 of 2** | **Geographical location:**  27 sites in Avon, UK  **Study dates:**  Sept 1996–Sept 1998  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 614  - Clinics/practices/ hospitals: 27  - Individual HCPs:  > MDs; 74 GP  > Practice nurse: 11  **User level of expertise/ proficiency:**  GPs and nurses were trained to use the computer based CDSS by one of the authors. | **Authors’ basic description of system:**  A computer-based CDSS was written for the two most commonly used practice computing systems (EMIS and AAH Meditel) so that it could be incorporated into routine clinical care. The system is identical to the New Zealand guidelines for the management of hypertension, except that absolute risk is presented numerically rather than pictorially.  The following patient information is required to ascertain absolute cardiovascular risk: sex, age, diabetes, smoking, blood pressure, cholesterol, body mass index, symptomatic cardiovascular disease, family history of ischaemic heart disease, and familial hypercholesterolaemia. The system then calculates the patient’s five year risk of a fatal or nonfatal cardiovascular event.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Diagnosis  - Pharmacotherapy  *b) Relationship to point of care:*  Not clearly described  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Intervention 1 = CDSS + cardiovascular risk chart  2) Intervention 2 = cardiovascular risk chart  Control = usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Number (%) of patients prescribed different numbers of cardiovascular drugs at baseline and 6-month followup—  0-1 classes of drugs:  Intervention 2 (n = 208): 68 (33)  Control (n = 137): 50 (37)  2 classes of drugs:  Intervention 2: 67 (32)  Control: 47 (34)  More than 3 classes of drugs:  Intervention 2: 73 (35)  Control: 40 (29)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Simple randomization using table random numbers  GPs, nurses, and patients were not blinded  Greater than 10% attrition rate at 12-month followup  Outcomes not consistently reported  **Applicability/ generalizability:**  The use of New Zealand guidelines may affect adoption in other care providers  Only involved general practice.  Only older patients involved in the study (60 to 80 years old) |
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| **Murray, Harris, Overhage, et al., 2004**  #4153  **Comparison 1 of 3** | **Geographical location:**  Indianapolis, IN  **Study dates:**  January 1, 1994–May 1, 1996 (patients recruited)  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2 factorial design  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 712  **User level of expertise/ proficiency:** NR | **Physician intervention**  **Authors’ basic description of system:**  Computer-based physician order-entry for hypertension management.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management (hypertension)  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Physician Intervention:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS  2 x 2 factorial design:  1) Control (n = 171)  2) Physician intervention (n = 181)  3) Pharmacist intervention (n = 180)  4) Dual intervention [physician + pharmacist] (n = 180) | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity (all hospitalizations)—  Control: 0.25 ± 0.89  Physician: 0.25 ± 0.69  Pharmacist: 0.25 ± 0.62  Dual: 0.19 ± 0.74  Morbidity (heart disease–specific hospitalizations)—  Control: 0.02 ± 0.13  Physician: 0.01 ± 0.10  Pharmacist: 0.01 ± 0.07  Dual: 0.01 ± 0.11  - Mortality: NR  - Validated measure of HRQOL or functional status: Bulpitts overall score, mean ± SD—  Control (n = 127): 36 ± 21  Physician Intervention (n = 124): 35 ± 20  Pharmacist intervention (n = 116): 37 ± 21  Dual intervention (n = 116): 38 ± 22  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed—  Control: n = 171  Physician intervention: n = 181  Pharmacist intervention: n = 180  Dual intervention: n = 180  All antihypertensive drug suggestions, # (%) of patients with any suggestion:  Control: 114 (67)  Physician: 123 (68)  Pharmacist: 117 (65)  Dual: 125 (69)  # of suggestions (mean #/patient ± SD):  Control: 245 (2.1 ± 1.1)  Pharmacist: 234 (2.0 ± 1.1)  Physician: 255 (2.1 ± 1.1)  Dual: 243 (1.9 ± 1.0)  Mean patient adherence score ± SD:  Control: 26 ± 33  Physician: 29 ± 36  Pharmacist: 25 ± 33  Dual: 35 ± 39  Start or increase ACE inhibitor, # (%) of patients with any suggestion:  Control: 91 (53)  Physician: 92 (51)  Pharmacist: 89 (42)  Dual: 96 (53)  Mean patient adherence score ± SD:  Start or increase ACE inhibitor:  Control: 30 ± 46  Physician: 44 ± 50  Pharmacist: 33 ± 47  Dual: 41 ± 49  Start diuretic, # (%) of patients with any suggestion:  Control: 58 (34)  Physician: 55 (30)  Pharmacist: 54 (30)  Dual: 52 (29)  Mean patient adherence score ± SD:  Control: 31 ± 47  Physician: 22 ± 42  Pharmacist: 22 ± 42  Dual: 25 ± 44  Start or increase calcium channel blocker, # (%) of patients with any suggestion:  Control: 51 (30)  Physician: 56 (31)  Pharmacist: 38 (21)  Dual: 46 (26)  Mean patient adherence score ± SD:  Control: 49 ± 51  Physician: 34 ± 48  Pharmacist: 47 ± 51  Dual: 39 ± 49  Start or increase β-blocker, # (%) of patients with any suggestion:  Control: 20 (12)  Physician: 31 (17)  Pharmacist: 35 (14)  Dual: 34 (19)  Mean patient adherence score ± SD:  Control: 45 ± 51  Physician: 45 ± 51  Pharmacist: 29 ± 46  Dual: 47 ± 51  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost (mean ± SD): Total charges—  Control (n = 171): 5149 ± 11,756  Physician Intervention (n = 181): 6200 ± 18,947  Pharmacist intervention (n = 180): 5445 ± 9612  Dual intervention (n = 180): 3122 ± 4633  Outpatient charges—  Control: 3005 ± 4318  Physician: 2681 ± 3520  Pharmacist: 2868 ± 3553  Dual: 2229 ± 2137  Inpatient charges—  Control: 2145 ± 9805  Physician: 3519 ± 17830  Pharmacist: 2577 ± 7709  Dual: 893 ± 3450  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Potential for contamination, one academic site  **Applicability/ generalizability:**  Well-established health IT infrastructure; EMR in place for 25+ years; residents |
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| **Murray, Harris, Overhage, et al., 2004**  #4153  **Comparison 2 of 3** | **Geographical location:**  Indianapolis, IN  **Study dates:**  January 1, 1994–May 1, 1996 (patients recruited)  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2 factorial design  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 712  **User level of expertise/ proficiency:** NR | **Pharmacist intervention**  **Authors’ basic description of system:**  Computer-based pharmacist intervention for hypertension management.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management (hypertension)  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Pharmacist Intervention:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS  2 x 2 factorial design:  1) Control (n = 171)  2) Physician intervention (n = 181)  3) Pharmacist intervention (n = 180)  4) Dual intervention [physician + pharmacist] (n = 180) | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity (all hospitalizations)—  Control: 0.25 ± 0.89  Physician: 0.25 ± 0.69  Pharmacist: 0.25 ± 0.62  Dual: 0.19 ± 0.74  Morbidity (heart disease–specific hospitalizations)—  Control: 0.02 ± 0.13  Physician: 0.01 ± 0.10  Pharmacist: 0.01 ± 0.07  Dual: 0.01 ± 0.11  - Mortality: NR  - Validated measure of HRQOL or functional status: Bulpitts overall score, mean ± SD—  Control (n = 127): 36 ± 21  Physician Intervention (n = 124): 35 ± 20  Pharmacist intervention (n = 116): 37 ± 21  Dual intervention (n = 116): 38 ± 22  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed—  Control: n = 171  Physician intervention: n = 181  Pharmacist intervention: n = 180  Dual intervention: n = 180  All antihypertensive drug suggestions, # (%) of patients with any suggestion:  Control: 114 (67)  Physician: 123 (68)  Pharmacist: 117 (65)  Dual: 125 (69)  # of suggestions (mean #/patient ± SD):  Control: 245 (2.1 ± 1.1)  Pharmacist: 234 (2.0 ± 1.1)  Physician: 255 (2.1 ± 1.1)  Dual: 243 (1.9 ± 1.0)  Mean patient adherence score ± SD:  Control: 26 ± 33  Physician: 29 ± 36  Pharmacist: 25 ± 33  Dual: 35 ± 39  Start or increase ACE inhibitor, # (%) of patients with any suggestion:  Control: 91 (53)  Physician: 92 (51)  Pharmacist: 89 (42)  Dual: 96 (53)  Mean patient adherence score ± SD:  Control: 30 ± 46  Physician: 44 ± 50  Pharmacist: 33 ± 47  Dual: 41 ± 49  Start diuretic, # (%) of patients with any suggestion:  Control: 58 (34)  Physician: 55 (30)  Pharmacist: 54 (30)  Dual: 52 (29)  Mean patient adherence score ± SD:  Control: 31 ± 47  Physician: 22 ± 42  Pharmacist: 22 ± 42  Dual: 25 ± 44  Start or increase calcium channel blocker, # (%) of patients with any suggestion:  Control: 51 (30)  Physician: 56 (31)  Pharmacist: 38 (21)  Dual: 46 (26)  Mean patient adherence score ± SD:  Control: 49 ± 51  Physician: 34 ± 48  Pharmacist: 47 ± 51  Dual: 39 ± 49  Start or increase β-blocker, # (%) of patients with any suggestion:  Control: 20 (12)  Physician: 31 (17)  Pharmacist: 35 (14)  Dual: 34 (19)  Mean patient adherence score ± SD:  Control: 45 ± 51  Physician: 45 ± 51  Pharmacist: 29 ± 46  Dual: 47 ± 51  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost (mean ± SD): Total charges—  Control (n = 171): 5149 ± 11,756  Physician Intervention (n = 181): 6200 ± 18,947  Pharmacist intervention (n = 180): 5445 ± 9612  Dual intervention (n = 180): 3122 ± 4633  Outpatient charges—  Control: 3005 ± 4318  Physician: 2681 ± 3520  Pharmacist: 2868 ± 3553  Dual: 2229 ± 2137  Inpatient charges—  Control: 2145 ± 9805  Physician: 3519 ± 17830  Pharmacist: 2577 ± 7709  Dual: 893 ± 3450  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Potential for contamination, one academic site  **Applicability/ generalizability:**  Well-established health IT infrastructure; EMR in place for 25+ years; residents |
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| **Murray, Harris, Overhage, et al., 2004**  #4153  **Comparison 3 of 3** | **Geographical location:**  Indianapolis, IN  **Study dates:**  January 1, 1994–May 1, 1996 (patients recruited)  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2 factorial design  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 712  **User level of expertise/ proficiency:** NR | **Dual intervention**  **Authors’ basic description of system:**  Computer-based physician and pharmacist (dual) order-entry for hypertension management.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management (hypertension)  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Dual Intervention:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS  2 x 2 factorial design:  1) Control (n = 171)  2) Physician intervention (n = 181)  3) Pharmacist intervention (n = 180)  4) Dual intervention [physician + pharmacist] (n = 180) | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity (all hospitalizations)—  Control: 0.25 ± 0.89  Physician: 0.25 ± 0.69  Pharmacist: 0.25 ± 0.62  Dual: 0.19 ± 0.74  Morbidity (heart disease–specific hospitalizations)—  Control: 0.02 ± 0.13  Physician: 0.01 ± 0.10  Pharmacist: 0.01 ± 0.07  Dual: 0.01 ± 0.11  - Mortality: NR  - Validated measure of HRQOL or functional status: Bulpitts overall score, mean ± SD—  Control (n = 127): 36 ± 21  Physician Intervention (n = 124): 35 ± 20  Pharmacist intervention (n = 116): 37 ± 21  Dual intervention (n = 116): 38 ± 22  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed—  Control: n = 171  Physician intervention: n = 181  Pharmacist intervention: n = 180  Dual intervention: n = 180  All antihypertensive drug suggestions, # (%) of patients with any suggestion:  Control: 114 (67)  Physician: 123 (68)  Pharmacist: 117 (65)  Dual: 125 (69)  # of suggestions (mean #/patient ± SD):  Control: 245 (2.1 ± 1.1)  Pharmacist: 234 (2.0 ± 1.1)  Physician: 255 (2.1 ± 1.1)  Dual: 243 (1.9 ± 1.0)  Mean patient adherence score ± SD:  Control: 26 ± 33  Physician: 29 ± 36  Pharmacist: 25 ± 33  Dual: 35 ± 39  Start or increase ACE inhibitor, # (%) of patients with any suggestion:  Control: 91 (53)  Physician: 92 (51)  Pharmacist: 89 (42)  Dual: 96 (53)  Mean patient adherence score ± SD:  Control: 30 ± 46  Physician: 44 ± 50  Pharmacist: 33 ± 47  Dual: 41 ± 49  Start diuretic, # (%) of patients with any suggestion:  Control: 58 (34)  Physician: 55 (30)  Pharmacist: 54 (30)  Dual: 52 (29)  Mean patient adherence score ± SD:  Control: 31 ± 47  Physician: 22 ± 42  Pharmacist: 22 ± 42  Dual: 25 ± 44  Start or increase calcium channel blocker, # (%) of patients with any suggestion:  Control: 51 (30)  Physician: 56 (31)  Pharmacist: 38 (21)  Dual: 46 (26)  Mean patient adherence score ± SD:  Control: 49 ± 51  Physician: 34 ± 48  Pharmacist: 47 ± 51  Dual: 39 ± 49  Start or increase β-blocker, # (%) of patients with any suggestion:  Control: 20 (12)  Physician: 31 (17)  Pharmacist: 35 (14)  Dual: 34 (19)  Mean patient adherence score ± SD:  Control: 45 ± 51  Physician: 45 ± 51  Pharmacist: 29 ± 46  Dual: 47 ± 51  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost (mean ± SD): Total charges—  Control (n = 171): 5149 ± 11,756  Physician Intervention (n = 181): 6200 ± 18,947  Pharmacist intervention (n = 180): 5445 ± 9612  Dual intervention (n = 180): 3122 ± 4633  Outpatient charges—  Control: 3005 ± 4318  Physician: 2681 ± 3520  Pharmacist: 2868 ± 3553  Dual: 2229 ± 2137  Inpatient charges—  Control: 2145 ± 9805  Physician: 3519 ± 17830  Pharmacist: 2577 ± 7709  Dual: 893 ± 3450  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Potential for contamination, 1 academic site  **Applicability/ generalizability:**  Well-established health IT infrastructure; EMR in place for 25+ years; residents |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Ornstein, Garr, Jenkins, et al., 1991**  #7209  **Comparison 1 of 3** | **Geographical location:**  Charleston, SC  **Study dates:**  July 1, 1988–July 1, 1989  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  - Clinician  - Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 7397  - Individual HCPs  (family medicine):  > MDs: 6  > Trainees: 43  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer-generated reminders for five preventive services by scanning each patient record for deficient preventive services. Reminder forms were generated for physicians and letters for patients.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS  Control  1) Intervention 1 = MD reminders  2) Intervention 2 = MD+PT reminders  3) Intervention 3 = PT reminders | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage change (95% CI) between study period—  Cholesterol:  Control (n = 1422): 9.1 (8.0 to 10.1)  Intervention 1 (n = 1826): 12.3 (11.3 to 13.2)  All P < 0.0001  Fecal occult blood test (FOBT):  Control (n = 618): 8.1 (4.7 to 11.5), P < 0.0001  Intervention 1 (n = 818): 5.1 (1.8 to 8.5), P = 0.0030  Mammography:  Control (n = 266): 15.7 (10.7 to 20.9), P < 0.0001  Intervention 1 (n = 345): 10.7 (4.7 to16.8), P = 0.0009  Pap smear:  Control (n = 843) = -0.9 (-4.0 to 2.1), P = 0.54  Intervention 1 (n = 1111): -4.5 (-7.1 to -1.9), P = 0.001  Tetanus:  Control (n = 1576): 3.8 (3.1 to 4.4)  Intervention 1 (n = 1988): 10.5 (9.8 to 11.3)  All P < 0.0001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Disposition of physician reminders—  Cholesterol, n = 1883  FOBT, n = 1817  Mammography, n = 1038  Pap smear, n = 1103  Tetanus, n = 2317  Total = 8158  Physician response, n (%):  Ordered test—  Cholesterol = 646 (34)  FOBT = 765 (42)  Mammography = 212 (20)  Pap smear = 247 (22)  Tetanus = 470 (20)  Total = 2340 (29)  Rescheduled—  Cholesterol = 182 (10)  FOBT = 172 (9)  Mammography = 148 (14)  Pap Smear = 248 (22)  Tetanus = 281 (12)  Total = 1027 (13)  Not indicated—  Cholesterol = 472 (25)  FOBT = 320 (18)  Mammography = 183 (18)  Pap smear = 356 (32)  Tetanus = 646 (28)  Total = 1977 (24)  Patient refused—  Cholesterol = 44 (2)  FOBT = 48 (3)  Mammography = 183 (18)  Pap smear = 32 (3)  Tetanus = 135 (6)  Total = 442 (5)  Did not discuss—  Cholesterol = 394 (21)  FOBT = 379 (21)  Mammography = 251 (24)  Pap smear = 158 (14)  Tetanus = 593 (26)  Total = 1775 (22)  Blank—  Cholesterol = 145 (8)  FOBT = 133 (7)  Mammography = 61 (6)  Pap smear = 66 (6)  Tetanus = 192 (8)  Total = 597 (7)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  4 of 49 physicians left during study period; replaced by other physicians  Statistically significant difference exists between baseline groups (race, insurance coverage, and visit frequency)  History and learning bias/Hawthorne effect in physicians during intervention period (same building)  **Applicability/ generalizability:**  Academic medical center  Single site  Clinical settings with patient or physicians better educated about preventive services might not respond as favorably to computer-based prompts |
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| **Ornstein, Garr, Jenkins, et al., 1991**  #7209  **Comparison 2 of 3** | **Geographical location:**  Charleston, SC  **Study dates:**  July 1, 1988–July 1, 1989  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  - Clinician  - Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 7397  - Individual HCPs  (family medicine)  > MDs: 6  > Trainee: 43  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer-generated reminders for five preventive services by scanning each patient record for deficient preventive services. Reminder forms were generated for physicians and letters for patients.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: NY  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS  Control  1) Intervention 1 = MD reminders  2) Intervention 2 = MD+PT reminders  3) Intervention 3 = PT reminders | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage change (95% CI) between study period—  Cholesterol:  Control (n = 1422): 9.1 (8.0 to 10.1)  Intervention 2 (n = 1732): 18.6 (17.8 to 19.5)  All P < 0.0001  Fecal occult blood test (FOBT):  Control (n = 618): 8.1 (4.7 to 11.5), P < 0.0001  Intervention 2 (n = 815): 17.7 (14.9 to 20.4), P <0.0001  Mammography:  Control (n = 266): 15.7(10.7 to 20.9), P < 0.0001  Intervention 2 (n = 332): 15.7 (11.1 to 20.2), P < 0.0001  Pap smear:  Control (n = 843): -0.9 (-4.0 to 2.1), P = 0.54  Intervention 2 (n = 1006): -0.8 (-3.7 to 2.1), P = 0.60  Tetanus:  Control (n = 1,576): 3.8 (3.1 to 4.4)  Intervention 2 (n = 1908): 12.0 (11.2 to 12.8)  All P <0.0001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Disposition of physician reminders—  Cholesterol, n = 1883  FOBT, n = 1817  Mammography, n = 1038  Pap smear, n = 1103  Tetanus, n = 2317  Total = 8158  Physician response, n (%)  Ordered test—  Cholesterol = 646 (34)  FOBT = 765 (42)  Mammography = 212 (20)  Pap smear = 247 (22)  Tetanus = 470 (20)  Total = 2340 (29)  Rescheduled—  Cholesterol = 182 (10)  FOBT = 172 (9)  Mammography = 148 (14)  Pap Smear = 248 (22)  Tetanus = 281 (12)  Total = 1027 (13)  Not indicated—  Cholesterol = 472 (25)  FOBT = 320 (18)  Mammography = 183 (18)  Pap smear = 356 (32)  Tetanus = 646 (28)  Total = 1977 (24)  Patient refused—  Cholesterol = 44 (2)  FOBT = 48 (3)  Mammography = 183 (18)  Pap smear = 32 (3)  Tetanus = 135 (6)  Total = 442 (5)  Did not discuss—  Cholesterol = 394 (21)  FOBT = 379 (21)  Mammography = 251 (24)  Pap smear = 158 (14)  Tetanus = 593 (26)  Total = 1775 (22)  Blank—  Cholesterol = 145 (8)  FOBT = 133 (7)  Mammography = 61 (6)  Pap smear = 66 (6)  Tetanus = 192 (8)  Total = 597 (7)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  4 of 49 physicians left during study period; replaced by other physicians  Statistically significant difference exists between baseline groups (race, insurance coverage, and visit frequency)  History and learning bias/Hawthorne effect in physicians during intervention period (same building)  **Applicability/ generalizability:**  Academic medical center  Single site  Clinical settings with patient or physicians better educated about preventive services might not respond as favorably to computer-based prompts |
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| **Ornstein, Garr, Jenkins, et al., 1991**  #7209  **Comparison 3 of 3** | **Geographical location:**  Charleston, SC  **Study dates:**  July 1, 1988–July 1, 1989  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  - Clinician  - Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 7397  - Individual HCPs  (family medicine):  > MDs: 6  > Trainees: 43  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computer-generated reminders for five preventive services by scanning each patient record for deficient preventive services. Reminder forms were generated for physicians and letters for patients.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: NY  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS  Control  1) Intervention 1 = MD reminders  2) Intervention 2 = MD+PT reminders  3) Intervention 3 = PT reminders | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage change (95% CI) between study period—  Cholesterol:  Control (n = 1422): 9.1 (8.0 to 10.1)  Intervention 3 (n = 1768): 13.6 (13.0 to 14.3)  All P < 0.0001  Fecal occult blood test (FOBT):  Control (n = 618): 8.1 (4.7 to 11.5), P < 0.0001  Intervention 3 (n = 782): 8.7 (5.8 to 11.6), P < 0.0001  Mammography:  Control (n = 266): 15.7 (10.7 to 20.9), P < 0.0001  Intervention 3 (n = 329): 2.8 (-3.0 to 8.5), P < 0.35  Pap smear:  Control (n = 843): -0.9 (-4.0 to 2.1), P = 0.54  Intervention 3 (n = 1054): -2.1 (-4.7 to 0.5), P = 12  Tetanus:  Control (n = 1576): 3.8 (3.1 to 4.4)  Intervention 3 (n = 1925): 9.5 (8.9 to 10.1)  All P < 0.0001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Disposition of physician reminders—  Cholesterol, n = 1883  FOBT, n = 1817  Mammography, n = 1038  Pap smear, n = 1103  Tetanus, n = 2317  Total = 8158  Physician response, n (%)  Ordered test—  Cholesterol = 646 (34)  FOBT = 765 (42)  Mammography = 212 (20)  Pap smear = 247 (22)  Tetanus = 470 (20)  Total = 2340 (29)  Rescheduled—  Cholesterol = 182 (10)  FOBT = 172 (9)  Mammography = 148 (14)  Pap Smear = 248 (22)  Tetanus = 281 (12)  Total = 1027 (13)  Not indicated—  Cholesterol = 472 (25)  FOBT = 320 (18)  Mammography = 183 (18)  Pap smear = 356 (32)  Tetanus = 646 (28)  Total = 1977 (24)  Patient refused—  Cholesterol = 44 (2)  FOBT = 48 (3)  Mammography = 183 (18)  Pap smear = 32 (3)  Tetanus = 135 (6)  Total = 442 (5)  Did not discuss—  Cholesterol = 394 (21)  FOBT = 379 (21)  Mammography = 251 (24)  Pap smear = 158 (14)  Tetanus = 593 (26)  Total = 1775 (22)  Blank—  Cholesterol = 145 (8)  FOBT = 133 (7)  Mammography = 61 (6)  Pap smear = 66 (6)  Tetanus = 192 (8)  Total = 597 (7)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  4 of 49 physicians left during study period; replaced by other physicians  Statistically significant difference exists between baseline groups (race, insurance coverage, and visit frequency)  History and learning bias/Hawthorne effect in physicians during intervention period (same building)  **Applicability/ generalizability:**  Academic medical center  Single site  Clinical settings with patient or physicians better educated about preventive services might not respond as favorably to computer-based prompts |
