**Table F1. Evidence Table**

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Abramson, *et al.,*  201276 | Cross-sectional | Measure EHR and HIE adoption in New York State hospitals | New York State | Hospital | **Survey of hospitals** | May-December 2009 |
| Abramson, *et al.,*  201477 | Cross-sectional | Measure EHR and HIE adoption in New York State nursing homes | New York State | Nursing homes | **Survey of nursing homes** | November 2011-  March 2012 |
| Abramson, *et al.,*  201496 | Cross-sectional | To determine rates of participation in HIE | New York | Hospitals | **Survey responses** | November 2012 -  February 2013 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Abramson, *et al.,*  201276 | Various HIEs around New York State | Type of data exchanged NR | NR | All 205 hospitals in New York State |
| Abramson, *et al.,*  201477 | Nursing homes around New York State | Exchange of data (NR) with pharmacies, lab, hospitals, physician offices, and RHIO | NR | All 632 nursing homes in New York State |
| Abramson, *et al.,*  201496 | NA | NA | NA | Surveyed Hospital IT directors or chief information officer |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Abramson, *et al.,*  201276 | Various HIEs | All hospitals in New York State | NA | None |
| Abramson, *et al.,*  201477 | Various HIEs | All nursing homes in New York State | NA | None |
| Abramson, *et al.,*  201496 | Contacted: 210 Hospitals  Respondents: 129 (61.4%)  Nonrespondents: 81 (38.6%) | All hospitals in New York state | NA | Results compared |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Abramson, *et al.,*  201276 | Participation in HIE | Participate in HIE (exchange of data) | NA | **Quantitative**  Descriptive statistics |
| Abramson, *et al.,*  201477 | Participation in HIE | Participate in HIE (exchange of data) | NA | **Quantitative**  Descriptive statistics |
| Abramson, *et al.,*  201496 | Use of HIE, if information is sent and/or received by the institution, type of institution information is shared with, barriers to implementation | NA | NA | **Descriptive statistics** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Abramson, *et al.,*  201276 | 23% of respondent hospitals participate and exchange data vs. 37% participate but do not exchange data vs. 40% do not participate | Low |
| Abramson, *et al.,*  201477 | 54.4% participate in HIE,  OR of participating in HIE: 2.26 more likely when have EHR  **Exchange with providers when EHR**  59.7% within system vs. 31.3% outside system  **HIE highest usage**  Pharmacies: 41.8%  Labs: 38.5%  Hospitals: 38.5% | Low |
| Abramson, *et al.,*  201496 | -79.1% (n=102) of respondents reported actively exchanging any electronic patient-level clinical data with an entity outside their institution in 2012 vs. 60% in 2009  Type of institution respondents exchanged data with: Hospitals outside your system: 70.6% (n=72) Ambulatory providers outside your system: 68.6% (n=70) Long term care facilities: 45.1% (n=46)  Home health agencies: 38.2% (n=39)  The most commonly exchanged data were radiology reports, followed by laboratory results. Only 45 respondents (44.1%) exchanged medication lists and clinical history with hospitals outside their system.  Respondents reporting participation in a regional arrangement for HIE: Any data exchange: 89.9% (n=116)  Actively sending and receiving data: 50.9% (n=59) Sending data only: 25.9% (n=30)  Receiving data only: 16.4% (n=19)  Barriers to HIE participation reported by responding hospitals: Privacy concerns: 54.7% (n=70)  Security concerns: 52.3% (n=67)  Lack of IT staff to support HIE: 38.2% (n=49) Lack of architecture to support HIE: 35.9% (n-46)  No differences in barriers among hospitals engaging in HIE and those not engaging in HIE were found. When hospitals engaged in sending and receiving data were compared with hospitals only sending or only receiving data hospitals only engaged in one activity were more likely to identify lack of architecture p=0.05 and cost of participating p=0.03 as barriers to HIE | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Adjerid and Padman, 2011140 | Cross-sectional | -Analyze data from compilation of privacy laws and Adler-Milstein 2009 analysis of RHIOs  -Examine association of state "consent prior to disclosure" laws with number of operational HIEs | U.S. | Any | **Survey**  Data from compilation of privacy laws and Adler-Milstein 2009 analysis of RHIOs | 2009-2010 |
| Adler-Milstein and Jha, 2014108 | Cross-sectional | -Analyze data from annual AHA survey of hospital IT  -Measure HIE usage among U.S. hospitals | U.S. | Any | **Survey**  Hospital survey database, augmented with market and other characteristic data | Late 2012 |
| Adler-Milstein, Bates, and Jha, 201179 | Cross-sectional | Measure number of RHIOs, participation in them by ambulatory practices and hospitals, and number financially viable | U.S. | Any | **Survey of RHIOs** | June 2008-December 2009 |
| Adler-Milstein, Bates, and Jha, 201325 | Cross-sectional | Measurement of types of data exchanged, organizations involved, and sources of financial support | U.S. | Any | **Survey of HIE organizations** | August-November 2012 |
| Adler-Milstein, DesRoches, and Jha, 2011107 | Cross-sectional | Measurement of participation in a regional HIO and exchange of data with hospitals or ambulatory providers of a different system | U.S. | Hospital | **Hospital survey database** | AHA survey from spring-summer 2009 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Adjerid and Padman, 2011140 | All in U.S. | All types | NA | 313 HIE initiatives from 2004-  2009 |
| Adler-Milstein and Jha, 2014108 | All in U.S. | All types | NA | 2,849 U.S. hospitals that responded to AHA IT survey |
| Adler-Milstein, Bates, and Jha, 201179 | All in U.S. | All types provided by a RHIO | NA | 197 organizations meeting definition of RHIO |
| Adler-Milstein, Bates, and Jha, 201325 | All in U.S. | All types | NA | 221 organizations facilitating HIE |
| Adler-Milstein, DesRoches, and Jha, 2011107 | All in U.S. | All types | NA | 3,101 acute-care, nonfederal hospitals that were U.S. based members of AHA |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Adjerid and Padman, 2011140 | All 313 HIE initiatives | HIE status; state health disclosure law status | None | None |
| Adler-Milstein and Jha, 2014108 | All of population | All hospitals responding to survey | None | None |
| Adler-Milstein, Bates, and Jha, 201179 | 165 RHIOs | All RHIOs | Not meeting definition of RHIO | None |
| Adler-Milstein, Bates, and Jha, 201325 | NA | All organizations facilitating HIE | Organizations only participating in HIE | None |
| Adler-Milstein, DesRoches, and Jha, 2011107 | Various HIEs | All acute-care, nonfederal hospitals that were U.S. based members of AHA | Hospitals that were federal or nonacute or were not members of AHA | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Adjerid and Padman, 2011140 | Total, operational, and failed HIE | -Health disclosure law  -Population  -Per capita GDP | HIE size not accounted for | **Quantitative**  Econometric models |
| Adler-Milstein and Jha, 2014108 | Participating in HIE | -Ownership  -Market position  -Size  -Teaching status  -Cardiac ICU  -System affiliation  -Medicaid admissions  -EHR system | NA | **Quantitative Multivariate Analysis**  OR of likelihood of participation |
| Adler-Milstein, Bates, and Jha, 201179 | Operational RHIOs, supporting stage 1 meaningful use, ambulatory practices and hospitals participating in RHIOs, and number of financially viable | Operational RHIOs, supporting stage 1 meaningful use, ambulatory practices and hospitals participating in RHIOs, and number of financially viable | NA | **Quantitative** |
| Adler-Milstein, Bates, and Jha, 201325 | Operational exchange or data, types of data exchanged, barriers to exchange | Operational exchange or data, types of data exchanged, barriers to exchange | NA | **Quantitative**  Descriptive statistics; compared with previous reports |