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| **Overhage, Tierney, and McDonald, 1996**  #6674 | **Geographical location:**  Indianapolis, IN  **Study dates:**  Oct 26, 1992–April 1993  **General setting:**  Academic  **Specific setting:**  Inpatient–non-ICU  **Study design:**  RCT, cluster group  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 1929 (of which 1622 were eligible)  - Training MDs: 78  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Twenty-two preventive care reminders derived from USPTF recommendations were printed on reports that the physicians received.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Complied with preventive care—  Intervention: 23%  Control: 24%  P = 0.78  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Preventive care for hospitalized  Patients in one academic center  Well-established health IT infrastructure and historically an early adopter of health IT |
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| **Overhage, Tierney, Zhou, et al., 1997**  #6468 | **Geographical location:**  Indianapolis, IN  **Study dates:**  Oct 1992–July 1993  **General setting:** Academic  **Specific setting:**  Inpatient–non-ICU  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  30 weeks  **Sample type(s) (with N randomized for each):**  - Patients: 2181 (for which 1686 had at least one order written)  - Training MDs, internal medicine: 86  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Corollary orders alert system to get MDs to order tests or treatments needed to monitor the effects of other tests or treatments.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: Average—  Intervention: 7.62 days  Control: 8.12 days  Difference of -0.5 days (95% CI  -0.17, 1.19; p = 0.94)  - Morbidity: NR  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: 24 hour compliance—  Intervention 46.3%  Control 21.9%  P < 0.0001  24-hour compliance—  Intervention: 50.4%  Control: 29.0%  P < 0.0001  Hospital stay compliance—  Intervention: 55.9%  Control: 37.1%  P < 0.0001  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Average hospital charges—  Intervention: $8,073  Control: $8,589  Difference of -$515.95 (95% CI  -$828.41, $1316.58; p = 0.68)  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  87 target orders  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  One academic medical center; well-established health IT infrastructure and history of being an early adopter of health IT; physicians had been using computer workstations to enter orders for more than 12 months; residents wrote orders |
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| **Palen, Price, Snyder, et al., 2010**  #14780 | Geographical location:  8 sites in Denver, Colorado  Study dates:  January 2005- September 2007  General setting:  Community  Specific setting:  Outpatient  Study design:  RCT, cluster randomization  Unit of randomization:  Clinic or team  Duration of intervention:  19 month(s)  Sample type(s) (with N randomized for each):  Clinics/practices/ hospitals: 8  User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  Age-specific alert implemented in an EHR targeted to a specific condition to reduce D-dimer testing in the elderly population.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  - Recommended clinical study ordered/completed:  Rate of completed D-dimer tests  per 1000 visits among patients 65  years and older—  Intervention clinics:  Prealert: 5.02  Postalert:1.52 (95% CI -4.20 to –  2.80; P < 0.001)  Control clinics:  Prealert: 2.11  Postalert: 0.81 (95% Cl -1.79 to  -0.80; P <.001).  Rate of completed D-dimer tests  per 1000 visits among patients <  65 years—  Intervention clinics:  Prealert: 4.15  Postalert: 4.29 (95% CI -0.34 to –  -0.61)  Control clinics:  Prealert: 3.84  Postalert: 4.35 (95% Cl, -0.460 to  0.460)    - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Single crossover cluster randomization was the actual study type  Quality assessment:  Overall rating: Fair  Comments:  Some patient baseline differences  Outcome assessors not blind to intervention status  Simple cluster by assigning half to control and intervention—not true randomization  **Applicability/ generalizability:**  Large multisite trial  No patient-centered outcomes  Well-established health IT infrastructure and history of being an early adopter of health IT |
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| **Palen, Raebel, Lyons, et al., 2006**  #2607 | **Geographical location:**  Colorado, US  **Study dates:**  Nov 1, 2002–Oct 31, 2003  **General setting:** NR  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Patients: 26,586  - Individual HCPs, internal medicine and family practice: 207  **User level of expertise/ proficiency:**  Intervention physicians received one-on-one training | **Authors’ basic description of system:**  Nonintrusive physician alerts were linked to specific medication orders. When physicians ordered these medications, guidelines for laboratory tests monitoring were suggested.  **Source/origin of system:**  Commercially developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement (nonintrusive alerts)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Lab testing performed as recommended—  Intervention: 56.6%  Control: 57% (8957 of 15,686), P = 0.31  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Nonintrusive alerts too weak  Robust health IT infrastructure |
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| **Paul, Andreassen, Tacconelli, et al., 2006**  #2377 | **Geographical location:**  - Israel  - Freiburg, Germany  - Rome, Italy  **Study dates:**  May 2004–November 2004  **General setting:**  Academic  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  **Study design:**  RCT, cluster randomized  **Unit of randomization:**  Hospital wards  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  Patients: 2,326  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The TREAT output includes the probability of infection and its severity, source of infection, pathogen distribution, mortality, and antibiotic coverage. TREAT recommends treatment by highlighting the top 3 antibiotic regimens with the highest cost-benefit difference and include no antibiotic treatment.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y, did preliminary cohort study  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell  *e) Other:* TREAT system was optional for physicians | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: Duration of hospital stay, median/mean (SD) (N = 2326)—  Control: 6/9.45 (11.52)  Intervention: 6/8.83 (11.29)  P value = 0.055  Duration of hospital stay among patients surviving 30 days median/mean (SD) (N = 1837)—  Control: 5/9.4 (12.2)  Intervention: 5/8.8 (11.9)  P value = 0.128  - Morbidity: Duration of fever, median/mean (SD) (N = 2326)—  Control: 1/2.5 (4.5)  Intervention: 1/2.4 (3.9)  P value = 0.253  - Mortality: 30 day mortality intention to treat, n (%)—  Control: 145 of 1012 (14.3%)  Intervention: 149 of 1153 (12.9)  P value = 0.61  30 day mortality per protocol, n (%)—  Control: 44 of 371 (11.9)  Intervention: 49 of 503 (9.7)  P value = 0.719  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Control: 176 of 273 (64.5%)  Intervention: 216 of 297 (72.7%)  OR (95% CI) P value  1.48 (1.03 to 2.11) 0.033  1.48 (0.95 to 2.29) 0.082 (adjusted)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Direct costs in Euros, mean (SD) per patient—  Control: 37.9 (54.2)  Intervention: 40.2 (57.6)  P value: 0.473  Overall side effect costs in Euros, mean (SD) per patient—  Control: 99.5 (1154.0)  Intervention: 100.1 (1085.1)  P value: 0.960  Ecological costs in Euros, mean (SD) per patient—  Control: 499.3 (414.1)  Intervention: 439.5 (388.4)  P value: 0.002  Total antibiotic costs in Euros, mean (SD) per patient—  Control: 623.2 (502.2)  Intervention: 565.4 (483.4)  P value: 0.007  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Blinded assessments to patient assignment;  cluster randomization design to minimize contamination  **Applicability/ generalizability:**  International academic settings  Locally developed system implemented in three different hospitals |
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| **Peterson, Radosevich, O'Connor, et al., 2008**  #830 | **Geographical location:**  24 sites in a single geographic region recruited through the Minnesota Academy of Physicians Research Network  **Study dates:**  June 2003–June 2004  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Patients: 7101  - Practices: 24  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A multicomponent intervention (TRANSLATE) that includes implementation of a diabetes registry, visit reminders, and patient-specific physician alerts for diabetes management.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  Chronic disease management:  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percentage of patients meeting diabetes performance measures at baseline and after intervention (means ± SEM)—  Blood pressure monitoring:  Baseline  IMPACT clinics: 95.1 ± 0.8  Control clinics: 94.3 ± 1.1  Intervention period  IMPACT clinics: 96.4 ± 0.6  Control clinics: 92.2 ± 1.2  P = 0.050  Renal testing:  Baseline  IMPACT clinics: 40.9 ± 4.4  Control clinics: 37.1 ± 4.3  Intervention period  IMPACT clinics: 64.1 ± 4.2  Control clinics: 31.8 ± 4.0  P < 0.001  Annual eye examination:  Baseline  IMPACT clinics: 35.5 ± 3.0  Control clinics: 24.8 ± 2.5  Intervention period  IMPACT clinics: 62.5 ± 3.1  Control clinics: 26.0 ± 2.6  P < 0.001  Foot examination:  Baseline  IMPACT clinics: 39.4 ± 4.2  Control clinics: 39.1 ± 4.2  Intervention period  IMPACT clinics: 68.8 ± 3.8  Control clinics: 33.5 ±3.9  P < 0.001  A1c testing:  Baseline  IMPACT clinics: 88.2 ± 1.5  Control clinics: 87.5 ± 1.5  Intervention Period  IMPACT clinics: 90.1 ± 1.1  Control clinics: 82.3 ± 1.9  P <0.001  LDL cholesterol testing:  Baseline  IMPACT clinics: 69.6 ± 3.0  Control clinics: 64.3 ± 3.2  Intervention period  IMPACT clinics: 78.0 ± 2.4  Control clinics: 64.6 ± 3.2  P < 0.001  % of mean eligible patients achieving recommended values—  A1c < 7  Intervention: 49%  Control: 43.8%  P < 0.001  SBP < 130  Intervention: 45%  Control: 40.6%  P < 0.001  LDL < 100  Intervention: 43%  Control: 35.5%  P < 0.001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Combined intervention aimed at MDs and patients  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Included only practices that did not have electronic medical records  Required a lot of work by site coordinator  Multiple components to intervention, including a site coordinator, local physician champion, education, admin support, etc. |
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| **Peterson, Rosenbaum, Waitman, et al., 2007**  #2332 | **Geographical location:**  Nashville, TN  **Study dates:**  12/8/2005–8/31/2006  **General setting:**  Academic  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  - Patients: 2987  - Individual HCPs: 778  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The CPOE-based text message displayed along with study dosing information communicated titration strategies, possible adverse effects, and key monitoring parameters. Geriatric dosing advisor follows guidelines for elderly patients.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Physicians used recommended doses—  Intervention: 28.6%  Control: 24.1%  P < 0.001  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  Poor description of control group, contamination, low use by MD, inadequate reporting of methods and results  **Applicability/ generalizability:**  One academic center  Proxy decisionmakers existed  Well-established health IT infrastructure |
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| **Phillips, Ziemer, Doyle, et al., 2005**  #3189  **AND**  **Ziemer, Doyle, Barnes, et al., 2006**  #2821  **Comparison 1 of 2** | **Geographical location:**  Atlanta, GA  **Study dates:**  January 1, 2000–December 31, 2002  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group, 2 x 2 factorial design  **Unit of randomization:**  Clinician  **Duration of intervention:**  3 years  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > Training MDs: 345 residents  **User level of expertise/ proficiency:**  Orientation yearly about the trial | **Authors’ basic description of system:**  The (computerized) reminders included both a flowsheet section—to show laboratory values, weight, blood pressure, and use of medications over a period of 6 to 18 months—and a recommendations section.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Computerized reminders-only group:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N (for reminders only group)  - CDSS accompanied by conventional education: Y (yearly) | **Comparator(s):**  2 x 2 factorial design:  1) Control  2) Reminders only  3) Feedback only  4) Reminders + feedback | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Impact of therapy Intensification on change in HbA1c levels (regression coefficient, P-value)—  Baseline HbA1c: 0.4348, < 0.001  Reminders only: -0.0667, 0.39  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Effect of the intervention on therapy intensification (regression coefficient, P-value)—  Reminders group at baseline: -0.0718, 0.77  Reminders group during intervention period: 0.0908, 0.18  From the text:  At baseline, there were no significant differences in health care provider behavior among the intervention groups (P > 0.70). After 1 year of the intervention, intensification of therapy increased in all 4 groups. However, the increases were significantly greater in both the feedback only and feedback + reminders group than among controls (P < 0.001 for both), but not in the reminders-only group compared with controls (P = 0.06).  During the intervention period, residents with more experience tended to intensify therapy more (P = 0.005 for PGY). Residents also intensified therapy more with younger patients (P = 0.001) and patients with higher BMI (P = 0.01). However, after adjusting for other factors, the feedback intervention significantly and independently increased the likelihood of intensification of therapy; in contrast, reminders had no significant independent impact and did not affect the impact of feedback (interaction term nonsignificant).  Over an average patient followup of 15 months within the intervention site, improvements in and final HbA1c (A1C) with feedback + reminders (\_A1C 0.6%, final A1C 7.46%) were significantly better than control (\_A1C 0.2%, final A1C 7.84%, *P*\_0.02).  Changes were smaller with feedback only and reminders only (*P* \_ NS versus control). Trends were similar but not significant with systolic blood pressure (sBP) and LDL cholesterol. Multivariable analysis showed that the feedback intervention independently facilitated attainment of American Diabetes Association goals for both A1C and sBP. Over a 2-year period, overall glycemic control improved in the intervention site but did not change in other primary care sites (final A1C 7.5 vs. 8.2%, *P* \_ 0.001).  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  High likelihood of contamination; inadequate reporting of methods  **Applicability/ generalizability:**  Population was primarily African American and economically disadvantaged  Did not use patient-centered outcomes  Included residents |
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| **Phillips, Ziemer, Doyle, et al., 2005**  #3189  **AND**  **Ziemer, Doyle, Barnes, et al., 2006**  #2821  **Comparison 2 of 2** | **Geographical location:**  Atlanta, GA  **Study dates:**  January 1, 2000–December 31, 2002  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group, 2 x 2 factorial design  **Unit of randomization:**  Clinician  **Duration of intervention:**  3 years  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > Training MDs: 345 residents  **User level of expertise/ proficiency:**  Orientation yearly about the trial | **Authors’ basic description of system:**  The (computerized) reminders included both a flowsheet section—to show laboratory values, weight, blood pressure, and use of medications over a period of 6 to 18 months—and a recommendations section.  Feedback sessions between one of the endocrinologists and a resident were approximately 5 minutes in duration and scheduled every 2 weeks. Feedback was based on IPCAAD report cards that showed individual provider actions or outcomes of the patients seen by that provider. Emphasis was placed on achieving ADA goals.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Computerized reminders + feedback group:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y (yearly) | **Comparator(s):**  2 x 2 factorial design:  1) Control  2) Reminders only  3) Feedback only  4) Reminders + feedback | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Impact of therapy intensification on change in HbA1c levels (regression coefficient, P-value)  Baseline HbA1c: 0.4348, < 0.001  Reminders + feedback: -0.0808, 0.46  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Effect of the intervention on therapy intensification (regression coefficient, P-value)—  Reminders + feedback group at baseline: -0.0204, 0.95  Reminders + feedback group during intervention period: 0.0125, 0.89  From the text:  At baseline, there were no significant differences in health care provider behavior among the intervention groups (P > 0.70). After 1 year of the intervention, intensification of therapy increased in all 4 groups. However, the increases were significantly greater in both the feedback only and feedback + reminders group than among controls (P < 0.001 for both), but not in the reminders-only group compared with controls (P = 0.06).  During the intervention period, residents with more experience tended to intensify therapy more (P = 0.005 for PGY). Residents also intensified therapy more with younger patients (P = 0.001) and patients with higher BMI (P = 0.01). However, after adjusting for other factors, the feedback intervention significantly and independently increased the likelihood of intensification of therapy; in contrast, reminders had no significant independent impact and did not affect the impact of feedback (interaction term nonsignificant).  Over an average patient followup of 15 months within the intervention site, improvements in and final HbA1c (A1C) with feedback + reminders (\_A1C 0.6%, final A1C 7.46%) were significantly better than control (\_A1C 0.2%, final A1C 7.84%, *P* = 0.02).  Changes were smaller with feedback only and reminders only (*P* = NS versus control). Trends were similar but not significant with systolic blood pressure (sBP) and LDL cholesterol. Multivariable analysis showed that the feedback intervention independently facilitated attainment of American Diabetes Association goals for both A1C and sBP. Over a 2-year period, overall glycemic control improved in the intervention site but did not change in other primary care sites (final A1C 7.5 vs. 8.2%, *P* = 0.001).  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  High likelihood of contamination; inadequate reporting of methods  **Applicability/ generalizability:**  Population was primarily African American and economically disadvantaged  Did not use patient-centered outcomes  Included residents |