| Adler-Milstein, DesRoches, and Jha, 2011107 | Participation in HIE and market characteristics | -Hospital profit status  -Market share  -Teaching status  -Size  -Cardiac ICU  -System affiliation  -Medicaid admissions  -EHR system | NA | **Quantitative**  Analysis of database Logistic regression models |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Adjerid and Padman, 2011140 | States with stronger privacy laws have more operational HIEs, fewer failed HIEs, and take less time to reach operational status. | NA |
| Adler-Milstein and Jha, 2014108 | -30% of hospitals engage in HIE, varying widely by state  -For-profit hospitals less likely to engage than nonprofit hospitals. Hospitals with larger market share or in less competitive markets more likely to exchange | Low |
| Adler-Milstein, Bates, and Jha, 201179 | -75 operational RHIOs, covering 14% of U.S. hospitals and 3% of ambulatory practices  -13 supporting meaningful use, covering 3% of hospitals, 0.9% of ambulatory practices; 67% not meeting criteria for financial viability | Low |
| Adler-Milstein, Bates, and Jha, 201325 | Predominant organization nonprofit;  **Sources of support**  Grants and contracts: 52%; participant fees: 28%; operating costs not covered by revenue: 57%  **Barriers to development**  Sustainability: 74%; lack of funding: 57%; privacy: 60%; mandates: 55%; technical barriers: 61%; competition: 56%; linking; 54% | Low |
| Adler-Milstein, DesRoches, and Jha, 2011107 | 10.7% participation in regional HIO; statistically significantly higher for private/nonprofit status, greater market bed share, teaching status, large size, cardiac ICU presence, and had EHR system | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Adler-Milstein, *et al.,* 200881 | Cross-sectional | Measurement of activities and financing of functioning RHIOs | U.S. | Any | **Survey of RHIOs** | July 2006-March 2007 |
| Adler-Milstein, Bates, and Jha*,* 200978 | Cross-sectional | Measurement of types of data exchanged, organizations involved, and sources of financial support | U.S. | Any | **Survey of operational RHIOs** | 2008, following up of survey from 2007 |
| Adler-Milstein, Landefeld, and Jha, 201080 | Cross-sectional | Measure factors associated with becoming operational and achieving financial viability | U.S. | Any | **Survey of RHIOs** | Mid-2008 |
| Afilalo, *et al.,* 200766 | RCT | Impact of sending family physicians electronic vs. mailed reports of ED visits for their patients | Montreal, Canada | ED and family physician practices | **Survey**  Survey of family physician satisfaction | Not stated but likely same as Lang, 2006 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Adler-Milstein, *et al.,* 200881 | All in U.S. | All types provided by a RHIO | NA | 138 organizations meeting definition of RHIO |
| Adler-Milstein, Bates, and Jha*,* 200978 | All in U.S. | All types | NA | 207 organizations defined as RHIOs |
| Adler-Milstein, Landefeld, and Jha, 201080 | All in U.S. | All types provided by a RHIO | NA | 131 organizations meeting definition of RHIO |
| Afilalo, *et al.,* 200766 | Adult university teaching hospital in Montreal | Report of ED visit sent to family physicians | NR | Patients visiting ED during 0800-2200 |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Adler-Milstein, *et al.,* 200881 | 32 RHIOs actively exchanging data | 20 RHIOs actively exchanging clinical data for 5000+ patients | Not actively exchanging data | None |
| Adler-Milstein, Bates, and Jha*,* 200978 | All 44 operational RHIOs exchanging data for ≥5,000 patients | All RHIOs exchanging data for  ≥5,000 patients | RHIOs not exchanging data or doing so for <5,000 patients | None |
| Adler-Milstein, Landefeld, and Jha, 201080 | 81 RHIOs currently or planning to exchange data for 5000+ patients | 81 RHIOs currently or planning to exchange data for 5000+ patients | Not meeting definition of RHIO | None |
| Afilalo, *et al.,* 200766 | 2,022 (out of 3,168) patients visiting ED | Patients visiting ED | Patients in altered mental state (129), state of agitation (21), or with language barrier (29) | ED visit summary provided electronically vs. on paper sent by mail |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Adler-Milstein, *et al.,* 200881 | Proportion of RHIOs sending and receiving data to different entities and proportion exchanging specific types of data | -Entity sending data  -Entity receiving data  -Type of data exchanged | NA | **Quantitative**  Descriptive statistics |
| Adler-Milstein, Bates, and Jha*,* 200978 | RHIO exchanging data for ≥5,000 patients | -Types of data  -Entities exchanging data  -Sources of financial support | NA | **Quantitative**  Descriptive statistics |
| Adler-Milstein, Landefeld, and Jha, 201080 | Factors associated with becoming operational and achieving partial or full financial viability | -Participation  -Types of data exchanged, focused on a specific population, history of collaborating, and sources of revenue | NA | **Quantitative**  Multivariate logistic regression for predictors |
| Afilalo, *et al.,* 200766 | Physician attitudes on aspects of continuity of care for patients | Survey | Physicians already are sent carbon copies of first page of ED note; self- report of followup data | **Quantitative** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Adler-Milstein, *et al.,* 200881 | **Entities providing data**  Hospitals: 83%; ambulatory settings: 67%; labs: 60%; imaging results: 56%  **Entities receiving data**  Ambulatory settings: 95%; hospitals: 83%; public health departments: 50%; payers: 44%  **Type of data exchanged**  Test results: 90%; inpatient data test results: 90%; inpatient data: 70%; medication history: 70%; outpatient data: 60% | Low |
| Adler-Milstein, Bates, and Jha*,* 200978 | **Source of funding**  Time or in-kind resources: 64%; recurring fee: 55%; grant: 48% **Types of data exchanged**  Test results: 84%; inpatient data: 70%; medication history: 66%; outpatient data: 64% 28% of operational RHIOs expected to eventually cover operating costs  **Barriers**  Lack of funding, concerns about privacy/security, legal/regulatory changes, costs higher than expected, technical/infrastructure challenges | Low |
| Adler-Milstein, Landefeld, and Jha, 201080 | Likelihood of being operational associated with exchanging narrow set of data and involving broad group of stakeholders, likelihood of financial viability associated with involvement of hospitals and ambulatory physicians and early funding from participants. Financial viability diminished with early grant funding. | Low |
| Afilalo, *et al.,* 200766 | ED visits followed up by electronic reports led to family physicians having OR of higher rate of information receipt, more useful information, better knowledge of ED visits, better patient management, and more actions initiated by physicians. There was not perception of higher rate of followup in family practice offices. | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| AHRQ, 2006166 | Multiple Case Studies | To describe current state HIE environment and analyze state HIE activities and initiatives. | National scan, in depth case studies of 8 States: Arizona, Florida, Hawaii, New York, North Carolina, Rhode Island, Tennessee, Utah | Multiple | Multiple Sources  Literature reviews, web-based research, reports, interviews, | 2005-2006 |
| Altman, *et al.,*  201257 | Cross-sectional | To assess clinicians’ impressions of an hourly notification of ED visit, hospital admission or hospital discharge with respect to the notifications effect on the continuity and coordination of patient care | New York | Family practice clinics | **Survey**  Interviews | July 2011-October 2011 |
| Anand, *et al.,* 201292 | Cross-sectional | Is real-time alerting useful and does it lead physicians to take action? | Indiana | Primary care physician offices | **Databases, questionnaire** Survey of value for real-time alerting for patient ED visit anywhere in state | June-November 2012 |