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| **Player, Gill, Mainous et al., 2010**  #14814 | **Geographical location:**  27 sites in US  States not reported  **Study dates:** NR  **General setting:** NR  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  - RCT, cluster randomization  **Unit of randomization:**  - Clinic or team  **Duration of intervention:**  NR  **Sample type(s) (with N randomized for each):**  - Patients 67,543  - Clinics/practices/ hospitals 27  - Individual HCPs: 119  > MDs [family medicine, internal medicine, or general practice]  > PAs/NPs  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  An EMR-based tool incorporating decision support for diagnosis and treatment of Gastro-esophageal reflux disease (GERD).  **Source/origin of system:**  Commercial  **Content:**  *a) Objective(s):*  - Diagnosis  - Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Percentage of total patients newly diagnosed with GERD—  Intervention (n = 24,111): 3.06%  Control (n = 29,926): 2.33%  P < 0.01  Odds ratio (CI 95%): 1.33 (1.13 to 1.56)  Percentage of patients newly diagnosed with GERD among those experiencing atypical symptoms without prior GERD diagnosis—  Intervention (n = 2532): 4.70%  Control (n = 3725): 2.39%  P < 0.01  Odds ratio (CI 95%): 2.02 (1.41 to 2.88)  - Recommended treatment ordered/prescribed: Percentage of total patients newly prescribed medication for GERD—  Intervention (n = 24,111): 1.52%  Control (n = 29,926); 1.10%  P = 0.32  Odds ratio (CI 95%): 1.11 (0.86 to 1.43)  Percentage of patients with a GERD diagnosis (past or present) and no prescribed GERD medication prior to study start that were prescribed GERD medication during study period—  Intervention (n = 3225): 24.25%  Control (n = 3669): 18.95%  P < 0.01  Odds ratio (CI 95%):1.37 (1.12 to 1.68)  Percentage of patients newly prescribed GERD medications among those experiencing atypical symptoms without prior GERD prescription—  Intervention (n = 2532): 8.81%  Control (n = 3725): 6.44%  P < 0.01  Odds ratio (CI 95%): 1.40 (1.08 to 1.83)  Percentage of patients newly prescribed GERD medications and newly diagnosed with GERD among those experiencing atypical symptoms without prior GERD diagnosis and GERD prescription—  Intervention (n = 2532): 2.33%  Control (n = 3725): 1.29%  P < 0.01  Odds ratio (CI 95%): 1.83(1.19 to 2.82)  - Impact on user knowledge:  NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  No concealment and blinding information  No baseline information  >10 % of patients were not followed up  **Applicability/ generalizability:**  Large sample of patient population  Large number of study sites including rural, suburban, and urban practices  Study clinics had been using the Centricity office EMR for at least one year |
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| **Price, 2005**  #3135 | **Geographical location:**  Vancouver, BC  **Study dates:**  2/02–4/02  **General setting:** NR  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  2 months  **Sample type(s) (with N randomized for each):**  - Patients: 80  - Individual HCPs: 8  **User level of expertise/ proficiency:**  High | **Authors’ basic description of system:**  PDA designed to improve adherence to 5 preventive measures in primary care.  **Source/origin of system:**  Commercially available (Palm OS PDA)  **Content:**  *a) Objective(s):*  Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system (Palm Pilot)  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:* Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  Control: n = 40 Intervention: n = 39  Cervical cancer:  88% 100%  Hyperlipidemia:  64% 94%  Colorectal cancer:  38% 65%  Prophylaxis with aspirin:  33% 81%  Hypertension:  97% 94%  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  Small; nonblinded; contamination;  physicians selected patients nonrandomly; nonrandom, selected subset of users  **Applicability/ generalizability:**  Highly motivated group of MDs that already had a PDA on site |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Raebel, Charles, Dugan, et al., 2007**  #1932 | **Geographical location:**  Denver, CO  **Study dates:**  5/18/05–5/17/06  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  Patients: 59,680  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Computerized pharmacy alert system plus collaboration between health care professionals in decreasing potentially inappropriate medication dispensing in elderly.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Intervention 543 of 29,840 (1.8%) prescribed inappropriate medication  Usual care 644 of 29,840 (2.2%) prescribed inappropriate medication  P = 0.002  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR:  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Monitored 11 medications inappropriate for elderly patients  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  One Kaiser group, all patients older than age 65  Very low rate of inappropriate medications used  Only looked at prescriptions written and not sold |
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| **Raebel, Chester, Newsom, et al., 2006**  #2748 | **Geographical location:**  Denver, CO  **Study dates:**  11/25/02–12/31/03  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  14 months  **Sample type(s) (with N randomized for each):**  Patients: 9139  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  When a patient was dispensed a target medication, the lab test was electronically assessed as completed or not. Not completed lab tests were sent to a clinical pharmacology call center that worked with patents to get lab testing. Abnormalities were sent to physician for decisionmaking designed to minimize physician burden completion within 14 days of dispensing medication.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed:  Intervention: completed lab tests, 64% (3114 of 4871)  Usual care: 58% (2773 of 4780)  P < 0.001  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Started with 14 medications and excluded 2  **Quality assessment:**  Overall rating: Good  Comments:  Overlap with Raebel, Lyons, Chester, et al., 2005  **Applicability/ generalizability:**  Blinded one Kaiser group |
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| **Raebel, Lyons, Chester, et al., 2005**  #3125 | **Geographical location:**  Denver, CO  **Study dates:**  9/9/02–12/31/03  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  16 months  **Sample type(s) (with N randomized for each):**  Patients: 10,169  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  When a patient was dispensed a target medication, the lab test was electronically assessed as completed or not. Not completed lab tests were sent to a clinical pharmacology call center that worked with patents to get lab testing. Abnormalities were sent to physician for decisionmaking designed to minimize physician burden.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Recommended lab tests completed—  Intervention: 79.1% (n = 4076; 95% CI 78.0%-80.2%)  Usual care: 70.25% (n = 3522; 95% CI, 68.9%-71.5%)  P < 0.001  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Studied 15 medications  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Physicians, patients, and pharmacists blinded to study group  One Kaiser group |
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| **Reeve, Tenni, and Peterson, 2008**  #1379 | **Geographical location:**  Melbourne, Australia  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Pharmacy  **Duration of intervention:**  6 weeks  **Sample type(s) (with N randomized for each):**  - Pharmacies: 15  Intervention: 31 pharmacies  Usual care: 21 pharmacies  - Pharmacists: 150  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Pharmacists were presented with an electronic prompt each time they dispensed an oral hypoglycemic agent. The prompt identified a patient potentially eligible for low-dose aspirin to prevent heart disease.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system-pharmacy system  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y- Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y- Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Overall documented clinical intervention rate—  Intervention: 1.74 per 100 patients (95% CI 1.55, 1.93)  Control: 0.91 (0.77, 1.05)  Mann–Whitney U-test, P < 0.001  Intervention—  2.55 aspirin treatment per 100 diabetic patients  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Community-based pharmacies not linked to medical record; not blinded |
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| **Rollman, Hanusa, Gilbert, et al., 2001**  #5453 | **Geographical location:**  Pittsburgh, PA  **Study dates:** NR; recruitment started between April 1997 and December 1998  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  20 months  **Sample type(s) (with N randomized for each):**  - Patients: 212  - Individual HCPs:  > MDs: 16 internists  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  EMR system generates interactive email alert (flag) to notify PCPs when the mood module identifies a patient as having major depression.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Email  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: N  (Note: researcher has to enter “major depression” manually into the problem list and forward a flag to the clinic’s scheduling secretary; page 190).  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  All received email alert “flag”—  1) Intervention 1 (active): Reminder plus patient-specific recommendation on paper/online encounter form; also, electronic prompts to schedule followup appointment  2) Intervention 2 (passive): Reminder on paper encounter form; no other intervention prompts  3) Control: usual care  Note that the analysis did not compare findings across groups, so only a single evidence table was prepared for this study | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: 3 days after notification—  Agree: 120 of 186 (65%)  Disagree: 24 of 186 (13%)  Uncertain: 42 of 186 (23%)  1 month after notification—  Agree: 147 of 186 (71%)  Disagree: 34 of 186 (16%)  Uncertain: 27 of 186 (13%)  154 days after notification—  Agree: 166 of 186 (78%)  Disagree: 36 of 186 (17%)  Uncertain: 10 of 186 (5%)  “There were no differences in the agreement rate or treatments provided across guideline exposure conditions.”  Stratification of results by intervention groups were done in graph format; actual value not available  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  The email alert flag required a response (per procedure paragraph 1); justification via interactive email sent after the initial response (per procedure paragraph 2)  The email alert flag was asynchronous; the reminder plus patient-specific recommendation (active) on paper/online encounter form was synchronous  Authors’ description seems to suggest that email alerts and paper encounter forms were used to remind physicians  **Quality assessment:**  Overall rating: Poor  Comments:  Interviewer (outcome assessor) masked to randomization status of a patient’s PCP.  PCPs were not blinded to their assignment condition  Small sample size (physicians)  Some baseline differences (age, male gender, single marital status, Hamilton depression rating scale score, SF-12 mental health composite score and MOS social support scale score  15 of 227 (7%) patients dropped out.  Did not adequately report outcome according to intervention groups  Inadequate analysis and reporting of findings.  **Applicability/ generalizability:**  Small sample size  Study conducted in an academic medical center |
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| **Rood, Bosman, van der Spoel, et al., 2005**  #3549 | **Geographical location:**  Amsterdam, Netherlands  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Inpatient – ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  10 weeks  **Sample type(s) (with N randomized for each):**  - Patients:  > Computerized decision support intervention: 66 patients  > Paper-based: 54 patients  - Individual HCPs:  > Training MDs: 6 fellows  >MDs: 5 intensive care  > Nurses: 93    **User level of expertise/ proficiency:**  Trained very well | **Authors’ basic description of system:**  System that notifies clinicians (nurses) of recommend insulin dosage and glucose-level monitoring.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS, paper-based version | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  1) Glucose in target range—  Intervention: 40.2%  Paper-based: 35.5%  2) Insulin guidelines—  Intervention: 77.3%  Paper-based: 64.2%  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  For nurses, not MDs  **Quality assessment:**  Overall rating: Good  Comments:  Only second phase randomized  **Applicability/ generalizability:**  Not all patients had diabetes; study conducted in the Netherlands |
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| **Rosser, Hutchison, McDowell, et al., 1992**  #7131 | **Geographical location:** Ottawa, Ontario, Canada  **Study dates:** 4/1/85–3/1/86  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Patients: 5589  - Clinics: 4  - Individual HCPs:  > Training: 12 to 16  > MDs: 4  > Nurses: 4  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A computer-generated reminder to ask the patient about tetanus vaccination was included on the routinely printed encounter form used for billing purposes. Until information about the procedure was recorded, the computer continued to generate reminders at subsequent visits.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Immunization  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/ no CDSS or KMS  4 arms, 3 of which involved computerized reminder systems:  1) Control  2) Physician reminders  3) Telephone reminders  4) Letter reminders  Data from a nonrandomized sample were reported as well | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Vaccination rates were 3.2% in the randomized controls (2.3% in nonrandomized controls); the difference in the recorded vaccination rate between control and the three reminder groups—  19.6% in the physician reminder group (95% CI 17.1%, 22.2%) P < 0.00001,  20.8% in the telephone reminder group (95% CI 18.3%, 23.5%), P < 0.00001  27.4% in the letter reminder group (95% CI 24.8%, 30.2%),  P < 0.00001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: NR  - Cost-effectiveness: Physician reminder group—  The cost per additional vaccination was $0.43 at a physician salary of $60 per hour and 0.22 at $30 per hour.  Telephone reminder group—  The cost of an additional vaccination was $5.43 at a salary of $15 per hour and $4.43 at $10 per hour.  Letter reminder group—  The cost for each additional vaccination recorded was $6.05.  **6) Impact on HCP use and implementation:** NR | **General comments:**  After adjusting for multiple comparisons, the intervention groups differed from the randomized controls but not from each other  **Quality assessment:**  Overall rating: Poor  Comments:  Incomplete reporting of methods and results; potential for contamination across intervention arms  **Applicability/ generalizability:**  Study conducted in Canada in 1985  Patient computer database since 1976 |
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| **Rosser, McDowell, and Newell, 1991**  #7172 | **Geographical location:** Ottawa, Ontario, Canada  **Study dates:** 10/1984–01/1985; 4/1/85–3/1/86  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Patients: 5589  - Clinics: 4  - Individual HCPs:  > Training: 12 to 16  > MDs: 4  > Nurses: 4  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Two interventions to improve rates of 5 preventive procedures were compared to a usual care control. In the physician intervention group, a reminder was generated from the EMR and placed in the preprinted encounter form. In the patient intervention groups, patients were either contacted by telephone (practice nurse attempted a maximum of 5 calls) or by letter.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Immunization  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Can’t tell N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/ no CDSS or KMS  4 arms, 3 of which involved computerized reminder systems:  1) Control  2) Physician reminders  3) Telephone reminders  4) Letter reminders  Data from a nonrandomized sample were reported as well | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Procedure (% of procedures performed)—  Administer influenza vaccine:  Nonrandomized control: 3.8  Randomized control: 9.8  Physician reminder 22.9  Letter reminder: 35.2  Telephone reminder: 37.0  Measure blood pressure:  Nonrandomized control: 18.6  Randomized control: 21.1  Physician reminder 30.7  Letter reminder: 40.5  Telephone reminder: 37.2  Assess smoking status:  Nonrandomized control: 9.5  Randomized control: 11.9  Physician reminder 37.9  Letter reminder: 49.1  Telephone reminder: 55.8  Obtain Papanicolau smear:  Nonrandomized control: 11.2  Randomized control: 13.7  Physician reminder 16.5  Letter reminder: 29.7  Telephone reminder: 30.0  Administer tetanus vaccine:  Nonrandomized control: 2.3  Randomized control: 3.2  Physician reminder 22.8  Letter reminder: 30.6  Telephone reminder: 24.0  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes: NR**  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  After adjusting for multiple comparisons, the intervention groups differed from the randomized controls but not from each other  **Quality assessment:**  Overall rating: Poor  Comments:  Incomplete reporting of methods and results; potential for contamination across intervention arms  **Applicability/ generalizability:**  Study conducted in Canada in 1985  Patient computer database since 1976 |
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| **Rossi and Every, 1997**  #6440 | **Geographical location:**  - Puget Sound VA  - Seattle, WA  **Study dates:**  3/96–8/96  **General setting:**  VA  **Specific setting:** Outpatient    **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 719  - Individual HCPs:  > General internal medicine: 71  > Training MDs: 44  > MDs: 15  > NPs : 12    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  In order to decrease the use of calcium channel blockers for patients with hypertension, the EMR was used to identify patients receiving these medications putatively for hypertension. A one-page computer-generated guideline reminder was placed in the clinic chart by the clinical pharmacist and collected by the ward clerk at the end of the visit.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  - Justification for not complying  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N  *e) Other:* The reminder cited national guidelines, recommended alternative medications, facilitated ordering those alternative medications, and requested that the physician justify the choice of calcium channel blocker if the medication was left unchanged | **Comparator(s):**  Usual care (although usual care at this site involved a sophisticated EMR) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prescription change from calcium channel blockers to other medication:  Control: < 1% (1 of 373)  Intervention: 11.3% (39 of 346) (p < 0.001)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Reasons for unchanged calcium channel blockers therapy—  Prescribed for angina: 71 (23%)  No hypertension: 48 (14%)  Failed blood pressure control with first-line therapy: 48 (14%)  Adverse effects on first-line therapy: 33 (10%)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments: An excellent study in all its elements. The authors provide some informal cost and cost-effectiveness numbers in the discussion section.  **Applicability/ generalizability:**  Participants had to already be successful users of a sophisticated EMR  VA setting |
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| **Rothschild, McGurk, Honour, et al., 2007**  #2216 | **Geographical location:** Boston, MA  **Study dates:**  April 2003–June 2004  **General setting:**  Academic    **Specific setting:**  Inpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  4 months  **Sample type(s) (with N randomized for each):**  - Patients (DS intervention): 1607  - Individual HCPs:  > Staff MDs (fourth-year to seventh-year residents, fellows, and attending physicians): 961  > Trainee MDs: 453  PG YR 1: 175  PG YR 2: 156  PG YR 3: 122  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Within the context of an existing EMR, transfusion orders in the intervention group were compared against guidelines. If inappropriate, physicians had to either change their order or state their reason for disagreement.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Transfusion ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N (although the trial was preceded by an education period) | **Comparator(s):**  Usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Transfusion guideline adherence, decision support-evaluated orders—  Final total appropriateness ratings, appropriate (%):  Assigned staff: 343 (32.6)  Housestaff control: 503 (32.5)  Housestaff intervention: 546 (40.4)  Final total appropriateness ratings, inappropriate (%):  Assigned staff: 708 (67.4)  Housestaff control: 1043 (67.5)  Housestaff intervention: 804 (59.6)  DS-agree orders:  Assigned staff: 321  Housestaff control: 470  Housestaff intervention: 411    Chart review confirms DS-agree:  Assigned staff: 238  Housestaff control: 349  Housestaff intervention: 305  Chart review changes to DS-disagree:  Assigned staff: 83  Housestaff control: 121  Housestaff intervention: 106  DS-disagree orders:  Assigned staff: 730  Housestaff control: 1,076  Housestaff intervention: 939  Chart review changes to DS-agree appropriate (%):  Assigned staff: 105 (14.4)  Housestaff control: 154 (14.3)  Housestaff intervention: 108 (11.5)  Chart review confirms DS-disagree inappropriate (%):  Assigned staff: 625 (85.6)  Housestaff control: 922 (85.7)  Housestaff intervention: 698 (74.3)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Physicians accepted 14% (133 of 939) of new DS-recommended orders, especially recommendations to increase transfusion doses (73%)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Very stringent criteria were used to classify orders as appropriate.  Study also included a posteducation phase; table only presents data for the DS intervention  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT infrastructure and historically an early adopter of health IT |