| Audet, Squires and Doty, 2014109 | Cross-sectional | Measurement of physician exchange of data outside of practice or to receive hospital discharge reports | U.S. | Physician offices | Surveys | March-July, 2012 (as well as comparison from data with 2009 survey, specific dates not provided) |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| AHRQ, 2006166 | Varies | Varies | 2003 to 2005 | All HIE projects in US in 2055- 2006 |
| Altman, *et al.,*  201257 | New York Clinical Information Exchange (NYCLIX) | Hourly electronic notifications sent to family practice clinicians when any of 3 patient events occur at a participating hospital:  (1) a new ED visit, (2) a hospital admission, or (3) a hospital discharge. | November 2010 | Family practice clinicians in single health system receiving HIE notifications  86% MDs  50% male |
| Anand, *et al.,* 201292 | Indiana HIE (IHIE) | Patient data concerning ED visit | 1994 | Known physicians (538) of patients (1,275) seen in an ED for asthma |
| Audet, Squires and Doty, 2014109 | All in U.S. | Physician exchange of data outside of practice or to receive hospital discharge reports | NA | 1,012 primary care physicians in 2012 |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| AHRQ, 2006166 | 101 HIE projects in 35 states for which information was available.  8 States for in depth case studies | HIE projects that included State and/or Medicaid involvement, targeted patients statewide or in large portions of the state, involve a RHIO or RHIO like organization | HIE projects within a single hospital or health system or that focused on administrative exchange or reducing fraud | Comparison of HIE project characteristics across states |
| Altman, *et al.,*  201257 | 14 of 20 total | Clinicians receiving notifications | None | Changes in practice as perceived by interviewee |
| Anand, *et al.,* 201292 | 79 physicians (10%) receiving 126 (15%) notifications | Physicians who had ≥1 patient seen in ED and faxed notification letter back to HIE | NA | Information helpful, resulted followup action |
| Audet, Squires, and Doty, 2014109 | Various HIEs | Primary care physicians in U.S. | NA | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| AHRQ, 2006166 | Number of HIE projects  Similarities and differences among projects | NA | NA | Qualitative |
| Altman, *et al.,*  201257 | Usage logs of number of notifications sent to each clinician over a period of several months, questionnaires | NA | NA | **Thematic analysis**  Themes of clinician perceptions identified and compared with recorded usage logs |
| Anand, *et al.,* 201292 | Rates of information helpful, resulted in followup action | Survey | None | **Quantitative**  Descriptive statistics |
| Audet, Squires, and Doty, 2014109 | Proportion of physicians exchanging data outside of practice or receiving hospital discharge reports | Proportion of physicians exchanging data outside of practice or receiving hospital discharge reports | NA | **Quantitative**  Descriptive statistics and logistic regression |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| AHRQ, 2006166 | States have multiple HIE projects  Project have similar goals but vary widely across other characteristics, particularly infrastructure which makes sharing lessons learned challenging  Most projects are in early stages and have overly optimistic timelines Funding varies widely  Sustainability is a long term goal but has not yet been realized. Most have not identified long term sources of funding While state are critical stakeholders many do not plan to play primary leadership roles indefinitely. | NA |
| Altman, *et al.,*  201257 | Notifications from an HIE system can enhance clinicians’ awareness of their patients’ interactions in the medical system. Clinicians perceived improvements in communication and followup scheduling as a result of notifications. Increase in clinician workload and change in responsibility may be unintended effects of notifications Workflow issues should be carefully considered. Timely notifications may further improve clinician-to-clinician communication | Moderate |
| Anand, *et al.,* 201292 | -35% found information helpful vs. 20% not helpful  -24% made followup call to patient vs. 4% sent attached letter | NA |
| Audet, Squires, and Doty, 2014109 | 32% use of HIE, with higher proportion for formal IT support, part of integrated system, receiving financial incentives, larger practice | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Bailey, *et al.,*  201339 | Retrospective cohort | To determine  whether HIE by ED personnel in the evaluation of patients  with headache reduces use of neuroimaging, increases adherence with guideline | Memphis, Tennessee | ED | **Log file**  Diagnostic neuroimaging, evidence-based guideline adherence | August 2007-July 2009 |
| Bailey, *et al.,*  201340 | Retrospective cohort | To determine whether HIE reduces repeated diagnostic imaging and costs in ED back pain evaluation | Memphis, Tennessee | ED | **Log file**  Administrative data for imaging log in patient record for HIE access | August 2007-July 2009 |
| Ben-Assuli, Shabtai, and Leshno, 201572 | Retrospective cohort | Probability of single-day admission and 7-day readmission when HIE viewed | Israel | ED | **Log file** | 2004-2007 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Bailey, *et al.,*  201339 | MidSouth e-Health Alliance (MSeHA). | MSeHA HIE connects 15 major adult hospitals and 2 regional clinic systems in 4 counties of the Memphis Metropolitan Statistical Area. Patient demographic, diagnosis, all hospital radiologic and laboratory reports, most procedure reports, and discharge summaries are exchanged. ED providers have read-only access to data. | 2007 | Patients presenting to participating EDs with principle diagnosis of headache |
| Bailey, *et al.,*  201340 | MidSouth e-Health Alliance (MSeHA), 15 major hospitals and 2 regional clinic systems in the 4 most populous counties of the Memphis Metropolitan Statistical Area. Decentralized, query-based exchange.  Consent was ‘opt-out. | Secure, password-protected, read-only access to clinical information from participating hospitals and clinics through a Web portal separate from each facility’s electronic health record system.  MSeHA HIE connects 15 major adult hospitals and 2 regional clinic systems in 4 counties of the Memphis Metropolitan Statistical Area. Patient demographic, diagnosis, all hospital radiologic and laboratory reports, most procedure reports, and discharge summaries are exchanged. ED providers have read-only access to data. | 2007 | All patients with an ED visit for back pain in the Alliance hospitals |
| Ben-Assuli, Shabtai, and Leshno, 201572 | Clalit HMO, Israel | Query | 2004 | All ED referrals |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Bailey, *et al.,*  201339 | 2,101 2nd or subsequent visits for 1,252 patients | ≥18years, a second or subsequent ED visit to a MSeHA participating general hospital’s ED between August 1, 2007 and  July 31, 2009 with a primary discharge diagnosis of primary headache disorder (ICD-9-CM codes 346.0, 346.1, 346.9 and 784.0); and no discharge diagnosis of stroke (ICD-9-CM 430–438), brain cancer (ICD-9- CM 191.x, 225.0 and V10.85), traumatic injury, motor vehicle accident, poisoning, or fall. | Primary diagnosis (ICD-9 codes) of variants of migraine (346.2), hemiplegic migraine (346.3), chronic migraine (346.7), other forms of migraine (346.8), and  tension headache (307.81,  339.1)  1st visit for headache | None |
| Bailey, *et al.,*  201340 | Patients: 478  Visits: 800 | ≥18 years, >1 visit to system ED for back pain, index (previous visit) with imaging | Discharge diagnosis of trauma or cancer. | Repeat visits in which HIE was accessed vs. repeat visits in which HIE was not used |