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| **Roukema, Steyerberg, van der Lei, et al., 2008**  #1540 | **Geographical location:** Rotterdam, Netherlands  **Study dates:**  9/1/03–12/31/05  **General setting:** NR  **Specific setting:**  Emergency department  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  28 months  **Sample type(s) (with N randomized for each):**  Patients: 164  **User level of expertise/ proficiency:**  Nurses received training on how to use system | **Authors’ basic description of system:**  All patients were followed with the basic CDS, which required approximately 2 minutes for the nurse to input information from the history and physical examination. For children with fever without known cause that were classified as being at high risk, intervention patients had the recommendation to order lab tests turned on while control patients did not.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis (or risk assessment preliminary to a diagnosis)  - Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care (with the other components of the CDS working) | **1) Impact on clinical outcomes:**  - Length of stay: Children in the intervention group had a median (25th to 75th percentile) length of stay at the ED of 138 (104–181) minutes. The median length of stay at the ED in the control group was 123 (83–179) minutes.  - Morbidity: NR  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Adherence to the advice to order laboratory tests—  Intervention: 82% (61 of 74)  Control: 44% (40 of 90)  p < 0.001, x2 test  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:** None  **Quality assessment:**  Overall rating: Good    Comments:  This small, and perhaps underpowered, study is testing a rather minor point since there is little reason to use the CDS with the recommendation to order lab tests turned off  **Applicability/ generalizability:**  Study conducted in the Netherlands  Study aim is of limited applicability in the U.S. |
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| **Roumie, Elasy, Greevy, et al., 2006**  #2556  **Comparison 1 of 2** | **Geographical location:**  Tennessee, US  **Study dates:** Patients identified: 7/03–12/03  Interventions performed: 6/14/04–6/18/04  Followup until: 12/31/04  **General setting:**  Academic and community  **Specific setting:**  Outpatient    **Study design:**  RCT, cluster randomization    **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 1827 randomized, 1341 assigned to groups  - Individual HCPs: 205 randomized, 182 included (101 staff physicians, 36 residents, 45 NPs/PAs)    **User level of expertise/ proficiency:**  High; must already be users of a sophisticated EMR | **Authors’ basic description of system:**  The provider education and alert intervention was a one-time reminder for every patient with uncontrolled hypertension, including guideline-based recommendations.  The patient intervention was a letter discussing behavioral strategies and noting that many patients require more than one medication. The provider education (control group) intervention included an email to providers containing a web link to the JNC 7 guidelines (intervention groups also received the email).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Chronic disease management  - Pharmacotherapy  *b) Relationship to point of care:*  Not clearly described  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Provider education + alert group:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care (included an EMR)  Three groups were compared, including two interventions:  1) Provider education (control)  2) Provider education + alert  3) Provider education + alert + patient education | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: n = 1341  Hospitalizations, n (%):  Provider education group: 12 of 324 (3.7)  Provider education + alert group: 16 of 547 (2.9)  Provider education + alert + patient education: 25 of 470 (5.3)  - Mortality: n = 1341  Deaths, n (%):  Provider education group: 8 of 324 (2.5)  Provider education + alert group: 3 of 547 (0.6)  Provider education + alert + patient education: 4 of 470 (0.9)  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Any changes in antihypertensive drugs, n (%)—  Provider education group: 104 of 324 (32.4), RR (95% CI): 0.88 (0.72, 1.08)  Provider education + alert group: 156 of 547 (28.5), RR (95% CI) 0.90 (0.73, 1.11)  Provider education + alert + patient education: 137 of 470 (29.1)  Mean medication adherence (SD), n = 948—  Provider education group: 0.89 (0.14)  Provider education + alert group: 0.89 (0.14)  Provider education + alert + patient education: 0.88 (0.16)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  While pairs of groups were not specifically subjected to formal statistical comparison, the pattern of the results suggests that, for the primary outcome, the provider education + alert + patient education group outperformed the other 2 groups, the results from these latter 2 groups being effectively similar  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Academic and community setting  Compares a DSS to a DSS enhanced by patient education |
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| **Roumie, Elasy, Greevy, et al., 2006**  #2556  **Comparison 2 of 2** | **Geographical location:** Tennessee, US  **Study dates:** Patients identified: 7/03–12/03  Interventions performed: 6/14/04–6/18/04  Followup until: 12/31/04  **General setting:**  Academic and community  **Specific setting:**  Outpatient    **Study design:**  RCT, cluster randomization    **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 1827 randomized, 1341 assigned to groups  - Individual HCPs: 205 randomized, 182 included (101 staff physicians, 36 residents, 45 NPs/PAs)    **User level of expertise/ proficiency:**  High; must already be users of a sophisticated EMR | **Authors’ basic description of system:**  The provider education and alert intervention was a one-time reminder for every patient with uncontrolled hypertension, including guideline-based recommendations.  The patient intervention was a letter discussing behavioral strategies and noting that many patients require more than one medication. The provider education (control group) intervention included an email to providers containing a web link to the JNC 7 guidelines (intervention groups also received the email).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Chronic disease management  - Pharmacotherapy  *b) Relationship to point of care:*  Not clearly described  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Provider education + alert + patient education group:  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care (included an EMR)  Three groups were compared, including two interventions:  1) Provider education (control)  2) Provider education + alert  3) Provider education + alert + patient education | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: n = 1341  Hospitalizations, n (%):  Provider education group: 12 of 324 (3.7)  Provider education + alert group: 16 of 547 (2.9)  Provider education + alert + patient education: 25 of 470 (5.3)  - Mortality: n = 1341  Deaths, n (%):  Provider education group: 8 of 324 (2.5)  Provider education + alert group: 3 of 547 (0.6)  Provider education + alert + patient education: 4 of 470 (0.9)  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Any changes in antihypertensive drugs, n (%)—  Provider education group: 104 of 324 (32.4), RR (95% CI): 0.88 (0.72, 1.08)  Provider education + alert group: 156 of 547 (28.5), RR (95% CI) 0.90 (0.73, 1.11)  Provider education + alert + patient education: 137 of 470 (29.1)  Mean medication adherence (SD), n = 948—  Provider education group: 0.89 (0.14)  Provider education + alert group: 0.89 (0.14)  Provider education + alert + patient education: 0.88 (0.16)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  While pairs of groups were not specifically subjected to formal statistical comparison, the pattern of the results suggests that, for the primary outcome, the provider education + alert + patient education group outperformed the other 2 groups, the results from these latter 2 groups being effectively similar  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Academic and community setting  Compares a DSS to a DSS enhanced by patient education |
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| **Roy, Durieux, Gillaizeau, et al., 2009**  #89 | **Geographical location:**  20 sites in France  **Study dates:**  6/1/05–6/30/06  **General setting:**  Community  **Specific setting:**  Emergency department  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team (facility)  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  - Patients: 1768 patients enrolled, 1645 patients analyzed  - Clinics/practices: 20  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  After introducing hand-held devices for data collection during a run-in period, intervention physicians received CDS through those same devices. First, they were asked to provide clinical data as input to a Geneva score, which estimates the probability of pulmonary embolism. The device then recommends tests that could potentially lead to a decision of diagnose/exclude PE. Test results are input into the device, the pretest probability of PE revised, and the process iterates.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care (but with continued data collection using hand-held devices) | **1) Impact on clinical outcomes:**  NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Appropriate diagnostic strategy applied (adjusted absolute change, %)—  Control: 10.9  Intervention: 30.2  Adjusted difference in change (95% CI), percentage points: 19.3 (2.9 to 35.6 p = 0.023)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: Data were input in real time for 80% of intervention patients and 39% of controls  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments: In the absence of receiving feedback from the device, control physicians used the device much less, introducing a potential bias of unknown magnitude. Nevertheless, the conclusion that the CDS improved process of care seems sound.  **Applicability/ generalizability:** This is not an intervention that is likely to be used in the U.S. |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Samore, Bateman, Alder, et al., 2005**  #3127 | **Geographical location:**  12 rural areas of Utah and Idaho  **Study dates:**  1/01–9/03  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Community  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  12 communities  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Practitioners could choose a paper- or PDA-based support tool to increase appropriateness (especially, to decrease inappropriate use) of antimicrobial agents. The PDA-based CDSS generated diagnostic and therapeutic recommendations on the basis of patient-specific information that was input about the suspected diagnosis or absence of specific symptoms and signs.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:* Therapeutic recommendations included over-the-counter medications for symptom control as well as prescription antimicrobials. For pediatric patients, the advice was customized to the patient’s weight and age. For cases of pneumonia, the system also calculated the patient’s pneumonia severity index score. | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Rates of antimicrobial prescribing did not change significantly during the first intervention year. In CDSS and community intervention–alone communities, a nonsignificant decrease of 1% and an increase of 3% from baseline were observed. In nonstudy communities, prescribing rates decreased by 3% compared with baseline.  During the second intervention year, prescribing rates in CDSS communities decreased 10% from baseline, whereas in the community intervention–alone communities and nonstudy communities, prescribing rates in 2003 increased by 1% and 6%, respectively.  Within CDSS communities, the overall antimicrobial prescribing rate declined by an absolute amount of 0.09 prescriptions per person-year between baseline and the second-intervention year. This translated to an expected reduction of 93 antimicrobial prescriptions per month in a rural community with a population size equal to the mean of the CDSS group.  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: 71% of physicians in the intervention communities used the decision support system  - Implementation of CDSS/KMS: NR | **General comments:**  The study also had a community intervention that is not relevant for our purposes  **Quality assessment:**  Overall rating: Fair  Comments: The complex and difficult-to-follow statistical analyses probably do not help get around the fact that there were only 12 communities studied  **Applicability/ generalizability:**  It is doubtful that an intervention that is not integrated into clinical workflow and which requires additional time for data entry would be generally acceptable, even for underresourced rural practices |
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| **Schriefer, Landis, Turbow, et al., 2009**  #326 | **Geographical location:**  Western NC  **Study dates:**  Early 2006  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Team  **Duration of intervention:**  2 months  **Sample type(s) (with N randomized for each):**  - Patients: 846  - Individual HCPs:  > Family medicine: 37 (13 faculty, 24 residents)    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  In addition to height and weight, for intervention patients the EMR additionally calculated BMI.  **Source/origin of system:** NR  **Content:**  *a) Objective(s):*  - Diagnosis  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Obese patients in the intervention group were more likely than controls to receive a diagnosis of obesity (16.6% vs 10.7%, p = 0.016), be referred for dietary treatment (14.0% vs 7.3%, p = 0.002), and be referred for exercise (12.1% vs 7.1%, p = 0.016)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  The methods did not mention that physicians were prompted to take any action as a result of a high BMI  **Quality assessment:**  Overall rating: Good  Comments: Not knowing whether the intervention prompted physicians into action limits the ability to interpret the results  **Applicability/ generalizability:**  A single practice, plus an intervention that could easily be strengthened by adding some recommendations |
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| **Sequist, Gandhi, Karson, et al., 2005**  #3343 | **Geographical location:**  20 sites in MA  **Study dates:**  October 2002–April 2003  **General setting:**  - Academic  - Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients 6243 (4549 patients with diabetes, 2199 patients with coronary artery disease [CAD])  - Clinics/practices/ hospitals: 20  - Individual HCPs:  > MDs: 194 primary care physicians  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  An integrated, patient-specific electronic clinical reminder system on diabetes and coronary artery disease (CAD).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:*  - Reminders displayed on the main patient summary screen along with patient medication list and problem list  - Succinct messages  - Passive reminders (do not require physician acknowledgement) | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Diabetes—  Annual cholesterol exam:  Baseline = 4957 (58%)  Enrolled = 1185 (14%)  Hazard ratio (95% CI) = 1.41 (1.15-1.72)  P < 0.001  Biennial hemoglobin A1c exam:  Baseline = 4868 (57%)  Enrolled = 2245 (26%)  Hazard ratio (95% CI) = 1.14 (0.89-1.46)  P = 0.29  Annual dilated eye exam:  Baseline = 1464 (17%)  Enrolled = 4049 (47%)  Hazard Ratio (95% CI) = 1.38 (0.81-2.32)  P = 0.23  CAD—  Annual cholesterol exam:  Baseline = 5039 (53%)  enrolled = 1151 (12%)  Hazard Ratio (95% CI) = 0.99 (0.75-1.29)  P = 0.92  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Adherence rates in the entire population and in the enrolled population for diabetes and CAD care, # (% of total population)—  Diabetes:  Hypertension/ACE inhibitor use:  Baseline = 2761 (62%)  Enrolled = 711 (16%)  Hazard Ratio (95% CI) = 1.42 (0.94-2.14)  P = 0.10  Statin use for LDL cholesterol ≥130mg/dL:  Baseline = 476 (31%)  Enrolled = 595 (38%)  Hazard Ratio (95% CI) = 1.10 (0.65-1.85)  P = 0.73  CAD:  Aspirin use:  Baseline = 2883 (41%)  Enrolled = 669 (9%)  Hazard Ratio (95% CI) = 2.36 (1.37-4.07)  P = 0.002  Beta-blocker use:  Baseline = 2701 (38%)  Enrolled = 808 (11%)  Hazard Ratio (95% CI) = 1.09 (0.72-1.63)  P = 0.69  Statin use for LDL cholesterol ≥130mg/dL:  Baseline = 495 (28%)  Enrolled = 385 (21%)  Hazard Ratio (95% CI) = 1.51 (1.05-2.17)  P = 0.03  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Electronic reminders useful for diabetes disease management = 53 (68%)  Electronic reminders useful for CAD management =41 (53%)  Electronic reminders improve quality of patient care = 121 (76%)  - HCP use: Lack of awareness of guidelines existence = 61 (38%)  Notice electronic reminders during patient encounter = 60 (38%)  Electronic reminders prompt physician to take specific action = 55 (35%)  - Implementation of CDSS/KMS: NR | **General comments:**  Both groups received paper-based reminders  **Quality assessment:**  Overall rating: Poor  Comments:  Clinically significant difference in baseline (race and insurance status)  Table 2 contains results that combine both intervention and control arms  255 PCPs were surveyed: 159 (62%) responded (Intervention, 78; Control, 81)  **Applicability/ generalizability:**  Locally developed system  Primary care physicians practicing at all 20 centers received electronic reminders in their practice previously  Well-established health IT infrastructure and historically an early adopter of health IT |
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| **Sequist, Zaslavsky, Marshall, et al., 2009**  #616 | **Geographical location:**  11 sites in MA  **Study dates:**  April 200 –June 2007  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:** Clinician  **Duration of intervention:**  15 months  **Sample type(s) (with N randomized for each):**  - Patients: 21,860  - Clinics/practices/ hospitals: 11  - Individual HCPs:  > MDs: 110 primary care physicians  **User level of expertise/ proficiency:**  Physicians in both intervention and control groups were educated about electronic reminders via a 1-hour presentation and discussion | **Authors’ basic description of system:**  Physicians received active and passive electronic reminders during office visits with patients overdue for colorectal cancer screening; passive alerts were present at any point within the electronic visit summary, and active alerts required acknowledgement from the user when placing orders.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Lab test ordering  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response (active)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y (active)  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N  *e) Other:* Passive and active alerts are available | **Comparator(s):**  Usual care/no CDSS or KMS; patient mailing intervention group | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Physician reminder intervention, pathologic findings—  Colonic adenoma:  Intervention (I): 650 (6.0%)  Control (C): 540 (4.9%)  Percentage point difference (95% CI) = 1.0 (-0.1 to 2.2)  P = 0.09  Colorectal cancer:  I: 17 (0.2%)  C: 17 (0.2%)  Percentage point difference (95% CI) = 0.0 (-0.1 to 0.1)  P = 0.99  Positive FOBT (among those patients who performed FOBT)  I: 27 (1.1%)  C: 32 (1.3%)  Percentage point difference (95% CI) =  -0.2 (-0.8 to 0.4)  P = 0.52  Patient mailing intervention, pathologic findings—  Colonic adenoma:  I: 622 (5.7%)  C: 568 (5.2%)  Percentage point difference (95% CI) = 0.5( -0.1 to 1.1)  P = 0.10  Colorectal cancer:  I: 19 (0.2%)  C: 15 (0.2%)  Percentage point difference (95% CI) = 0.0 (-0.1 to 0.1)  P = 0.43  Positive FOBT (among those patients who performed FOBT):  I: 47 (1.7%)  C: 12 (0.5%)  Percentage point difference (95% CI) = 1.2 (0.6 to 1.7)  P < 0.001  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Receipt of colorectal cancer screening by intervention status (all patients: N = 21,860)—  Physician reminder group:  I: 41.9%  C: 40.2%  Percentage point difference (95% CI) = 1.6 (-2.7 to 5.9)  P = 0.47  0 primary care visits, N = 7643:  I: 19.1%  C: 16.0%  Percentage point difference (95% CI) = 3.0 (-1.1 to 7.2)  P = 0.15  1 to 2 primary care visits, N = 9011:  I: 53.2%  C: 51.5%  Percentage point difference (95% CI) = 1.6 (-3.8 to 7.1)  P = 0.56  More than 3 primary care visits, N = 5206:  I: 59.5%  C: 52.7%  Percentage point difference (95% CI) = 6.0( -0.5 to 12.5)  P = 0.07  Patient mailing intervention group:  I: 44%  C: 38.1%  Percentage point difference: 5.8 (4.5, 7.1)  P < 0.001  0 primary care visits, N = 7643:  I: 19.6%  C: 15.6%  Percentage point difference (95% CI) = 3.9( 2.2 to 5.6)  P < 0.001  1 to 2 primary care visits, N = 9011:  I: 55.6%  C: 49.0%  Percentage point difference (95% CI) = 6.6 (4.7 to 8.4)  P <0.001  More than 3 primary care visits, N = 5206:  I: 59.5%  C: 52.3%  Percentage point difference (95% CI) = 7.1 (4.4 to 9.8)  P < 0.001  Types of colorectal cancer screening tests  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: Perceived proportion of electronic reminders that accurately reflected patients’ screening status—50% (IQR 30% to 80%)  Perceived effectiveness of electronic reminders in increasing the colorectal screening rate among patients (poststudy survey of 43 eligible physicians, n = 33 intervention group)—  Electronic reminders were very effective: 9%  Somewhat effective: 47%  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  Two types of intervention: patient mailing and physician electronic reminders  Results of patient intervention are not included in this abstraction  43 of 55 physicians in the intervention group surveyed; only 33 responded  **Quality assessment:**  Overall rating: Fair  Comments:  Patients in the intervention group and control group were similar for both the patient-level and physician-level randomizations  Interaction of patient and physician intervention status possibly affecting outcomes (results indicated that it is not statistically significant)  No important baseline differences  **Applicability/ generalizability:**  Integrated medical groups using advanced electronic health record  Use of EHR in ambulatory settings since 1997 |
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| **Shojania, Yokoe, Platt, et al., 1998**  #6206 | **Geographical location:**  Boston, MA  **Study dates:**  6/20/96–3/30/97  **General setting:**  Academic  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  - Acute  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  - Patients: 1798  - Individual HCPs: 396 MDs  - Events: 5536  **User level of expertise/ proficiency:**  All users familiar with CPOE | **Authors’ basic description of system:**  Computer screen displaying, at the time of physician order entry, an adaptation of the Centers for Disease Control and Prevention guidelines for appropriate vancomycin use.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Total orders per prescriber (P = 0.04)—  #, ± SD, mean (25-75% quartiles):  Control (n = 1911): 16.7, ± 29.2, 5.0 (1.0-15)  Intervention (n = 1345): 11.3, ± 19.9, 3.0 (1.0-11)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Study set at Women and Brigham’s  No patient-centered outcomes |
|  |  |  |  |  |  |
| **Simon, Smith, Feldstein, et al., 2006**  #14023 | **Geographical location:**  Oregon and Washington  **Study dates:**  November 2000–June 2004  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  Designed as cluster RCT, but data not analyzed as such  **Unit of randomization:**  Practice  **Duration of intervention:**  18 months  **Sample type(s) (with N randomized for each):**  - Patients: 30,924  - Clinics/practices/ hospitals: 15  - Individual HCPs: 126 MDs    **User level of expertise/ proficiency:**  Familiar with CPOE | **Authors’ basic description of system:**  The computerized age-specific alerts occurred at the time of prescribing a targeted, potentially inappropriate medication and suggested an alternative medication.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  1) Control is drug-specific computerized alert system  2) Intervention is age/drug-specific computerized alert system | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Alerts per prescriber (average)—  Control: 18 (14 [82%] false positive)  Intervention: 4 (0 false positive)  The transition in January 2003 from drug-specific alerts to patient-specific alerts for the same target medications resulted in a continuation of the established downward trend without apparent change in the level (P = 0.75) or slope (P = 0.22) of the time series  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Data not analyzed and reported according to a priori analytic plan  **Applicability/ generalizability:**  Locally developed system  Control arm was a previously implemented CDSS  No patient-centered results |
|  |  |  |  |  |  |
| **Smith, Feldstein, Perrin, et al., 2009**  #440 | **Geographical location:** NR  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  25 days  **Sample type(s) (with N randomized for each):**  Patients: 961  **User level of expertise/ proficiency:**  Users were familiar with EMS system used to deliver alerts | **Authors’ basic description of system:**  In the EMR intervention, a patient-specific electronic message was sent to the primary care clinician from the chair of the HMO’s patient-safety committee stating that computer records indicated the patient had received a new medication, that laboratory monitoring was recommended, and that the patient had not received the test(s) between 6 months before and 5 days after the dispensing.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  4 groups:  1) EMR reminder to PCP  2) Automated voice message to patients  3) Pharmacy team outreach  4) Usual care | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Cost and cases with all recommended baseline laboratory tests completed by arm per 100 patients (total cases completed, total cost)—  Usual Care: 22, $2092  EMR Intervention: 48, $3748  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  No patient-centered outcomes |
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| **Smith, Shah, Bryant, et al., 2008**  #1172 | **Geographical location:**  Rochester, MN  **Study dates:**  July 1, 2001–December 31, 2003  **General setting:**  Community  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  30 months  **Sample type(s) (with N randomized for each):**  - Patients: 639  - Clinics/practices/ hospitals: 6  - Individual HCPs:  > MDs: 97 internists and family medicine  **User level of expertise/ proficiency:**  New system for users | **Authors’ basic description of system:**  Telemedicine intervention of specialty advice and evidence-based messages regarding medication management for cardiovascular risk.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  - Online access  - Email  *b) Delivery mode:*  System-initiated (“push”) (email messages)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Process of diabetes care, ADA-NCQA provider score, median (range); P = 0.41—  Control (n = 277): 58 (5 to 80)  Intervention (n = 358): 56 (0 to 80)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: The average time for completing a specialty review was 4.4 minutes; only 68 (5%) of reviews took longer than 10 minutes to complete  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Estimate of total costs for 1 year ($), mean (bootstrap 95% CI); P = 0.02  Control (n = 277): 8564 (6628 to 10,763)  Intervention (n = 358): 6252 (5105 to 7640)  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: In 438 (59%) instances, endocrinologists considered the reminder message and the advice useful, and in 364 (49%) instances, they reported using the message to manage the patient.  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Setting was Mayo Clinic  Was locally developed |
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| **Stiell, Clement, Grimshaw, et al., 2009**  #135 | **Geographical location:**  Canada (12 hospitals in several provinces)  **Study dates:** NR  **General setting:**  - Academic  - Community  **Specific setting:**  Emergency department  **Study design:**  RCT, matched pair cluster randomization  **Unit of randomization:**  Hospitals  **Duration of intervention:**  2 years  **Sample type(s) (with N randomized for each):**  - Patients: 11,824  - Clinics/practices/ hospitals: 12  **User level of expertise/ proficiency:**  Users familiar with CPOE system used for intervention | **Authors’ basic description of system:**  A mandatory real-time reminder of the Canadian C-Spine Rule at the point of requisition for imaging was implemented. Any cervical spine imagining that was ordered required the doctor to check the rule criteria or to indicate the reason for overriding the rule before the diagnostic imaging department processed the request.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Diagnostic imaging rates of 11,824 participants with injury of the cervical spine during 12 months before and after periods (# of patients [mean % (SD)] imaged)—  Before period:  Control: 2413 (52.8 [8.6])  Intervention: 3267 (61.7 [15.0])  After period:  Control: 2516 (58.9 [7.0])  Intervention: 3628 (53.3 [13.5])  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Study conducted in Canada |
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| **Strom, Schinnar, Aberra, et al., 2010**  #14937 | Geographical location:  2 sites in Pennsylvania  Study dates:  8/9/2006–2/13/2007  General setting:  Academic  Specific setting:  Inpatient  Study design:  RCT, parallel group  Unit of randomization:  Clinician  Duration of intervention:  6 months  Sample type(s) (with N randomized for each):  Patients: 96  Individual HCPs: 1971  Training MDs: 1872  NPs: 99  User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  An automatic hard-stop pop-up alert implemented into the CPOE to prevent concomitant orders of trimethoprim-sulfamethoxazole and warfarin.  **Source/origin of system:**  Locally developed (customized)  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Alert adherence of not reordering the alert- triggering drug within 10 minutes of firing (correct ordering decisions):  Control: 13.5% (20 of 148) alerts  Intervention: 57.2% (111 of 194) alerts  Adjusted odds ratio: 0.12 (95% CI  0.045-0.33)  Mean number of alerts per provider:  Intervention = 3.53  Control = 3.29  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use:  Intervention group was less  likely than the control group to  reorder the alert-triggering drug  after adjusting for provider type  (resident physician or nurse  practitioner) as a confounder and  accounting for clustering by  provider  Adjusted odds ratio: 0.12 (95% CI 0.045 to 0.33)  Unadjusted odds ratio: 0.12 (95% CI 0.07 to 0.20)  - Implementation of CDSS/KMS: NR | **General comments:**  None  Quality assessment:  Overall rating: Fair  Comments:  Valid outcome measures; limited details of baseline characteristics providers  **Applicability/ generalizability:**  Large sample size of clinicians, but alert was triggered by only 100 providers and involved only 96 patients  Academic setting and thus intervention was primarily used by residents |
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| **Strom, Schinnar, Bilker, et al., 2010**  #14938 | Geographical location:  2 sites in Pennsylvania  Study dates:  8/2/2006–12/15/2007  General setting:  Academic  Specific setting:  Inpatient  Study design:  RCT, parallel group  Unit of randomization:  Clinician  Duration of intervention:  15 months  Sample type(s) (with N randomized for each):  Patients: 528  Individual HCPs: 1963  > Training MDs: 1865  > NPs: 98    User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  A pop-up alert implemented into the CPOE to prevent concomitant orders of warfarin and NSAIDs.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  (commercially available passive alert in CPOE that warned provider not to prescribe the combination of drugs with no response requirement) | **1) Impact on clinical outcomes:**  NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed:  - Recommended clinical study ordered/completed:  - Recommended treatment ordered/prescribed:  Alert adherence of not reordering the alert- triggering drug within 10 minutes of firing—  Control: 28% (154 of 560) alerts  Intervention group 25% (114 of 464) alerts  Adjusted OR of inappropriate ordering: 1.22 (95% CI 0.69 to 2.16)  P = 0.48  Mean number of alerts per provider:  Intervention = 3.5  Control = 4.5  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Customized alert  Quality assessment:  Overall rating: Fair  Comments:  Valid outcome measures; limited details of baseline characteristics or providers    **Applicability/ generalizability:**  Large study implemented for 15 months in two academic settings |
|  |  |  |  |  |  |
| **Subramanian, Fihn, Weinberger, et al., 2004**  #4111 | **Geographical location:**  Indianapolis, IN  Seattle, WA  **Study dates:** NR  **General setting:**  VA  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  1 year  **Sample type(s) (with N randomized for each):**  - Patients: 720  - Clinicians: 91 (44 control, 47 intervention)  **User level of expertise/ proficiency:**  Users already familiar with receiving notifications. Intervention is simply modification to notifications in patient charts. | **Authors’ basic description of system:**  Physicians were randomly assigned to receive either (1) care suggestions generated with electronic medical record data and symptom data obtained from questionnaires mailed to patients within 2 weeks of scheduled outpatient visits (intervention group) or (2) suggestions generated with electronic medical record data alone (control group).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS; this study compares EMR-based suggestions (control) with EMR and symptom-based suggestions (intervention) | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Hospitalization at 6 and 12 months (mean ± SD)—  At 6 months (P = 0.0002):  Control (n = 365): 0.7 ± 0.4  Intervention (n = 355): 1.5 ± 1.1  At 12 months (P = 0.05):  Control ( n = 365): 1.7 ± 0.7  Intervention ( n = 355): 2.3 ± 1.2  - Mortality: NR  - Validated measure of HRQOL or functional status: SF-36: Physical component scale (mean ± SD)—  Change from enrollment to 6 months (P = 0.2):  Control (n = 319): 1.8 ± 1.8  Intervention (n = 311): 0.8 ± 1.9  Change from enrollment to 12 months (P = 0.03):  Control (n = 280): 1.3 ± 2.0  Intervention (n = 269): -0.6 ± 2.0  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Provider adherence to heart failure care suggestions, # of suggestions (# [%] adhered to)—  At 6 months (P = 0.4):  Control: 479 (90 [20%])  Intervention: 528 (110 [23%])  At 12 months (P = 0.4):  Control: 665 (185 [30%])  Intervention: 738 (221 [33%])  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  In this study, the clinic is already using a CDSS for chronic heart failure care decision support (baseline), and the investigators are examining the impact of adding symptom information from a manual survey  **Quality assessment:**  Overall rating: Fair  Comments: Randomization by coin flip; insufficient methods reporting  **Applicability/ generalizability:**  General setting: VA hospital |
|  |  |  |  |  |  |
| **Sundaram, Lazzeroni, Douglass, et al., 2009**  #258 | **Geographical location:**  Palo Alto, CA  **Study dates:**  January 2001–September 2001  **General setting:**  VA  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  9 months  **Sample type(s) (with N randomized for each):**  Individual HCPs: 32 MDs  **User level of expertise/ proficiency:**  All users familiar with EMR used for CDSS | **Authors’ basic description of system:**  The study intervention was computer-based reminders to assess HIV risk behaviors or to offer HIV testing; feedback on adherence to reminders was provided.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Change in HIV screening rates (P = 0.75)—  Control: 0.52%  Intervention: 0.29%  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Reasons for not following recommendations on reminders—  Lack of time:  Preintervention: 21 (66)  Postintervention: 18 (64)  Disagree with recommendation in general:  Preintervention: 6 (19)  Postintervention: 3 (11)  Disagree with recommendation for that patient visit:  Preintervention: 22 (69)  Postintervention: 20 (17)  Recommendation not received concurrently with visit:  Preintervention: 8 (25)  Postintervention: 9 (32)  - HCP satisfaction: Clinical practice reminders are useful (Preintervention: n = 32 clinicians; postintervention = 28)  Agree:  Preintervention: 21 (66)  Postintervention: 17 (61)  Disagree:  Preintervention: 5 (16)  Postintervention: 5 (18)  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Set at VA hospital associated with Stanford Hospital |

| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Tamblyn, Huang, Perreault, et al., 2003**  #4434 | **Geographical location:**  Quebec, Canada  **Study dates:**  January 1997–February 1998  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  13 months  **Sample type(s) (with N randomized for each):**  - Patients: 12,560  - Individual HCPs:  > MDs: 107 primary care  **User level of expertise/ proficiency:**  New system for all users | **Authors’ basic description of system:**  Physicians in the CDS group had access to information on current and past prescriptions through a dedicated computer link to the provincial seniors’ drug insurance program. When any of 159 relevant prescribing problems were identified by the CDS software, the physician received an alert that identified the nature of the problem, possible consequences, and alternative therapy.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Percentage of patients with at least one potentially inappropriate prescription—  At baseline:  Control: 33.3%  Intervention: 31.8%  During the study the number of new potentially inappropriate prescriptions per 1000 visits was significantly lower (18%) in the CDS group than in the control group (relative rate 0.82, 95% confidence interval 0.69 to 0.98)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Set in Canada |
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| **Tamblyn, Huang, Taylor, et al., 2008**  #1158  **Comparison 1 of 2** | **Geographical location:**  Montreal, Quebec, Canada  **Study dates:**  February 1, 2004–September 30, 2004  **General setting:** NR  **Specific setting:** Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 3449  - Individual HCPs:  > MDs: 28 general practitioners or family physicians  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A single-blind, cluster randomized controlled trial was conducted to assess the benefits of customizable computer-triggered versus on-demand drug decision support in reducing the prevalence of prescribing problems.  Computer-triggered alerts  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS:  1) Intervention is computer-triggered alerts  2) Comparator is on-demand drug decision support | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prevalence of any prescribing problem at end of the intervention period—  Computer-triggered (N = 13 MDs, 1069 patients): N = 389 (38.8%)  On-demand (N = 12 MDs, 416 patients): N = 116 (30.1%)  Odds ratio = 1.31  95% CI = 0.89 to 1.92  P-value = 0.17  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Total number of prescribing problems—  Computer-triggered (N = 14 MDs, 1899 patients): 6505  On-demand (N = 14 MDs, 1550 patients): 4445  Prescribing problem alerts revised by study MD—  Computer-triggered: 81 (12.1%)  On-demand: 31 (75.6%)  Prescribing problem alerts ignored by study MD—  Computer-triggered: 585 (87.8%)  On-demand: 10 (24.4%)  Reasons for ignoring prescribing alerts, # (% ignored)—  Total number of alerts seen and ignored:  Computer-triggered: 585  On-demand: 10  Benefit greater than risk:  Computer-triggered: 159 (27.1%)  On-demand: 1 (10.0%)  Drug/disease information incorrect:  Computer-triggered: 97 (16.5%)  On-demand: 0 (0%)  Interaction already known:  Computer-triggered: 113 (19.2%)  On-demand: 9 (90.0%)  Need to consult with prescribing physician:  Computer-triggered: 36 (6.1%)  On-demand: 0 (0%)  No time at this visit:  Computer-triggered: 5 (0.9%)  On-demand: 0 (0%)  Not clinically important:  Computer-triggered: 173 (29.5%)  On-demand: 0 (0%)  Patient resistant to change:  Computer-triggered: 4 (0.7%)  On-demand: 0 (0%)  - HCP satisfaction: NR  - HCP use: Total number of prescribing problems—  Computer-triggered (N = 14 MDs, 1899 patients): 6505  On-demand (N = 14 MDs, 1550 patients): 4445  Prescribing problem alerts seen by study MD—  Computer-triggered: 668 (10.3%)  On-demand: 41 (0.9%)  Prescribing problem alerts revised by study MD—  Computer-triggered: 81 (12.1%)  On-demand: 31 (75.6%)  Prescribing problem alerts ignored by study MD—  Computer-triggered: 585 (87.8%)  On-demand: 10 (24.4%)  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: No true control; study compared two new interventions with no usual care control arm  **Applicability/ generalizability:**  Set in Canada  Academic setting  Control arm did not represent usual practice |
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| **Tamblyn, Huang, Taylor, et al., 2008**  #1158  **Comparison 2 of 2** | **Geographical location:**  Montreal, Quebec, Canada  **Study dates:**  February 1, 2004–September 30, 2004  **General setting:** NR  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinician  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 3449  - Individual HCPs:  > MDs: 28 general practitioners or family physicians  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A single-blind, cluster randomized controlled trial was conducted to assess the benefits of customizable computer-triggered versus on-demand drug decision support in reducing the prevalence of prescribing problems.  On-demand decision support  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  Justification for not complying  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/HER  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS:  1) Intervention is computer-triggered alerts  2) Comparator is on-demand drug decision support | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Prevalence of any prescribing problem at end of the intervention period—  Computer-triggered (N = 13 MDs, 1069 patients): N = 389 (38.8%)  On-demand (N = 12 MDs, 416 patients): N = 116 (30.1%)  Odds ratio = 1.31  95% CI = 0.89 to 1.92  P-value = 0.17  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Total number of prescribing problems—  Computer-triggered (N = 14 MDs, 1899 patients): 6505  On-demand (N = 14 MDs, 1550 patients): 4445  Prescribing problem alerts revised by study MD—  Computer-triggered: 81 (12.1%)  On-demand: 31 (75.6%)  Prescribing problem alerts ignored by study MD—  Computer-triggered: 585 (87.8%)  On-demand: 10 (24.4%)  Reasons for ignoring prescribing alerts, # (% ignored)—  Total number of alerts seen and ignored:  Computer-triggered: 585  On-demand: 10  Benefit greater than risk:  Computer-triggered: 159 (27.1%)  On-demand: 1 (10.0%)  Drug/disease information incorrect:  Computer-triggered: 97 (16.5%)  On-demand: 0 (0%)  Interaction already known:  Computer-triggered: 113 (19.2%)  On-demand: 9 (90.0%)  Need to consult with prescribing physician:  Computer-triggered: 36 (6.1%)  On-demand: 0 (0%)  No time at this visit:  Computer-triggered: 5 (0.9%)  On-demand: 0 (0%)  Not clinically important:  Computer-triggered: 173 (29.5%)  On-demand: 0 (0%)  Patient resistant to change:  Computer-triggered: 4 (0.7%)  On-demand: 0 (0%)  - HCP satisfaction: NR  - HCP use: Total number of prescribing problems—  Computer-triggered (N = 14 MDs, 1899 patients): 6505  On-demand (N = 14 MDs, 1550 patients): 4445  Prescribing problem alerts seen by study MD—  Computer-triggered: 668 (10.3%)  On-demand: 41 (0.9%)  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: No true control; study compared two new interventions with no usual care control arm  **Applicability/ generalizability:**  Set in Canada  Academic setting  Control arm did not represent usual practice |