| Ben-Assuli, Shabtai, and Leshno, 201572 | 340,804 admitted and 474,310 non-admitted patients | Referred to ED and had a creatinine test | None | Access HIE information |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Bailey, *et al.,*  201339 | Use of diagnostic neuroimaging (CT, CT angiography, MRI or MRI angiography), evidence-based guideline adherence and economic | -Any HIE use  -HIE use by physician or nurse practitioner  -HIE use by administrative/nursing staff | nonuse of HIE | **Quantitative**  Modeling using the generalized estimating equation method to adjust for repeated measures (since some subjects had >1 visit) and for clustering of subjects within hospital system |
| Bailey, *et al.,*  201340 | -Use of repeated lumbar or thoracic imaging  -% cases HIE used  -Cost | -HIE accessed by any ED staff during repeat ED visit (Yes/No)  -Type of staff accessing HIE (MD or Nurse Practitioner vs. admin or nursing) | -Patient age, sex and race  -Comorbidity  -Hospital  -Number of previous ED visits | **Quantitative**  Chi2  Multivariate: generalized estimating equation |
| Ben-Assuli, Shabtai, and Leshno, 201572 | Same-day admission and 7-day readmission | Access HIE information | None | **Quantitative**  Same-day admission and 7-day readmission via logistic regression |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Bailey, *et al.,*  201339 | **OR (95% CI ) of any HIE use**  Neuroimaging: 0.38 (0.29 to 0.50)  Adherence to guideline: 1.33 (1.02 to 1.73)  -Increased odds of neuroimaging by subjects of older age, black race, and higher comorbidity  -Prior visits lower the odds of imaging 7%, but the effect was reduced to 2% with use of HIE  - No significant change in costs  **Secondary analyses**  -Administrative/nursing staff neuroimaging: OR 0.25 (95% CI, 0.18 to 0.34)  -Physician/Nurse Practitioner HIE use and interaction terms for previous visits were not significantly associated  -No secondary analyses were significant for guideline adherence | Low |
| Bailey, *et al.,*  201340 | Repeated imaging for any HIE: OR 0.36 (95% CI, 0.18 to 0.71), p<0.05 Visits with repeated imaging: 22.4% (179/800)  HIE used: 12.5%  -Physician or Nurse practitioner use of HIE lowered OR for repeat imaging OR 0.47 (95% CI, 0.23 to 0.96)  - No cost savings associated with HIE use because of increased CT imaging when health care providers used HIE | Low |
| Ben-Assuli, Shabtai, and Leshno, 201572 | When external information viewed, probability of single-day admission decreased 9.5% and of 7-day readmission decreased 6.5% | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Ben-Assuli, Shabtai, and Leshno, 201341 | Retrospective Cohort | To determine whether HIE use was associated with reduced readmissions and "avoidable" admissions | Main Israeli HMO network | 7 acute care hospitals EDs belonging to largest Israeli HMO | **Log file** | 2004-2007 |
| Bouhaddou, *et al.,*  201182 | Multiple site case studies with focus on identification of patients eligible, matching, and consent; usage | Across 3 large integrated delivery systems, how many patients can and will participate; how much used | San Diego, California | Integrated delivery system | **Database and survey** Patient identifier and demographic data | NR |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Ben-Assuli, Shabtai, and Leshno, 201341 | Largest Israeli HMO network 3.8 million patients, operates 7 hospitals | Clinical and administrative data from all HMO hospitals, community clinics and thousands of labs, imaging centers etc. Demographics, prescriptions, allergies, lab, imaging, past medical history, procedures. | 2004 | Adult patients presenting to Israeli ED with 1 of 5 main diagnosis; gastroenteritis, abdominal pain, chest pain, pneumonia organism, urinary tract infection |
| Bouhaddou, *et al.,*  201182 | Veterans Lifetime Electronic Record (VLER) | Query-based, transfer of records between integrated delivery systems | NR | Patients of 3 large IDSs who opted in to HIE |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Ben-Assuli, Shabtai, and Leshno, 201341 | 115,719 ED Visits | NR | NR | HIE vs. local EMR and no EMR HIE vs. local EMR use |
| Bouhaddou, *et al.,*  201182 | 1,144 patients shared between VA and KP  Nationwide Health Information Network allows users to pull in data from other organizations. The VA and DoD used the VLER systems for eHealth exchange with private sector. Federated pull (query-based) model Transfer of records between integrated delivery systems; National query-based. Patient consent: Opt- in. | Patients identified as getting care in VA and KP | None | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Ben-Assuli, Shabtai, and Leshno, 201341 | -OR for 7-day readmission for gastroenteritis, abdominal pain, chest pain, pneumonia organism or urinary tract infection  -OR for 1-day admission for gastroenteritis, abdominal pain, chest pain, pneumonia organism, or urinary tract infection  -Economic | -MD Viewed EMR  -MD Viewed local EMR  -MD viewed external information (HIE)  -HMO to which patient belonged  -Differential Diagnosis  -ED sub department (Int. med or surgical)  -Specific Hospital  -Age  -Gender  -Authors list all these variables as independent but some are more confounding per se | -Age  -Gender  -HMO  -ED  -Hospital | **Quantitative**  -t test for continuous variables  -Chi2 for dichotomous  -Multi-variate regression analysis  -P<0.05, no adjustment for multiple hypothesis testing |
| Bouhaddou, *et al.,*  201182 | Patients who opted in and provided valid authorization, with subsequent measure of records exchanged between KP and VA 2- 3 per week | -Patients correlated across KP and VA  -Actual records exchanged | NA | **Quantitative**  Survey, descriptive statistics |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Ben-Assuli, Shabtai, and Leshno, 201341 | **OR for all 5 differential diagnosis as composite**  Readmission within 7 days: 0.52 for HIE vs. local EMR and no EMR, p<0.001 1-day admission: 0.76, p<0.001  Readmission within 7 days: 1.272, p=0.05 for local EMR vs. HIE 1-day admission: 1.13, p=0.005 for local EMR vs. HIE  -Decrease in readmissions within 7 days when HIE used 56.1%  -Decrease in single-day readmissions when HIE used 29.0%  -Viewing external medical history more highly correlated with lower single-day admissions and 7-day readmissions than local medical history | Low |
| Bouhaddou, *et al.,*  201182 | Of 363 patients who opted in and provided valid authorization, 264 could be correlated; exchange of records between KP and VA 2-3 per week. Older patients were more likely to consent for HIE. | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Byrne, *et al.,*  2014116 | Multiple site case studies | Describe key findings, lessons, implications from VLER pilot project | 12 sites across U.S. | Unrestricted | **Audit logs, database, survey, interviews, documents from meetings**  Veterans authorization preferences, system dashboard, VA provider (11/12 site) and veteran interviews. 73 provider interviews, 50 veteran interviews | December 2009-  October 2012 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Byrne, *et al.,*  2014116 | Veterans Lifetime Electronic Record (VLER) | Query-based HIE between VA, DOD, nonfederal care organizations. The Nationwide Health Information Network. The VA and DoD used the VLER systems for eHealth exchange with private sector. Federated pull model transfer of records between integrated delivery systems; 12 total sites, 4 did 3 way exchange, 8 did 2 way between VA and private sector. Federated pull model via eHealth Exchange | December 2009 | Veterans |