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| **Tamblyn, Reidel, Huang, et al., 2009**  #240 | **Geographical location:**  Montreal, Quebec, Canada  **Study dates:** NR  **General setting:** NR  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  Patients: 2293  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A single-blind randomized controlled trial was conducted to assess the benefits of providing an adherence-tracking and alert system for patients receiving medications for cardiovascular diseases.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Drug profile reviewed—  Control (N = 1127): 400 (35.5%)  Odds ratio = 1  Intervention (N = 1166): 519 (44.5%)  Odds ratio = 1.46  95% CI = 1.21 to 1.76, P < 0.0001  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Adherence status to drug profile review—  Control N (%):  Adherent: 204 of 625 (32.6%)  Nonadherent (< 80%): 196 of 502 (39.0%)  Intervention N (%)  Adherent: 269 of 649 (41.5%)  Nonadherent (< 80%): 250 of 517 (48.4%)  Odds ratio = 1.37  95% CI = 1.16 to 1.62, P < 0.0002  Change in therapy during the 6-month followup period for discontinuation of therapy for adverse effects—  Control (N = 1127):  N = 23 (2.0%)  Odds ratio = 1  Intervention (N = 1166):  N = 27 (2.3%)  Odds ratio = 1.18  95% CI = 0.63 to 2.19, P = 0.61  Adherence status to change in therapy during the 6-month followup period for discontinuation of therapy for adverse effects—  Control N (%):  Adherent: 10 of 625 1.6%  Nonadherent (< 80%) 13 of 502 2.6%  Intervention N (%):  Adherent: 18 of 649 2.8%  Nonadherent (< 80%) 9 of 517 1.7%  Odds ratio = 1.01  95% CI = 0.52 to 1.94, P = 0.98  Change in therapy during the 6-months followup period for increase in therapy—  Control (N = 1127):  N = 328 (29.1%)  Odds ratio = 1  Intervention (N = 1166):  N = 332 (28.5%)  Odds ratio = 0.98  95% CI = 0.80 to 1.21, P = 0.86  Adherence status to change in therapy during the 6-months followup period adherence status for increase in therapy—  Control N (%):  Adherent: 169 of 625 (27.0%)  Nonadherent (< 80%): 159 of 502 (31.7%)  Intervention N (%):  Adherent: 177 of 649 (27.3%)  Nonadherent (< 80%): 155 of 517 (30.0%)  Odds ratio = 1.14  95% CI = 0.94 to 1.38, P = 1.93  Adherence to cardiovascular medications in the 6 months before and after the intervention for lipid-lowering and antihypertensive therapy—  Control (N = 1127):  Before mean = 79.2  After mean = 72.9  Difference (SD) = -6.4 (24.1)  Intervention (N = 1166):  Before mean = 79.7  After mean = 73.5  Difference (SD) = -6.2 (24.1)  Adjusted difference = 0.11  95% CI = -1.8 to 2.1, P = 0.90  Adherence status to cardiovascular medications in the 6 months before and after the intervention for lipid-lowering and antihypertensive therapy—  Control:  Adherent before mean: 95.5; after mean: 80.3; diff (SD): –15.1 (18.6)  Nonadherent before mean: 59.1; after mean: 63.6; diff (SD): 4.5 (25.8)  Intervention:  Adherent before mean: 95.3; after mean: 80.2; diff (SD): –15.1 (17.9)  Nonadherent before mean: 60.2; after mean: 65.1; diff(SD) 4.9 (26.3)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating:  Good  **Applicability/ generalizability:**  Set in Canada  Academic setting  New system, but built off previously used drug management and ordering system |
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| **Taylor, Thompson, Lessler, et al., 1999**  #6112 | **Geographical location:**  Seattle, WA  **Study dates:**  September 1995– November 1996  **General setting:**  - Academic  - Community  **Specific setting:**  Outpatient    **Study design:**  RCT, firm system  **Unit of randomization:**  - Clinician  - Patient  **Duration of intervention:**  15 months  **Sample type(s) (with N randomized for each):**  - Patients: 314  - Individual HCPs:  > Training MDs: 17  > Attending physicians: 15  **User level of expertise/ proficiency:**  Academic detailing session for intervention firms | **Authors’ basic description of system:**  The intervention program included a computer-generated provider mammography prompt that routinely appeared on intervention firm patient profile reports (for those women never screened at the hospital or out of compliance with institutional guidelines for interval screening).  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Lab test ordering  - Initiating discussion with patient  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Mammography completion within 8 weeks of index clinic visit—  Intervention (n = 232): 49%  Control (n = 82): 22%  P < 0.001  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  CDSS was only one part of a multi-intervention strategy including physician education, provider prompts, patient education, patient transportation assistance  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Approximately one-third age-eligible women were not entered in the study    Urban setting |
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| **Terrell, Perkins, Dexter, et al., 2009**  #260 | **Geographical location:**  Indianapolis, IN  **Study dates:**  January 12, 2005–July 7, 2007  **General setting:**  Academic  **Specific setting:**  Emergency department (ED)  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:**  2.5 years  **Sample type(s) (with N randomized for each):**  - Individual HCPs:  > MDs: 63 emergency department MDs  - Patients visits: 7458, of which 5,162 (69%) led to an ED discharge    **User level of expertise/ proficiency:**  Intervention was integrated into an electronic prescribing system the users were already familiar with | **Authors’ basic description of system:**  Decision support to decrease the prescription of potentially inappropriate medications to older adults discharged from the ED and to identify the various reasons why providers reject decision support.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Pharmacotherapy  - Preventive care  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: NR  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Prescriptions that were inappropriate, n (%)—  Control: 103 (5.4)  Intervention: 69 (3.4)  P-value = 0.006  Odds ratio (95% CI): 0.59 (0.41 to 0.85)  Visits with an inappropriate medication prescription, n (%)—  Control: 99 (3.9)  Intervention: 69 (2.6)  P-value = 0.2  Odds ratio (95% CI): 0.55 (0.34 to 0.89)  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Intervention physicians accepted 49 of 114 (43%) decision support recommendations pertaining to potentially inappropriately prescribed medications  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good    **Applicability/ generalizability:**  Academic setting  Well-established health IT infrastructure  Not patient-centered outcomes |
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| **Terrell, Perkins, Hui, et al., 2010**  #14951 | Geographical location:  Indianapolis, IN  Study dates:  7/22/2005–7/7/2007  General setting:  Academic  Specific setting:  - Emergency department  - Acute  Study design:  RCT, parallel group  Unit of randomization:  Clinician  Duration of intervention:  2 years  Sample type(s) (with N randomized for each):  - Patients: 2783  - Individual HCPs: 42  > Training MDs  > MDs [emergency medicine]    User level of expertise/ proficiency: NR | **Authors’ basic description of system:**  Decision support for emergency physicians in an established computerized physician order entry system to reduce excessive medication dosing for patients with clinically important renal impairment.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed:  Percentage of targeted medications that were excessively dosed—  Control: 74% (34/46)  Intervention: 43% (31/73)  P = 0.001  Effect size: 31%; 95% CI 14% to 49%  Percentage of excessive dosing by faculty physicians—  Control: 69%  Intervention: 41%  Effect size: 28%; 95% CI 5% to 51%  Percentage of excessive dosing by resident physicians—  Control: 86%  Intervention: 47%  Effect size: 39%; 95% CI 2% to 75%  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  Quality assessment:  Overall rating: Fair  Comments: No important baseline differences  Valid outcome measures  **Applicability/ generalizability:**  Well-established health IT infrastructure and history of being an early adopter of health IT  Long study duration  Majority of study patients were women or African American  Single site study prevents having a more generalizable result |
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| **Thomas, Lewis, Watson, et al., 2004**  #3745 | **Geographical location:**  5 general practices in Bristol and Cardiff, UK  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  Patients: 762  **User level of expertise/ proficiency:**  New guidelines provided for both control and intervention (with additional guidance for intervention). Both control and intervention were nonexperts for new guidelines and intervention system. | **Authors’ basic description of system:**  The experimental intervention required participants to complete a computerized psychosocial assessment that generated a report for the GP including patient-specific treatment recommendations. The control patients were treated as usual with access to locally agreed guidelines.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  More effective mental health treatment, assessed by lower score on standardized scoring system  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y (printout integration with paper chart)  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: NR  - Mortality: NR  - Validated measure of HRQOL or functional status: Mean quality-of-life (QOL) scores at baseline and at followup adjusted for baseline scores with analysis of covariance—  Control:  Baseline QOL score (n = 387):  Mean (95% CI): 4.7 (4.4 to 4.9)  6-week QOL score (n = 319):  Mean (95% CI): 5.8 (5.4 to 6.1)  6-month QOL score (n = 299):  Mean (95% CI): 6.2 (5.8 to 6.6)  Intervention:  Baseline QOL score (n = 358):  Mean (95% CI): 4.8 (4.5 to 5.1)  6-week QOL score (n = 283):  Mean (95% CI): 5.9 (5.5 to 6.2) P = 0.73  6-month QOL score (n = 243):  Mean (95% CI): 6.4 (6.0 to 6.9) P = 0.52  - Adverse events: NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Significant loss to followup (26% at 6 months)  **Applicability/ generalizability:**  No information about familiarity with system or guidelines  Intervention was locally developed |
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| **Tierney, Hui, and McDonald, 1986**  #7374  **Comparison 1 of 2** | **Geographical location:**  Indianapolis, IN  **Study dates:**  April 1983–January 1984  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  - Patients: 6045  - Individual HCPs  > Training MDs: 135  - Events: 16,258  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Reminder system to compare the effect of monthly feedback reports of compliance with immediate specific reminders given to physicians at the time of patient visits on 13 preventive care protocols.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Preventive care  - Immunization  - Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  The effects of specific reminders given to them at the time of patient visits | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percent compliance with preventive care protocols in eligible patients—  Group A preventive care protocols:  Control: 15%  Intervention: 30%  Group B preventive care protocols:  Control: 10%  Intervention: 22%  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Included training MDs  Well-established health IT infrastructure  Not patient-centered outcomes |
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| **Tierney, Hui, and McDonald, 1986**  #7374  **Comparison 2 of 2** | **Geographical location:**  Indianapolis, IN  **Study dates:**  April 1983–January 1984  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  - Patients: 6045  - Individual HCPs  > Training MDs: 135  - Events: 16,258  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Reminder system to compare the effect of monthly feedback reports of compliance with immediate specific reminders given to physicians at the time of patient visits on 13 preventive care protocols.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Preventive care  - Immunization  - Lab test ordering  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Y  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS  The effects of supplying monthly feedback reports of compliance with preventive care protocols | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: Percent compliance with preventive care protocols in eligible patients—  Group A preventive care protocols:  Control: 15%  Intervention: 22%  Group B preventive care protocols:  Control: 10%  Intervention: 14%  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Users’ response to the feedback reports—  Mark the chart on the next visit: 80%  Stop the reminder: 9.8%  Protocol not applicable in this patient: 8.5%  Pull the chart for review now: 1.3%  Reschedule the patient earlier: 0.5%  Physicians more often disagreed with the suggested action for therapeutic interventions (such as calcium supplements, digitalis, or nitrates) than for clinical testing (e.g., fecal occult blood or mammography)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Included training MDs  Well-established health IT infrastructure  Not patient-centered outcomes |
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| **Tierney, McDonald, Hui, et al., 1988**  #15375 | **Geographical location:**  Indianapolis, IN  **Study dates:**  March 24–September 30, 1986  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients 9496  - Individual HCPs:112  > Training MDs 98  > MDs [general internists] 14  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A microcomputer that displays the predicted probabilities of test abnormalities to physicians when ordering outpatient tests.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Diagnosis  - Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:** NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Charges for study tests per patient visit—  Intervention = $11.18 ± 0.59 [SEM]  Control = $12.27 ± 0.63  P < 0.05  Charges for study tests per patient visit by residents—  Intervention = $11.44  Control = $12.70  P < 0.05  Charges for non-study tests per patient—  Intervention = $27.05  Control = $26.65  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS:  Before the intervention, there were no differences in charges for study tests between intervention and control patients. During the intervention period, these charges dropped 10.8% for intervention patients (P < 0.05) while decreasing only 3.7% for control patients (not significant). After the intervention was discontinued, the ordering of study tests returned to prestudy levels, and again there was no difference between intervention and control patients. | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  No information on randomization, blinding and concealment  Baseline information not available  Learning bias  **Applicability/ generalizability:**  Single study site enrolled in an academic setting  Physicians were required to use microcomputers to enter orders since November 1984  Well-established health IT infrastructure and history of being an early adopter of health IT |
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| **Tierney, McDonald, Martin et al., 1987**  #15376 | **Geographical location:**  Indianapolis, IN  **Study dates:** NR  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  16 weeks  **Sample type(s) (with N randomized for each):**  - Patients 5946  - Individual HCPs: 111  > Training MDs: 97  > MDs [general internists] 14  - Events: 8148 visits  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A microcomputer-based order-entry system that displays past relevant diagnostic test results on the ordering of selected outpatient tests by physicians.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:* Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Number of tests ordered per 1000 visits—  All study tests:  Control = 558  Intervention = 510  Number of study tests ordered per patient—  Control = 0.56 ± 0.03 [SE]  Intervention = 0.51 ± 0.03  P = 0.05  Number of non-study tests ordered per patient—  Control = 1.00 ± 0.05  Intervention = 0.97 ± 0.04  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:**  - Number of patients seen/unit time: NR  - Clinician workload: NR  - Efficiency: Intervention took 4.5 seconds (8%) longer than control to order study tests (P < 0.01)  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Total cost for study tests ordered per 1000 visits—  Control = $13994  Intervention = $12171  Patient charges for study tests ordered per scheduled visit—  Control = $13.99 ± 0.77  Intervention = $12.17 ± 0.62  P = 0.01  Patient charges for non-study tests ordered per scheduled visit—  Control = $28.59 ± 1.50  Intervention = $27.54 ± 1.34  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Physicians were not blinded to the intervention and no information on concealment  Baseline information not available  Learning bias  **Applicability/ generalizability:**  Single study site enrolled in an academic setting with a well-established health IT infrastructure  Short intervention duration  Physicians were required to use microcomputers to enter orders since November 1984 |
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| **Tierney, Overhage, Murray, et al., 2003**  #4334  **Comparison 1 of 2** | **Geographical location:**  Indianapolis, IN  **Study dates:**  January 1, 1994–May 1, 1996  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2 factorial  **Unit of randomization:**  - Clinic or team  - Clinician  **Duration of intervention:**  28 months  **Sample type(s) (with N randomized for each):**  - Patients: 706  - Clinics/practices/ hospitals: 32  - Individual HCPs:  > Training MDs: 61  > MDs: 33 general internists  > Nurse practitioner: 1  > Pharmacists: 20  **User level of expertise/ proficiency:**  Intervention modified the electronic medical record users were already familiar with | **Authors’ basic description of system:**  Evidence-based cardiac care suggestions, approved by a panel of local cardiologists and general internists, were displayed to physicians and pharmacists as they cared for enrolled patients. Multifaceted intervention including a physician intervention, pharmacist intervention, both interventions, and control.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Y  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS  1) Physician Intervention  2) Pharmacist Intervention | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Number of hospitalizations, ± SD [all]—  Control (N = 181): 0.5 ± 1.1  Intervention (N = 197): 1.1 ± 1.9  Number of hospitalizations, ± SD [heart disease–specific]—  Control (N = 181): 0.2 ± 0.5  Intervention (N = 197): 0.2 ± 0.6  - Mortality: NR  - Validated measure of HRQOL or functional status: HRQOL outcomes (n = 480)—  No differences between groups in any of the SF-36 subscales or the 4 subscales of the CHQ  Overall health status on chronic heart disease questionnaire subscales, ± SD  Control (no intervention) (n = 119): 4.6 ± 1.2  Physician Intervention (n = 142): 4.5 ± 1.2  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Compliance with treatment suggestions; all cardiac care suggestions—  Control (N = 181)  Patients with any suggestions, n (%): 163 (90)  Suggestions, mean/patient ± SD: 589 (3.6 ± 1.7)  Suggestions complied with, n (%) : 130 (22)    Physician intervention (N = 197)  Patients with any suggestions, n (%): 174 (88)  Suggestions, mean/patient ± SD: 648 (3.7 ± 1.9)  Suggestions complied with, n (%): 152 (23)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Direct health care charges ± SD—  Control: 7025 ± 17,024  Physician intervention: 6302 ± 10,928  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT infrastructure  Did use some patient-centered outcomes  Recommendations based on evidence-based guideline published by the Agency for Health Care Policy and Research and national professional organizations |
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| **Tierney, Overhage, Murray, et al., 2003**  #4334  **Comparison** **2 of 2** | **Geographical location:**  Indianapolis, IN  **Study dates:**  January 1, 1994–May 1, 1996  **General setting:**  Academic  **Specific setting:**  Outpatient  **Study design:**  RCT, 2 x 2 factorial  **Unit of randomization:**  - Clinic or team  - Clinician  **Duration of intervention:**  28 months  **Sample type(s) (with N randomized for each):**  - Patients: 706  - Clinics/practices/ hospitals: 32  - Individual HCPs:  > Training MDs: 61  > MDs: 33 general internists  > Nurse practitioner: 1  > Pharmacists: 20  **User level of expertise/ proficiency:**  Intervention modified the electronic medical record users were already familiar with | **Authors’ basic description of system:**  Evidence-based cardiac care suggestions, approved by a panel of local cardiologists and general internists, were displayed to physicians and pharmacists as they cared for enrolled patients. Multifaceted intervention including a physician intervention, pharmacist intervention, both interventions, and control.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Noncommittal acknowledgement  **Information delivery:**  *a) Delivery format:*  - Integrated with CPOE/EHR  - Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Y  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS:  1) Physician Intervention  2) Pharmacist Intervention | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Number of hospitalizations, ± SD [all]—  Control: 0.5 ± 1.1  Intervention: 0.5 ± 1.0  Number of hospitalizations, ± SD [heart disease–specific]—  Control: 0.2 ± 0.5  Intervention: 0.2 ± 0.6  - Mortality: NR  - Validated measure of HRQOL or functional status: HRQOL outcomes (n = 480)—  No differences between groups in any of the SF-36 subscales or the 4 subscales of the CHQ  Overall health status on chronic heart disease questionnaire subscales, ± SD  Control (no intervention) (n = 119): 4.6 ± 1.2  Pharmacist Intervention (n = 106): 4.6 ± 1.2  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Compliance with treatment suggestions; all cardiac care suggestions—  Control (N = 181):  Patients with any suggestions, n (%): 163 (90)  Suggestions, mean/patient ± SD: 589 (3.6 ± 1.7)  Suggestions complied with, n (%): 130 (22)  Pharmacist intervention (N = 158):  Patients with any suggestions, n (%): 140 (89)  Suggestions, mean/patient ± SD: 535 (3.8 ± 1.9)  Suggestions complied with, n (%): 125 (23)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Direct health care charges ± SD—  Control (N = 181): 7025 ± 17,024  Pharmacist intervention (N = 158): 7387 ± 13,206  - Cost-effectiveness:  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT infrastructure  Did use some patient-centered outcomes  Recommendations based on evidence-based guideline published by the Agency for Health Care Policy and Research and national professional organizations |
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| **Tierney, Overhage, Murray, et al., 2005**  #3487  **Comparison 1 of 2** | **Geographical location:**  Indiana  **Study dates:**  1/1/1994–5/1/1996  **General setting:**  Academic  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT: 2 x 2 factorial randomization  **Unit of randomization:**  Clinicians randomized by half-day practice sessions and patients randomized to intervention or control pharmacists  **Duration of intervention:**  28 months  **Sample type(s) (with N randomized for each):**  - Patients: 706  - Individual HCPs:  > MDs: 274 internal medicine (25% faculty and 75% residents)  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Patient-specific, guideline-based care suggestions.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Physician intervention  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N (physicians required to enter severity of symptoms)  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Another CDSS/KMS  2 x 2 factorial design with 4 resulting groups:  1) No intervention (control)  2) Physician intervention  3) Pharmacist intervention  4) Both interventions | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: All hospitalizations—  Control: 0.4 ± 0.8  Physician: 0.5 ± 1.6  Pharmacist: 0.5 ± 1.1  Both: 0.4 ± 1.1  For reactive airways disease hospitalizations—  Control: 0.1 ± 0.3  Physician: 0.1 ± 0.5  Pharmacist: 0.1 ± 0.5  Both: 0.1 ± 0.5  - Mortality: NR  - Validated measure of HRQOL or functional status: Short-form 36 subscales—  General health:  Control: 34 ± 22  Physician: 37 ± 24  Pharmacist: 29 ± 25  Both: 35 ± 20  Chronic respiratory disease questionnaire subscales—  Overall health status:  Control: 4.2 ± 1.1  Physician: 4.4 ± 1.2  Pharmacist: 4.3 ± 1.3  Both: 4.1 ± 1.1  Asthma quality-of-life questionnaire subscales—  Overall health status:  Control: 3.7 ± 1.3  Physician: 4.0 ± 1.5  Pharmacist: 4.2 ± 1.4  Both: 4.2 ± 1.1  - Adverse events: NR  **2) Impact on health care process outcomes:**  All indicated tests and treatments suggestions adhered to:  Control: 135 (32%)  Physician intervention: 161 (32%)  Pharmacist intervention: 123 (32%)  Both interventions: 173 (37%)  - Recommended preventive care ordered/completed: Influenza vaccination, N (%) of suggestions adhered to—  Control: 36 (42%)  Physician: 37 (40%)  Pharmacist: 34 (43%)  Both: 37 (37%)  Pneumococcal vaccination, N (%) of suggestions adhered to—  Control: 7 (9%)  Physician: 7 (8%)  Pharmacist: 6 (8%)  Both: 15 (16%)  - Recommended clinical study ordered/completed: Obtain pulmonary function test, N (%) of suggestions adhered to—  Control: 4 (6%)  Physician: 6 (6%)  Pharmacist: 4 (6%)  Both: 9 (12%)  - Recommended treatment ordered/prescribed: Start ipratropium, N (%) of suggestions adhered to—  Control: 17 (25%)  Physician: 30 (42%)  Pharmacist: 15 (25%)  Both: 23 (35%)  Start inhaled β-agonist, N (%) of suggestions adhered to—  Control: 23 (70%)  Physician: 18 (60%)  Pharmacist: 13 (52%)  Both: 16 (67%)  Switch to cheaper β-agonist, N (%) of suggestions adhered to—  Control: 17 (71%)  Physician: 23 (77%)  Pharmacist: 13 (65%)  Both: 30 (91%)  Increase/decrease theophylline dose, N (%) of suggestions adhered to—  Control: 16 (67%)  Physician: 26 (67%)  Pharmacist: 18 (72%)  Both: 20 (65%)  Stop ipratropium, N (%) of suggestions adhered to—  Control: 12 (57%)  Physician: 7 (32%)  Pharmacist: 10 (56%)  Both: 16 (57%)  Start inhaled corticosteroid, N (%) of suggestions adhered to—  Control: 1 (11%)  Physician: 2 (11%)  Pharmacist: 3 (30%)  Both: 3 (27%)  Start oral corticosteroid, N (%) of suggestions adhered to—  Control: 2 (22%)  Physician: 5 (50%)  Pharmacist: 2 (50%)  Both: 3 (33%)  Mean medication compliance score (Inui measure) (%)—  Control: 80  Physician: 81  Pharmacist: 80  Both: 82  Mean medication compliance score (Morisky measure)—  Control: 0.88 ± 1.0  Physician: 0.95 ± 1.1  Pharmacist: 0.85 ± 1.0  Both: 0.89 ± 1.1  N (%) of subjects with ≥ 2 prescription refills—  Control: 96 (87%)  Physician: 128 (95%)  Pharmacist: 89 (81%)  Both: 109 (92%)  Medication possession ratio (mean ± SD) p < 0.05 after adjusting for baseline values—  Control: 0.92 ± 1.0  Physician: 0.98 ± 0.8  Pharmacist: 1.00 ± 2.7  Both: 1.1 ± 2.0  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:**  - Patient satisfaction with physician:  Control: 2.1 ± 0.7  Physician: 1.9 ± 0.9  Pharmacist: 2.0 ± 0.9  Both: 2.1 ± 0.6  - Patient satisfaction with pharmacist:  Control: 2.1 ± 0.7  Physician: 2.1 ± 0.7  Pharmacist: 2.1 ± 0.8  Both: 2.0 ± 0.6  **5) Impact on economic outcomes:**  - Cost: Outpatient charges—  Control: $3,129 ± 2,921  Physician: $3,142 ± 3,381  Pharmacist: $2,814 ± 3,282  Both: $3,177 ± 3,558  Inpatient charges:--  Control: $2,671 ± 6,805  Physician: $4,864 ± 17,257  Pharmacist: $2,519 ± 7,267  Both: $2,475 ± 8,699  Total health care charges—  Control: $5,800 ± 8,536  Physician: $8,006 ± 18,720  Pharmacist: $5,333 ± 9,400  Both: $5,652 ± 10,579  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  Study arm allocation not fully random (post-randomization adjustments made), multiple comparisons leading to probably underpowered study, participants not blinded, and inadequate statistical analysis and reporting of findings  **Applicability/ generalizability:**  Academic setting  Physicians in training (residents) were among the clinicians  Relevant, valid, and reproducible patient-centered outcomes were used |
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| **Tierney, Overhage, Murray, et al., 2005**  #3487  **Comparison 2 of 2** | **Geographical location:**  Indiana  **Study dates:**  1/1/1994–5/1/1996  **General setting:**  Academic  **Specific setting:**  - Outpatient  - Chronic  **Study design:**  RCT: 2 x 2 factorial randomization  **Unit of randomization:**  Clinicians randomized by half-day practice sessions and patients randomized to intervention or control pharmacists  **Duration of intervention:**  28 months  **Sample type(s) (with N randomized for each):**  - Patients: 706  - Individual HCPs:  > MDs: 274 internal medicine (25% faculty and 75% residents)  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Patient-specific, guideline-based care suggestions.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Chronic disease management  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Pharmacist intervention  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  2 x 2 factorial design with 4 resulting groups:  1) No intervention (control)  2) Physician intervention  3) Pharmacist intervention  4) Both interventions | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: All hospitalizations—  Control: 0.4 ± 0.8  Physician: 0.5 ± 1.6  Pharmacist: 0.5 ± 1.1  Both: 0.4 ± 1.1  For reactive airways disease hospitalizations—  Control: 0.1 ± 0.3  Physician: 0.1 ± 0.5  Pharmacist: 0.1 ± 0.5  Both: 0.1 ± 0.5  - Mortality: NR  - Validated measure of HRQOL or functional status: Short-form 36 subscales—  General health:  Control: 34 ± 22  Physician: 37 ± 24  Pharmacist: 29 ± 25  Both: 35 ± 20  Chronic respiratory disease questionnaire subscales—  Overall health status:  Control: 4.2 ± 1.1  Physician: 4.4 ± 1.2  Pharmacist: 4.3 ± 1.3  Both: 4.1 ± 1.1  Asthma quality-of-life questionnaire subscales—  Overall health status:  Control: 3.7 ± 1.3  Physician: 4.0 ± 1.5  Pharmacist: 4.2 ± 1.4  Both: 4.2 ± 1.1  - Adverse events: NR  **2) Impact on health care process outcomes:**  All indicated tests and treatments suggestions adhered to:  Control: 135 (32%)  Physician intervention: 161 (32%)  Pharmacist intervention: 123 (32%)  Both interventions: 173 (37%)  - Recommended preventive care ordered/completed: Influenza vaccination, N (%) of suggestions adhered to—  Control: 36 (42%)  Physician: 37 (40%)  Pharmacist: 34 (43%)  Both: 37 (37%)  Pneumococcal vaccination, N (%) of suggestions adhered to—  Control: 7 (9%)  Physician: 7 (8%)  Pharmacist: 6 (8%)  Both: 15 (16%)  - Recommended clinical study ordered/completed: Obtain pulmonary function test, N (%) of suggestions adhered to—  Control: 4 (6%)  Physician: 6 (6%)  Pharmacist: 4 (6%)  Both: 9 (12%)  - Recommended treatment ordered/prescribed: Start ipratropium, N (%) of suggestions adhered to—  Control: 17 (25%)  Physician: 30 (42%)  Pharmacist: 15 (25%)  Both: 23 (35%)  Start inhaled β-agonist, N (%) of suggestions adhered to—  Control: 23 (70%)  Physician: 18 (60%)  Pharmacist: 13 (52%)  Both: 16 (67%)  Switch to cheaper β-agonist, N (%) of suggestions adhered to—  Control: 17 (71%)  Physician: 23 (77%)  Pharmacist: 13 (65%)  Both: 30 (91%)  Increase/decrease theophylline dose, N (%) of suggestions adhered to—  Control: 16 (67%)  Physician: 26 (67%)  Pharmacist: 18 (72%)  Both: 20 (65%)  Stop ipratropium, N (%) of suggestions adhered to—  Control: 12 (57%)  Physician: 7 (32%)  Pharmacist: 10 (56%)  Both: 16 (57%)  Start inhaled corticosteroid, N (%) of suggestions adhered to—  Control: 1 (11%)  Physician: 2 (11%)  Pharmacist: 3 (30%)  Both: 3 (27%)  Start oral corticosteroid, N (%) of suggestions adhered to—  Control: 2 (22%)  Physician: 5 (50%)  Pharmacist: 2 (50%)  Both: 3 (33%)  Mean medication compliance score (Inui measure) (%)—  Control: 80  Physician: 81  Pharmacist: 80  Both: 82  Mean medication compliance score (Morisky measure)—  Control: 0.88 ± 1.0  Physician: 0.95 ± 1.1  Pharmacist: 0.85 ± 1.0  Both: 0.89 ± 1.1  N (%) of subjects with ≥ 2 prescription refills—  Control: 96 (87%)  Physician: 128 (95%)  Pharmacist: 89 (81%)  Both: 109 (92%)  Medication possession ratio (mean ± SD) p < 0.05 after adjusting for baseline values—  Control: 0.92 ± 1.0  Physician: 0.98 ± 0.8  Pharmacist: 1.00 ± 2.7  Both: 1.1 ± 2.0  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:**  - Patient satisfaction with physician:  Control: 2.1 ± 0.7  Physician: 1.9 ± 0.9  Pharmacist: 2.0 ± 0.9  Both: 2.1 ± 0.6  - Patient satisfaction with pharmacist:  Control: 2.1 ± 0.7  Physician: 2.1 ± 0.7  Pharmacist: 2.1 ± 0.8  Both: 2.0 ± 0.6  **5) Impact on economic outcomes:**  - Cost: Outpatient charges—  Control: $3,129 ± 2,921  Physician: $3,142 ± 3,381  Pharmacist: $2,814 ± 3,282  Both: $3,177 ± 3,558  Inpatient charges—  Control: $2,671 ± 6,805  Physician: $4,864 ± 17,257  Pharmacist: $2,519 ± 7,267  Both: $2,475 ± 8,699  Total health care charges—  Control: $5,800 ± 8,536  Physician: $8,006 ± 18,720  Pharmacist: $5,333 ± 9,400  Both: $5,652 ± 10,579  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  Study arm allocation not fully random (post-randomization adjustments made), multiple comparisons leading to probably underpowered study, participants not blinded, and inadequate statistical analysis and reporting of findings  **Applicability/ generalizability:**  Academic setting  Physicians in training (residents) were among the clinicians  Relevant, valid, and reproducible patient-centered outcomes were used |
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| **Evidence table (key questions 2–4) (continued)** | | | | | |
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| **Study ID** | **Study and Sample Characteristics** | **CDSS/KMS Test Intervention** | **Comparator(s)** | **Results** | **Comments/**  **Quality/ Applicability** |
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| **Unrod, Smith, Spring, et al., 2007**  #2098 | **Geographical location:**  New York, NY  **Study dates:**  Physician recruitment occurred in 2002–2004  **General setting:**  Community  Specific setting:  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Clinician  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Patients: 580  - Individual HCPs:  > MDs: 70 family or internal medicine  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A computer-tailored intervention designed to increase smoking cessation counseling by primary care physicians: “We tested an intervention that integrates a brief, tailored expert-system report with face-to-face physician-delivered counseling …”  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Initiating discussion with patient  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based.    *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Y  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Y (“academic detailing”) | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR    GEE generalized linear modeling indicated that intervention physicians exceeded controls on “Assess,” “Advise,” “Assist,” and “Arrange”  (p < 0.0001)  More intervention than control physicians advised their patients to quit smoking (OR 2.79; 95% CI 1.70, 4.59)  7-day point prevalence abstinence—  Intervention: 12%  Control: 8%  OR: 1.77; 95% CI 0.94, 3.34, p-value: 0.078  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments: Participants not blinded, outcomes not assessed using validated methodology, insufficient data regarding whether physicians or patients selected to participate are representative of larger populations  **Applicability/ generalizability:**  Community setting  Locally developed system  All physicians were paid $150, and physicians in the intervention group received an additional $50. Patients were paid $20 for completing initial assessments and $10 for the followup interview. |
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| **Vadher, Patterson, and Leaning, 1997A**  #6536 | **Geographical location:**  1 site in London, England  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  Patients: 148  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  Management by trainee doctors (to achieve therapeutic range of international normalized ration [INR] of 2 to 3) with indirect assistance from computerized decision support system (intervention group) or without such assistance (control group).  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Median time to achieve a stable dose was significantly lower in intervention group than in controls (7 days versus 9 days, P = 0.01) without excessive overtreatment or undertreatment with anticoagulant. Patients in intervention group spent greater proportion of time in therapeutic range, both as inpatients (59% versus 52%) and as outpatients (64% versus 51%).  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  Issues in blinding control MDs from the computerized decision support system’s suggestions  **Applicability/ generalizability:**  Setting was England  Study’s control arm included physicians also treating intervention patients, so control arm may have been biased |
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| **Vadher, Patterson, and Leaning, 1997B**  #6464 | **Geographical location:**  1 site in London, England  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient  **Duration of intervention:**  1 month  **Sample type(s) (with N randomized for each):**  - Patients: 177  - Individual HCPs:  > Training MDs: 3  > PAs/NPs: 1  **User level of expertise/ proficiency:**  NP given training in the use of the CDSS over a period of 1 month | **Authors’ basic description of system:**  The quality of anticoagulant control achieved by a nurse practitioner using a computer decision support system (CDSS) was compared with that achieved by trainee doctors without CDSS.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y/  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: In this study, 57.6% of INRs were within the therapeutic range in the nurse practitioner group compared with 43.3% in the clinician group  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: Dose suggestion acceptance in the nurse practitioner group for patients with therapeutic range of 2-3 was 88% compared with agreement between the CDSSand the clinicians (60%)  Acceptance of dose suggestion in the nurse practitioner group for patients with therapeutic range of 3-4.5 was 67% compared with agreement between the CDSS and the clinicians (73%)  - HCP satisfaction: NR  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Fair  Comments:  It was difficult to shield the clinicians from the CDSS suggestions due to logistical problems, and hence there may have been some learning and carryover effect in the decisions made in the clinician group  **Applicability/ generalizability:**  Set in England |
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| **van Wijk, van der Lei, Mosseveld, et al., 2001**  #5433 | **Geographical location:**  44 sites in the Delft region, Netherlands  **Study dates:**  03/1996–02/1997  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  Cluster RCT  **Unit of randomization:**  Practice  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Clinics/practices/ hospitals: 46  - Individual HCPs:  > MDs: 62 general practitioners  **User level of expertise/ proficiency:**  After BloodLink was installed, one of the authors gave a brief orientation presentation to the participating practitioners | **Authors’ basic description of system:**  CDSS for blood test ordering that included two different versions of the same set of tests:  (1) BloodLink-Guideline presented physicians with an indication-oriented order form based on guidelines where the user selected the appropriate guideline and indication and then the system proposed the relevant tests  (2) BloodLink-Restricted presented the physician with an order form with a restricted number of tests available  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Lab test ordering  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Y  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Another CDSS/KMS:  1) BloodLink-Guideline (an indication-oriented order form)  2) BloodLink-Restricted (an order form with a restricted number of tests) | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Relative risk of the # of tests ordered per form per practice was 1.19 (95% CI: 1.10 to 1.19) for the BloodLink-Restricted group, with the BloodLink-Guideline group as the referent  Number of tests ordered per form mean [±SD], median: GPs who had access to BloodLink-Guideline ordered 20% fewer tests per form than did GPs who had access to BloodLink-Restricted (mean [±SD], 5.5 ± 0.9 tests versus 6.9 ± 1.6 tests [median, 6.6 versus 4.6], respectively; p = 0.003).  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: NR  - HCP use: Of the 12,742 order forms that the laboratory received from practices using BloodLink-Restricted, 11,151 orders (88%) were made by using the software; the remaining 1591 orders were placed by using traditional paper order forms.  Of the 12,668 orders placed by the practices using Blood-Link-Guideline, 9091 (71%) were generated by using the decision support system.  - Implementation of CDSS/KMS: NR | **General comments:**  Users had the choice of using BloodLink or a paper form to order tests  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Study conducted in the Netherlands  Community setting, with apparently good generalizability to other GPs in the Netherlands  Locally developed system |