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| **Author, Year** | **N Sample Description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Byrne, *et al.,*  2014116 | 12 pilot sites  N=73 provider and 50 veteran interview | 12 VLER pilot sites. Veterans included were any who opted in. | None | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Byrne, *et al.,*  2014116 | -Veterans accept  -Veteran concerns about participation  -Veterans perceived benefit  -Veteran awareness of VLER use during their care  -Veterans preference of signed authorizations  -Metrics of exchanged data | NA | NA | **Mixed Methods**  Quantitative, descriptive analysis on usage; qualitative, thematic analysis |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Byrne, *et al.,*  2014116 | -64,237 veterans provided authorization and opted in  -Opted in then out: <0.01%  -Veterans matched with exchange partner: 31,080 (48%), range: 12-88%  -Highest matching rates with exchange partners using social security number in their algorithm  -Inbound discloser's to VA from exchange partners 5,524  -Outbound disclosure to exchange partner 13,913  -Inbound disclosures to VA from exchanged partners per matched patients 18/100  -Unique VA patient with exchange partner data retrieved: 2,724  -Unique VA providers retrieving exchange partner data: 1,764  - Percent of matched veterans for whom there was ≥1 disclosure to VA from exchange partner: 9%  -75% of providers trusted VLER data, 90% trusted privacy and security  -Most frequently cited provider benefits, more data for medical decision making, improved quality of care, reduced repeat testing, timelier and faster access to information  -23/73 interviewed providers reported using VLER, 79% of users reporting overall satisfaction  -43% reported challenges with system response time, 29% with identifying patients who might have data  -Identified minimizing provider steps in information retrieval, one site Indiana HIE had an automated query resulting in push into their system to allow providers pushed access anytime a patient was admitted discharged or transferred  -Providers at outside organizations did not having additional sign ones  -Workflow improvements suggested by outside users was to have data pushed in their EMR  -Sustaining HIE requires ongoing resources and oversight, often unanticipated technical issues arose  -Requires national policies and central coordination  -None of the veterans interviewed were aware if their providers were using HIE, the user-interfaces at the sites face the provider not the patient  -Providers increased usage after training on VLER system  -Providers noted barriers of missing data, additional sign-on and need for better integration with workflow | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Campion, *et al.,*  201397 | Cross-sectional | Determine the extent to which automated HIE queries supported patient encounters. | Binghamton, New York | Hospital/clinic | **HIE log data** | 2010 until 23 months following |
| Campion, *et al.,*  201258 | Cross-sectional | What is usage and satisfaction of push and pull HIE | Buffalo and Rochester, New York | Health systems, health departments, practice associations, RHIO | **Survey**  Online survey responses from 112/584 invited physicians (19% response rate) | July-December 2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Campion, *et al.,*  201397 | Southern Tier HealthLink RHIO in Binghamton, New York part of SHIN-NY. Automated queries occurred evening prior to ambulatory patient appointments to generate CCRs and for the hospitals during ED visits, at inpatient admission, inpatient unit transfer and provided CCD doc to providers. Providers could also log in manually. Auto queries started month 1 for clinics and month 17 for hospitals. | Lawson Cloverleaf HIE, centralized data repository with MPI. 5 hospitals, one imaging center and 30 ambulatory care practices affiliated with single integrated delivery system. | 2005 | ≥18 years, with positive consent to participate in HIE |
| Campion, *et al.,*  201258 | HealtheLINK (Buffalo) and Rochester RHIO | Direct exchange (push) of local lab and radiology results; query- based (pull) searching for lab and radiology results across greater Buffalo and Rochester area.  Robust RHIOs using HIE platform from Axolotl Corporation (San Jose, California) | 2007-2009 | Physicians |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Campion, *et al.,*  201397 | 202,365 auto queries | ≥18 years, who had automated HIE query generated, which occurred when a care transition occurred | Lack of known provider or lack of known facility in auto-queries from HIE | NA |
| Campion, *et al.,*  201258 | 112/584 invited physicians (19% response rate). Only 99 completed. 75% were primary care providers. Most practices had 2-19 providers. | Physicians who completed survey and rated overall outcome of satisfaction with HIE | Respondents who did not rate satisfaction with HIE | Compared various attributes of HIE for push vs. pull |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Campion, *et al.,*  201397 | Generation of automated HIE queries | NA | NA | **Quantitative**  Descriptive statistics |
| Campion, *et al.,*  201258 | Use of push vs. pull HIE. Satisfaction with types of HIE. | Type of HIE: push or pull | NR | **Quantitative**  Descriptive statistics |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Campion, *et al.,*  201397 | -202,365 automated HIE queries: 54% to hospitals, 46% to clinics  -After exclusions, duplicates removed: 145,668 unique patient encounters  -81,687 unique patients provided consent for query based HIE during study period, 41% had ≥1 supported encounter  -For the 33,219 patient with ≥1 clinic encounter: median IQR 3  -98% of patients had between 1 and 20 encounters, 71% had ≥2  -530 patients with ≥20 encounters  -52% occurred in hospital, 48% in clinics  **Care Transitions**  -28% of the 145,668 unique encounters occurred as care transitions  -53% were patients from a clinic to hospital, 36% in reverse, 11% clinic to clinic | NA |
| Campion, *et al.,*  201258 | -80% used push HIE and 53% used pull HIE  -A greater proportion of MDs reported using push HIE always or most of the time (68%) vs. pull HIE (19%), p=0.001  -MDs more satisfied with push HIE vs. pull HIE, p<.0.05  -112 physician respondents (19% response), 13 then excluded for 99 participants  ->50% of physicians felt HIE improved 8 domains; access to timely, completeness, accurate information, admin efficiency, communication with colleagues, and quality  -Only 30% felt it improved reducing test redundancy and security of PHI  -Physicians who used push and pull vs. only single type had higher rates of perceived effects of HIE in same 8 domains, (3of 8 domains p<0.05) | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Campion, *et al.,*  201398 | Cross-sectional survey | Measure usage patterns of query based HIE with respect to practice sites, users, patients, and data | 3 separate RHIOs  encompassing 1 community each (~1 million patient population) in New York state (from HEAL-NY) | Unclear, inpatient/ outpatient | **System log data** Demographics of patient, provider character (i.e. role, location etc.) | A, B: January 2009- March 2011  C: September 2010-  May 2011 |
| Caffrey and Park- Lee, 201393 | Cross-sectional | To determine use of EHR and HIE by residential care communities. | U.S. | Residential care communities | **Survey**  2010 National Survey of Residential Care Facilities | 2010 |
| Carr, *et al.,* 201470 | Case series | Does HIE reduce unneeded test ordering and costs, admissions | Charleston, South Carolina | ED | **Questionnaire**  User-initiated survey, with costs calculated for self-reported testing not performed | August-December 2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Campion, *et al.,*  201398 | NY State HIE consists of 12 RHIOs (HEAL NY) | Axolotl Virtual Health Record-commercial product. Web based secure stand alone portal. Federated architecture with MPI, RLS and user directory. | 2007, 2007, 2010;  A, B and C, respectively. | All patients |
| Caffrey and Park- Lee, 201393 | NR | NR | NR | Residential care communities |
| Carr, *et al.,* 201470 | Carolina eHealth Alliance | Access to EHRs and ED from all hospitals in region | NR | Physicians, Nurse Practitioners, Physician Assistants, and students |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Campion, *et al.,*  201398 | Combined 2.9 million total patients in 3 RHIO communities | All patients | None | NA |