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| **van Wyk, van Wijk, Sturkenboom, et al., 2008**  #1487  **Comparison 1 of 2** | **Geographical location:**  38 sites in the Delft region, Netherlands  **Study dates:**  Practices recruited May and June 2004  **General setting:**  Community  **Specific setting:**  Outpatient, chronic care  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Clinics/practices/ hospitals: 38  - Individual HCPs:  > Training MDs  > MDs, GPs: 80  **User level of expertise/ proficiency:**  High; only practices with full EHRs for more than 1 yearincluded | **Authors’ basic description of system:**  The CDSS is integrated within the EHR to provide decision support as part of the clinician’s workflow. Two CDSS versions were developed: (1) CDSS on-demand and (2) CDSS alerting. In the on-demand version, the user had to actively initiate the overview screen. In the alerting version, the recommendations were automatically shown to the user.  **Source/origin of system:**  Commercially available (ELIAS EHR)  **Content:**  *a) Objective(s):*  - Screening and treatment of dyslipidemia  - Preventive care  - Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  Alerting DSS group  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  3 Groups:  1) Alerting: recommen-dations automatically shown to the user  2) On-demand: user has to actively initiate the overview screen  3) Control: no overview screen available | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive ordered/completed: Adjusted RR for total patients requiring screening, with control group (n = 882) as referent (95% CI)—  Alerting group (n = 1079): 1.76 (1.41,2.20)  On-demand group (n = 1249): 1.28 (0.98,1.68)  Adjusted RR for total patients requiring screening, with on-demand group as referent (95% CI)—  Alerting group: 1.40 (1.08,1.81)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Adjusted RR for total patients requiring treatment, with control group (n=766) as referent (95% CI)—  Alerting group (n = 1218): 1.40 (1.15,1.70)  On-demand group (n = 969): 1.19 (0.94,1.50)  Adjusted RR for total patients requiring treatment, with on-demand group as referent (95% CI)—  Alerting group: 1.18 (0.96,1.45)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Well-designed and executed 3-arm study with a head-to-head comparison of 2 CDSS systems with a usual care control  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Netherlands study  Community setting  Appears to be locally developed modification of a commercially available system |
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| **van Wyk, van Wijk, Sturkenboom, et al., 2008**  #1487  **Comparison 2 of 2** | **Geographical location:**  38 sites in the Delft region, Netherlands  **Study dates:**  Practices recruited May and June 2004  **General setting:**  Community  **Specific setting:**  Outpatient, chronic care  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:** NR  **Sample type(s) (with N randomized for each):**  - Clinics/practices/ hospitals: 38  - Individual HCPs:  > Training MDs  > MDs, GPs: 80  **User level of expertise/ proficiency:**  High; only practices with full EHRs for more than 1 yearincluded | **Authors’ basic description of system:**  The CDSS is integrated within the EHR to provide decision support as part of the clinician’s workflow. Two CDSS versions were developed: (1) CDSS on-demand and (2) CDSS alerting. In the on-demand version, the user had to actively initiate the overview screen. In the alerting version, the recommendations were automatically shown to the user.  **Source/origin of system:**  Commercially available (ELIAS EHR)  **Content:**  *a) Objective(s):*  - Screening and treatment of dyslipidemia  - Preventive care  - Diagnosis  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  On-demand DSS group  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Another CDSS/KMS  3 Groups:  1) Alerting: recommen-dations automatically shown to the user  2) On-demand: user has to actively initiate the overview screen  3) Control: no overview screen available | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive ordered/completed: Adjusted RR for total patients requiring screening, with control group (n = 882) as referent (95% CI)—  Alerting group (n = 1079): 1.76 (1.41,2.20)  On-demand group (n = 1249): 1.28 (0.98,1.68)  Adjusted RR for total patients requiring screening, with on-demand group as referent (95% CI)—  Alerting group: 1.40 (1.08,1.81)  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Adjusted RR for total patients requiring treatment, with control group (n = 766) as referent (95% CI)—  Alerting group (n = 1218): 1.40 (1.15,1.70)  On-demand group (n=969): 1.19 (0.94,1.50)  Adjusted RR for total patients requiring treatment, with on-demand group as referent (95% CI)—  Alerting group: 1.18 (0.96,1.45)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  Well-designed and executed 3-arm study with a head-to-head comparison of 2 CDSS systems with a usual care control  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Netherlands study  Community setting  Appears to be locally developed modification of a commercially available system |
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| **Vissers, Biert, van der Linden, et al., 1996**  #6717  **AND**  **Vissers, Hasman, and van der Linden, 1995**  #6793 | **Geographical location:**  Nijmegen, Netherlands  **Study dates:**  October 13, 1992–June 9, 1993  **General setting:**  Academic  **Specific setting:**  Emergency department  **Study design:**  RCT, crossover  **Unit of randomization:**  Clinician  **Duration of intervention:**  7 months  **Sample type(s) (with N randomized for each):**  - Patients: 224  - Individual HCPs:  > Training MDs: 8  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  ProtoVIEW provides protocol information for diagnostic and therapeutic purposes. ProtoVIEW is supplied with a protocol that contains mainly therapeutic information about the management of common isolated fractures.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  - Diagnosis  - Other [general reference]  *b) Relationship to point of care:*  - Synchronous  - Asynchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Standalone system  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: N  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: N  - No need for additional clinician data entry: N  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Y  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: Can’t tell | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Adjusted treatments from proposed initial treatment to final initial treatment—  Baseline Period:  Total Changes: 2 of 39 (5%)  Trial Period:  Total Changes:  Control Group: 14 of 99 (14%)  Intervention Group: 26 of 125 (21%)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  Acceptance and attitude toward ProtoVIEW as a useful information source (1-5 scale where 1 = strongly disagree, 5 = strongly agree)—  - HCP acceptance: NR  - HCP satisfaction: (mean scores)  Appropriate information for most patients: 3.8  ProtoVIEW is easy to use: 3.9  Clear and convenient presentation: 4.2  Slower than other information sources: 3.4  Diagnostic and/or therapeutic delay shorter: 2.1  ProtoVIEW serves as a useful training source: 4.7  Performance increases: 2.2  Computer support might be useful in clinical decision making: 4.1  Less conversation with colleagues: 2.4  Would use system in daily practice: 3.3  - HCP use: NR    - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Setting was the Netherlands  Locally developed |
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| **Walker, Fairley, Walker, et al., 2010**  #15004 | **Geographical location:**  68 sites in Melbourne, Victoria, Australia  **Study dates:**  Feb 20, 2006–Oct 9, 2007  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  12 months  **Sample type(s) (with N randomized for each):**  - Clinics/practices/ hospitals 68  - Individual HCPs: 225  > MDs [general practice]    **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  An on-screen computer alert prompting general practitioners to discuss Chlamydia testing with women aged between 16 and 24 years.  **Source/origin of system:**  Commercially available  **Content:**  *a) Objective(s):*  - Lab test ordering  - Initiating discussion with patient  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: N  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: N  - Provision of decision support results to patients as well as providers: Can’t tell  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Chlamydia testing (95% CI)—  Intervention: 12.2% (9.1 to 15.3)  Control: 10.6% (8.5 to 12.7)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Alerts did not operate for 14.8% of the time  **Applicability/ generalizability:**  Large study conducted within the metropolitan area  More female GPs in the study  High ineligibility rate where many clinics were not included because of low female patients |
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| **Weir, Lees, MacWalter, et al., 2003**  #4696 | **Geographical location:** NR  **Study dates:** NR  **General setting:**  - Academic  - Community  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  - Outpatient  - Acute  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  Clinic or team  **Duration of intervention:**  6 months  **Sample type(s) (with N randomized for each):**  - Patients: 1952  - Clinics/practices/ hospitals: 16  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  To evaluate the influence on prescribing practice of a computer-based decision support system (CDSS) that provided patient-specific estimates of the expected ischaemic and haemorrhagic vascular event rates under each potential antithrombotic therapy.  **Source/origin of system:**  Not clearly described  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  NR (assume no response requirement)  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: Can’t tell  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Can’t tell  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Optimal therapy prescribed—  Control: 140 (34%)  Intervention: 56 (30%)  Estimated relative risk reduction in ischaemic and haemorrhagic vascular events—  Control: 16.3% (13.1 to 23.8)  Intervention: 16.7% (13.5 to 22.9)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:**  From Physician Survey (N = 9)—  - HCP acceptance: NR  - HCP satisfaction: The format in which the evidence was presented was acceptable to eight clinicians. Three respondents disagreed with the CDSS.  All respondents confirmed that the CDSS information was available sufficiently soon to be of use in the prescribing decision.  Finally, 55% (5.9) of respondents felt that the CDSS had influenced their prescribing practice.  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  Comments:  Details of particular CDSS not fully explained  **Applicability/ generalizability:**  Did not use patient-centered outcomes |
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| **White, Lindsay, Pryor, et al., 1984**  #7405 | **Geographical location:**  Salt Lake City, UT  **Study dates:** NR  **General setting:**  Community  **Specific setting:**  - Inpatient–ICU  - Inpatient–non-ICU  **Study design:**  RCT, parallel group  **Unit of randomization:** Patient  **Duration of intervention:**  3 month(s)  **Sample type(s) (with N randomized for each):**  Patients: 396  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  A computerized monitoring system was developed and implemented at LDS Hospital, whereby patients were automatically monitored for existing signs and predisposing factors of digoxin intoxication.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Asynchronous  **Decision support:**  *Response requirement:*  No response requirement  **Information delivery:**  *a) Delivery format:*  Paper-based  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations: N  - Provision of decision support at time and location of decision making: N  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: N  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: Can’t tell  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Physician actions, any action taken—  Frequency for alert group: 175  Frequency for nonalert group: 136  Weighted ratio (Al/NAl): 1.22  Statistical p-value: < 0.003 S  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Locally developed  Not patient-centered outcomes  Well-established health IT infrastructure |
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| **Wilson, Torrance, Mollison, et al., 2006**  #2468 | **Geographical location:**  Grampian region of Scotland  **Study dates:**  January 1, 2000–June 30, 2002  **General setting:**  Community  **Specific setting:**  Outpatient  **Study design:**  RCT, cluster randomization  **Unit of randomization:**  - Clinician  - Practice  **Duration of intervention:**  8 months  **Sample type(s) (with N randomized for each):**  - Clinics/practices/ hospitals: 86  - Individual HCPs:  > MDs: 346 general practitioners  **User level of expertise/ proficiency:** NR | **Authors’ basic description of system:**  The risk assessment module gave clear instructions on the information required from a patient and assisted users in making a rapid decision about whether or not a patient met Scottish referral guidelines.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  - Initiating discussion with patient  - Providing information to GP to enable informed discussions with patients  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  NR (unclear whether response requirement)  **Information delivery:**  *a) Delivery format:*  Not clearly described  *b) Delivery mode:*  User-initiated (“pull”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Can’t tell  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Can’t tell  - No need for additional clinician data entry: Can’t tell  - Request documentation of the reason for not following CDSS recommendations: Can’t tell  - Provision of decision support at time and location of decision making:  - Recommendations executed by noting agreement: Can’t tell  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Can’t tell  - Promotion of action rather than inaction: Can’t tell  - Justification of decision support via provision of reasoning: Can’t tell  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: Y  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: Y | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:** NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: Proportion (%) of referred patients with elevated genetic risk—  Intervention: 49 of 85 (58%)  Control: 14 of 29 (48)  Risk ratio (95%CI): 1.18 (0.88, 1.37)  - Recommended treatment ordered/prescribed: NR  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:**  - Cost: Total average cost for the software development (2001 prices) was £71.69 per CD, with a marginal cost for each additional CD of £3.12. The cost for each GP attending the postgraduate education session was £106.07 per GP (marginal cost = £77.60).  - Cost-effectiveness: NR  **6) Impact on HCP use and implementation:**  - HCP acceptance: NR  - HCP satisfaction: When the primary outcome (self-reported GP confidence in activities related to managing patients concerned about genetic risk of breast cancer) was examined for the latter group of respondents (those who reported use of the software), statistically significantly higher self-reported confidence was noted for the activity of “reassuring low-risk patients” compared with the 127 intervention group respondents who did not use the software (moderately or very confident, 20 of 22 versus 63 of 127, P < 0.001).  - HCP use: NR  - Implementation of CDSS/KMS: NR | **General comments:**  None  **Quality assessment:**  Overall rating: Poor  Comments:  From the discussion section: Less than half of the intervention GPs to whom it (the CDSS) had been supplied reported awareness if its existence, and only a third of this group actually used it  Implications for limitations related to incomplete outcome data and inappropriate control arms  **Applicability/ generalizability:**  Conducted in Scotland  Locally developed  Intervention providers not required to use intervention |
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| **Zanetti, Flanagan, Cohn, et al., 2003**  #4771 | **Geographical location:**  Boston, MA  **Study dates:**  March 23, 2000–June 23, 2000  **General setting:**  Academic  **Specific setting:**  Inpatient [cardiac surgery]  **Study design:**  RCT, parallel group  **Unit of randomization:**  Patient/ cardiac procedures  **Duration of intervention:**  3 months  **Sample type(s) (with N randomized for each):**  Patients: 449 randomized, 273 eligible  **User level of expertise/ proficiency:**  New CDSS for all users in intervention group | **Authors’ basic description of system:**  An audible and visual reminder on the operating room computer console at 225 minutes after the administration of preoperative antibiotics or control. After another 30 minutes, the circulating nurse was required to indicate whether a followup dose of antibiotics had been administered.  **Source/origin of system:**  Locally developed  **Content:**  *a) Objective(s):*  Pharmacotherapy  *b) Relationship to point of care:*  Synchronous  **Decision support:**  *Response requirement:*  Mandatory response  **Information delivery:**  *a) Delivery format:*  Integrated with CPOE/EHR  *b) Delivery mode:*  System-initiated (“push”)  **Contextual factors/features influencing the implementation and use of CDSS/KMS:**  *a) General system features:*  Integration with charting or order entry system to support workflow integration: Y  *b) Clinician-system interaction features:*  - Automatic provision of decision support as part of clinician workflow: Y  - No need for additional clinician data entry: Y  - Request documentation of the reason for not following CDSS recommendations:/N  - Provision of decision support at time and location of decision making: Y  - Recommendations executed by noting agreement: N  *c) Communication content features:*  - Provision of a recommendation, not just an assessment: Y  - Promotion of action rather than inaction: N  - Justification of decision support via provision of reasoning: N  - Justification of decision support via provision of research evidence: Can’t tell  *d) Auxiliary features:*  - Local user involvement in development process: Y  - Provision of decision support results to patients as well as providers: N  - CDSS accompanied by periodic performance feedback: N  - CDSS accompanied by conventional education: N | **Comparator(s):**  Usual care/no CDSS or KMS | **1) Impact on clinical outcomes:**  - Length of stay: NR  - Morbidity: Attack rate of surgical site infection after procedures eligible for intraoperative redosing—  Baseline: 48 of 480 (10%)  Control: 8 of 136 (6%)  Intervention: 5 of 137 (4%)  (P = 0.4 compared with the control group and P = 0.02 compared with baseline)  - Mortality: NR  - Validated measure of HRQOL or functional status: NR  - Adverse events: NR  **2) Impact on health care process outcomes:**  - Recommended preventive care ordered/completed: NR  - Recommended clinical study ordered/completed: NR  - Recommended treatment ordered/prescribed: Eligible patients who received intraoperative antibiotic redosing, # (%)—  Control (N = 136): 55 (40%)  Intervention (N = 137): 93 (68%)  P < 0.001  Eligible intervention patients for which redosing refused (N = 137):19 (14%)  - Impact on user knowledge: NR  **3) Impact on workload, efficiency, and organization of health care delivery:** NR  **4) Impact on relationship-centered outcomes:** NR  **5) Impact on economic outcomes:** NR  **6) Impact on HCP use and implementation:** NR | **General comments:**  None  **Quality assessment:**  Overall rating: Good  **Applicability/ generalizability:**  Well-established health IT and historically early adoption of health IT among users  Intervention was locally developed  Study used patient-centered outcomes |

Abbreviations: ADHD = attention deficit hyperactivity disorder, AE = adverse event, ARI = acute respiratory illness, ATP = Adult Treatment Panel, AVM = automated voice message, BG = blood glucose, BMI = body mass index, BP = blood pressure, C = control group, CAD = coronary artery disease, CAIP = computer-assisted insulin protocol, CDSS = clinical decision support system, CHF = congestive heart failure, CI = confidence interval, CPOE = computerized physician/provider order entry, DCP = diabetes care protocol, DVT = deep vein thrombosis, ED = emergency department, EHR = electronic health record, EMR = electronic medical record, EPO = erythropoietin, ER = emergency room, FOBT = fecal occult blood test, FPTK = fall prevention toolkit, FRS = Framingham Risk Score, GP = general practitioner, HCP = health care provider, HIT = health information technology, HMO = health maintenance organization, HRQOL = health-related quality of life, ICU = intensive care unit, INR = international normalized ratio, IPCAAD = Improving Primary Care of African Americans with Diabetes, IQR = interquartile range, JNC = Joint National Committee, KMS = knowledge management system, LDL = low density lipoprotein, LLT = lower lipid levels, MI = myocardial infarction, mo = month/months, MPC = model predictive control, N = number, NAEPP = National Asthma Education and Prevention Program, NPT = near-patient testing, NR = not reported, NS = not significant, NSAID = nonsterioidal anti-inflammatory drug, OR = odds ratio, p = probability, PA = physician assistant, PCP = primary care physician, PDA = personal digital assistant, PE = pulmonary embolism, QALY = quality-adjusted life year, RCT = randomized controlled trial, RR = relative risk, Sbp = systolic blood pressure, SD = standard deviation, SE = standard error, SOC = standard of care, UC = usual care, vs = versus, wk = week/weeks, yr = year/year