| Caffrey and Park- Lee, 201393 | Sampled: 3,605  Interviewed: 2,302 | Residential care communities that have been licensed, registered, listed, certified or otherwise regulated by the states with >4 beds, >1 resident currently living in the community, and provide room and board with at least 2 meals a day, around the clock onsite supervision, and help with personal care such as bathing and dressing or health=related services such as medication management. | Communities licensed to serve severely mentally ill or intellectually or developmentally disabled populations exclusively. Nursing homes were also excluded unless they had a unit or wing meeting inclusion criteria where residents could be enumerated separately. | NA |
| Carr, *et al.,* 201470 | 18,529 patient encounters, with 998 logons (5.39%) by  60 clinicians. 138 (13.8%) surveys completed. 105 (10.5%) of patients had data in HIE. | All survey responses from HIE users | NA | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Campion, *et al.,*  201398 | -% practice sites accessing data  -Type of practice accessing HIE  -Number of roles and primary practice of users accessing HIE  -Characteristics of patients whose data was accessed  -Consenting of patients related to access | NA | NA | **Quantitative**  Descriptive statistics |
| Caffrey and Park- Lee, 201393 | % of residential care communities that used EHR with computerized support for HIE | NA | NA | **Quantitative**  Regression |
| Carr, *et al.,* 201470 | -Services, costs, and admissions avoided  -Perceived time saved | Tests, costs, and admissions avoided | NA | **Quantitative**  Self-reported tests and admissions avoided, calculation of costs saved based on local data. |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Campion, *et al.,*  201398 | A vs. B vs. C  -Of sites registered to use system: 18% vs. 30% vs. 82% accessed in first 9 months  -After 27 months 60% vs. 59% vs. NR of sites had accessed  -In each community majority of practice sites from which access occurred were out patient  -In A and B majority of sessions were from outpatient sites, C was inpatient  -Registered users in community: 368 vs. 3461 vs. 118  -More than 1/2 users accessing system in A and B were nurses + staff, in C 2/3 were MDs + physician extenders  -Majority of all users practiced in ambulatory setting  -Patients whose data was accessed were older than those whose was not and then the entire population  -For community A&B majority had data accessed on same day as consent  -Majority of patients in A and B had their data accessed in community setting, C was inpatient  -% of patient whose data was accessed from ≥2 sites in first 9 months: 0.1% vs. 1.8% vs. 0.01%; after 27 months: 0.1% vs. 11.6% vs. NR  -System access occurred from 60% to 82% of practice sites registered to use system, depending on community  -Proportions of patients whose data were accessed varied between 5%-60%  -Most frequently accessed data were patient summaries, followed by lab and radiology data | NA |
| Caffrey and Park- Lee, 201393 | 17% of residential care communities reported using EHR  **% of residential care communities using EHR with computerized system to support HIE by provider type:**  Any provider: 40  Pharmacy: 23  Other health or long-term care provider: 20 Physician: 17  Corporate office: 17  Other: 17 | Low |
| Carr, *et al.,* 201470 | -Reported avoiding: 30.5% lab/micro tests ($462), 47.6% radiology tests ($161,000), 19% consultations ($4,000), 11.4% admissions ($118,000)  -86.7% reported improved quality of care  -81% reported time savings, averaging 120.8 minutes | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Chang, *et al.,*  201051 | Cross-sectional | Development and evaluation of enhanced reporting of lab data based on data available to HIE | Indiana | Physician office, outpatient | **Survey**  Survey of physicians who were potential users of reporting interface | 2 week period in 2007 |
| Codagnone and Lupiañez- Villanueva, 201394 | Cross-sectional | To measure and explain levels of availability and use (adoption) of eHealth applications and services | 31 countries: EU27 countries plus Croatia, Iceland, Norway and Turkey | Varies as this was an international survey | **Survey, interviews, focus groups** | October 25, 2012 to  March 6, 2013 |
| Dixon, Miller, and Overhage, 2013141 | Cross-sectional | What are barriers to participation in a mature state HIE? | Indiana | Small hospitals, small physician practices, and large physician practices | **Survey and interviews**  Initial mixed methods interviews with most physician groups given online survey | August 2009-March 2010 |
| Dixon, Jones, and Grannis, 201383 | Cross-sectional | Awareness and engagement of infection preventionists in HIE for public health surveillance | 6 states with HIE - 3 funded by CDC for explicit HIE- based reporting and three with mature HIEs | Case reporting for public health reporting of notifiable conditions | **Survey**  Online survey of 63 infection preventionists | NR |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Chang, *et al.,*  201051 | Indiana Network for Patient Care | Collection of all lab data with enhancements (prior results, other historical lab results, prescriptions, encounters), pharmacy data, and patient encounter data | Not stated, but in 1990s | Primary care physicians who were users of HIE |
| Codagnone and Lupiañez- Villanueva, 201394 | Varies as this was an international survey | Varies as this was an international survey | Varies as this was an international survey | Random sample of general practitioners who use a computer |
| Dixon, Miller, and Overhage, 2013141 | Indiana HIE (IHIE) | Full medical record in HIE | 1994 | Small hospitals, small physician practices, and large physician practices in Indiana who were not participating in HIE |
| Dixon, Jones, and Grannis, 201383 | 6 states with mature HIEs but details not explicitly provided | 6 states with HIE — 3 funded by CDC for explicit HIE-based public health surveillance reporting for infections, versus three with mature HIEs, but without active surveillance reporting.  63 preventionists. | Not specific, would be variable by state | Infection preventionists |

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| **Author, Year** | **N Sample Description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Chang, *et al.,*  201051 | NA | Convenience sample of primary care physicians | NA | None |
| Codagnone and Lupiañez- Villanueva, 201394 | 9,196 general practitioners | General practitioners who use a computer | General practitioners who don't use a computer | Comparison of HIE use by country to prior survey in 2007 |
| Dixon, Miller, and Overhage, 2013141 | 12 small hospitals, 20 small physician practices, and 11 large physician practices who were not participating in HIE | Small hospitals, small physician practices, and large physician practices in Indiana who were not participating in HIE | Small hospitals, small physician practices, and large physician practices in Indiana who were participating in HIE | Barriers of cost, lack of sufficient technical or human resources, or lack of awareness regarding value proposition |
| Dixon, Jones, and Grannis, 201383 | NA | Infection preventionists in public health departments in 6 states | NA | Comparisons in states with active public health surveillance vs. those without |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Chang, *et al.,*  201051 | Evaluation of developed report | Various factors related to usefulness and completeness | NA | **Quantitative**  Satisfaction survey |
| Codagnone and Lupiañez- Villanueva, 201394 | Use of 15 functions of HIE and 4 functions of telehealth. Comparison with previous survey in 2007. | Country, Types of HIE use | Addressed thoroughly in multiple analyses of use and adoption. | **Quantitative multivariate analysis**  Factor analysis to create 1 overall composite indicator, and 4 smaller composite indicators (EHR, HIE, telehealth, PHR).  Comparison with 2007 results. |
| Dixon, Miller, and Overhage, 2013141 | Barriers of cost, lack of sufficient technical or human resources, or lack of awareness regarding value proposition | Survey | None | **Mixed methods**  Qualitative content analysis of interviews and quantitative tabulation of surveys |
| Dixon, Jones, and Grannis, 201383 | -EHR use  -EHR involvement in implementation  -Involvement in HIE  -Method for notifiable case reporting | -Organizations with EHR  -Involved in implementation of EHR  -Engaged in HIE  -Reporting methods for notifiable cases | NA | **Quantitative**  Descriptive Statistics |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Chang, *et al.,*  201051 | -9 physicians sampled  -Average 5 point Likert scales reported showed perception was generally favorable. ELRs well organized (4.2±0.97) and easy to interpret (4.3±0.50). Additional data elements were valuable: relevant test (4.2±0.97), contextual drugs (4±0.89), visit histories (3.25±0.71) and computer generated clinical reminders (3.25±0.71). Compared with traditional lab results ELRs generally saved time (3.78±0.67), reduce the need to search for information (3.67±0.71) and improve quality of care (3.78±0.67). Physicians asked whether they would prefer to use ELRs instead of traditional reports (3.78±0.67). | Moderate |
| Codagnone and Lupiañez- Villanueva, 201394 | Substantial increases in HIE use between 2007 and 2013. Qualitative results on barriers to adoption and use. Countries with National Health Systems have high HIE use that countries with social insurance or transition systems.  Barriers to implementation included lack of interoperability, issues with system resilience, and security concerns. Systems that focused on administrative rather than clinical applications were used less. | Low |
| Dixon, Miller, and Overhage, 2013141 | **Barriers (small hospitals, small physician practices, large physician practices)**  Cost: 100%, 50%, 55%  Lack of sufficient technical or human resources: 42%, 45%, 36% Lack of awareness regarding value proposition: 33%, 15%, 36% | Moderate |
| Dixon, Jones, and Grannis, 201383 | -72% in organizations with EHR; 20% involved in implementation of EHR; 10% engaged in HIE; 49% unaware of organizational involvement in HIE  -<5% reporting via secure email, web-based entry, through EHR, or through HIE each | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Dixon, McGowan, and Grannis, 201142 | Retrospective cohort | To determine completeness and quality of data for public health electronic laboratory reporting in an HIE | Indiana | Public health | **Log file**  -7.5 lab results reported in HIE  -Statutory public health reporting records | November 14, 2010-  December 15, 2010 |
| Dobalian, *et al.,*  2012142 | Cross-sectional | Describe lessons learned from one Nationwide Health Information Network implementation | Long Beach, California | 3 hospitals, 2 ambulatory practice groups | **Interviews**  Test data | 2008 |
| Dullabh and Hovey, 2013158 | Multiple case studies | 1) Assess the experience of states in establishing governance structures, technical services to enable health information exchange, and privacy and security frameworks; 2) Assess stakeholder priorities, current use, and anticipated need for information exchange; 3) Identify common enablers, barriers, and challenges; and 4) Collect and characterize lessons learned. | Maine, Nebraska, Texas, Washington, Wisconsin | Health Systems, provider association, state health IT coordinators, state public health agencies | **Site visits, interviews, focus groups**  Not clearly stated but suggests: lab exchange, e-prescribing and exchanging clinical care documents. | November 29, 2011 -  March 21, 2012 |
| Fairbrother, *et al.,*  2014143 | Cross-sectional | Describe the Beacon community program experience | Greater Cincinnati area, Ohio | Primary care, hospitals, federally qualified health centers and community centers insurance partners | **Interviews**  Alerts for diabetic and pediatric asthma patients in ED or admitted sent to primary care. | Fall 2012 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Dixon, McGowan, and Grannis, 201142 | Indiana HIE (IHIE)- includes lab reports | Reporting of all lab data | NR, but in 1990s | All patients having lab tests |
| Dobalian, *et al.,*  2012142 | One site in Nationwide Health Information Network, another used First Gateways exchange (HealthView). This specific HIE was called Long Beach Network for Health | Make inpatient and outpatient data available to ED. Were not yet able to exchange data about patient care. | 2008 | ED patients |
| Dullabh and Hovey, 2013158 | Not described per state | States had two models of HIE: “thin layer” model with services based on light infrastructure (Texas, Washington and Wisconsin), or a heavy infrastructure model (Nebraska and Maine) with features such as a central repository" | NR | NR |
| Fairbrother, *et al.,*  2014143 | 87 primary care, 18 hospital, 7 federally qualified health centers and community centers, 3 insurance partners | Data exchange, registries, alerts to PC practices when patient in ED or admitted to hospital. | September 1, 2010 -  March 31, 2013 | Adult diabetics, pediatric asthma patients |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Dixon, McGowan, and Grannis, 201142 | 7.6 million lab reports from 168 hospitals and lab information systems, of which 16,365 from 49 hospitals and lab information systems were enhanced by a Notifiable Condition Reporter | All laboratory values | NA | Proportion of fields in lab reports that were complete |
| Dobalian, *et al.,*  2012142 | N=18 to sample | NR | NR | Participants in LBNH vs. not in LBNH |
| Dullabh and Hovey, 2013158 | N=105 to sample; no response rate reported. | NR | NR | Comparison of 5 states |
| Fairbrother, *et al.,*  2014143 | N=38 interviews to sample | Adult diabetics, pediatric asthma patients | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Dixon, McGowan, and Grannis, 201142 | Comparison of completeness of lab test results for regular and enhanced systems | 19 data elements | NA | **Quantitative**  Completeness of data fields |
| Dobalian, *et al.,*  2012142 | Descriptive narrative only | NA | NA | **Qualitative** |
| Dullabh and Hovey, 2013158 | Descriptive narrative only | NA | NA | **Qualitative** |
| Fairbrother, *et al.,*  2014143 | Descriptive narrative only | NA | NA | **Qualitative** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Dixon, McGowan, and Grannis, 201142 | -Patient identifiers and test, name, and results were nearly 100% complete for both; most but not all measures more complete for enhanced system  -15 of 18 record fields showed improved completeness with enhanced system. Units of measure, normal range and abnormal flag fields all showed reduced completeness with enhanced system. No tests of statistical significance performed. | Low |
| Dobalian, *et al.,*  2012142 | "Despite a limited concentration on ED care, virtually all respondents noted concerns regarding the sustainability, or business case, for the exchange of health information." | NA |
| Dullabh and Hovey, 2013158 | "Results show the last 2 years have seen unprecedented growth in HIE infrastructure. Key factors such as maturity of HIE at baseline and healthcare market characteristics have shaped governance models and technical infrastructures." "Given the significant concerns about sustainability and who will pay for state-offered services in the long term, it may also prove beneficial to ensure that states have assistance, either from state or national informational resources, in developing both sustainability plans and contingency plans." | NA |
| Fairbrother, *et al.,*  2014143 | Despite some setbacks and delays, the basic technology infrastructure was built, the alert system was implemented, 19 practices focusing on diabetes improvement were recognized as patient-centered medical homes, and many participants agreed that the program had helped transform care. | High |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Feldman and Horan, 201143 | Retrospective cohort | To determine challenges and successes of HIE for Social Security disability determination | Virginia | SSA, MedVirginia HIE, and Bon Secours Health System | **Database, interviews, audit logs**  Semi-structured interviews of 43 individuals from the 3 participating organizations | June-November 2009 |
| Dullabh, 2014159 | Multiple Case Studies | To understand the effects of the State HIE Program on HIE progress | Six US States Iowa, Mississippi, New Hampshire, Utah, Vermont and Wyoming | Multiple | Site visits, interviews, meetings | 2012-2014 |
| Feldman, Schooley, and Bhavsar, 2014144 | Cross-sectional | Obtain insights into technical, organizational, and governance issues of a large private health system participating in a state HIE | Virginia | Integrated delivery system | **Interviews, observations, documents**  Direct observation, informal information gathering, document analysis, and semi-structured interviews | August 2012-June 2013 |
| Finnell and Overhage, 2010133 | Cross-sectional | To describe the underlying technology, the utilization statistics, and the survey results from the medics who used an integrated emergency medical service point-of-care system and RHIE system | Indianapolis, Indiana | EMS providers using tablets | **Survey, database** | July 1, 2009-  December 31, 2009 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Feldman and Horan, 201143 | Medical Evidence Gathering Through Health IT (MEGAHIT) | Data for Social Security disability determination transmitted from health system through HIE to SSA via NHIN, push of background, lab, and medication data in a CCD from health system to SSA | February 2008 | Patients being evaluated for Social Security disability determination; interviewed included personnel from the 3 participating organizations |
| Dullabh, 2014159 | Multiple | Most projects enabled both directed and query-based HIE. While services varied they included care summary exchange, lab results, public health reporting, and transmission of admission/discharge/transfer messages. | Varies | State HIE programs supported by the Office of the National Coordinator (U.S. Federal Government). |
| Feldman, Schooley, and Bhavsar, 2014144 | ConnectVirginia EXCHANGE | Query of Continuity of Care Documents | August 2012 | All patients in Invoa IDS |
| Finnell and Overhage, 2010133 | 30 hospitals, 5 health systems, Marian County Health Department and various physician practices. | EMS providers use a button that links to the Indiana Network for Patient Care (INPC). Data are stored in a secured, password protected, centralized database. Medics receive a data abstract (pdf) of patient demographics, lab, ED, inpatient, chief complaint, coded diagnoses and procedures. | Started in 1994 | Number of patients who were seen by EMS. |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Feldman and Horan, 201143 | 203 | Members of 3 organizations | NA | None |
| Dullabh, 2014159 | Programs In 6 states | States not included in prior rounds of case studies.  States were selected for variation in program factors, state contextual factors, state HIE progress, | States included in prior case studies of this program | Programs were compared across states in terms of leadership models and other characteristics. |
| Feldman, Schooley, and Bhavsar, 2014144 | 10 individuals from IDS, HIE, and vendors | Members of all organizations | None | None |
| Finnell and Overhage, 2010133 | 26,754 patient contacts by medics. Also survey of 58 medics on use of INPC | Invited all 180 medics. 58/180 responded | NR | Comparison of use over time of study. |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Feldman and Horan, 201143 | Technical, organizational, and governance attributes | Mean Social Security disability case processing time 59 days (vs. average of 84) | NA | **Quantitative, Mixed Methods** Development of Collaborative Enactment Model |
| Dullabh, 2014159 | Provider participation  Critical mass of data exchange | Technical model Leadership model  Variety and type of stakeholders | NA | Qualitative |
| Feldman, Schooley, and Bhavsar, 2014144 | Technical, organizational, and governmental attributes | NA | NA | **Qualitative**  Themes extracted from data |
| Finnell and Overhage, 2010133 | Number of unique medic users over 6 months, number of INPC requests. | HIE use, barriers to use | NR | **Quantitative**  Multivariable analysis |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Feldman and Horan, 201143 | -Technical challenges of HIE can be overcome but organizational and governance factors are also important  30% decrease in mean case processing time from 84 to 59 days from the usual method to HIE supported method, respectively. | Moderate |
| Dullabh, 2014159 | Local stakeholder needs in the long and short term influenced decisions Other factors were cost, privacy and security  Tangible intermediate goals supported implementation.  Providing value and meeting Stage 2 meaningful use criteria were related to estimates of sustainability. Most programs were planning to use subscription fees for long term financial support. | NA |
| Feldman, Schooley, and Bhavsar, 2014144 | Some technical challenges required workarounds, leadership and adequate resources essential, and appropriate decision making authority required | NA |
| Finnell and Overhage, 2010133 | Over a six month study period, requests for patient data via HIE increased from 15% to 26% per patient contact. The majority of medics surveyed felt the HIE information was an important for delivering quality patient care. | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Foldy, 200784 | Cross-sectional | Description of projects, stages, users, organizational home, governance, scope, standards, drivers, challenges, recommendations | Wisconsin | Any | **Survey**  Unable to access due to broken URL link | 2006 |
| Fontaine, *et al.,*  201085 | Cross-sectional | Examine factors that motivate or prevent small primary care practices from participating in EHR and HIE use as mandated by Minnesota e-Health Law from 2007 | Minnesota | Primary care practices with <20 providers in 1 of the 3 described HIE regions | **Survey and Interviews** | November 10, 2008-  February 20, 2009 |
| Frisse, *et al.,*  201244 | Retrospective cohort | To examine the financial impact of HIE in EDs | Memphis, Tennessee | ED | **Log file**  Tennessee Hospital Association billing database of all ED visit records | January 2007-  December 2008 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Foldy, 200784 | NA | HIE defined as projects in which multiple independent organizations routinely send or receive electronic clinical information about patients for purposes other than billing or claims payment | NA | eHealth board, staff, consultants, workgroup members and survey respondents all nominated the survey recipients |
| Fontaine, *et al.,*  201085 | Various HIEs | 9 primary care practices in Minnesota  3 HIE initiatives in Minnesota 1) a 10 year old HIO that promotes HIE and coordinates immunization registry, 2) network of independent metropolitan community clinics that received MN e-health grant funding to implement EHRs, 3) initiative to develop PHR with congestive heart failure patients | NR | 39 participants in discussions |
| Frisse, *et al.,*  201244 | MidSouth e-Health Alliance (MSeHA) | 11 of 12 hospitals accessed information through a dedicated secure web portal. 1 hospital printed encounter summaries as part of triage for the first 10 months of the study.  Patient demographic, diagnosis, all hospital radiologic and laboratory reports, most procedure reports, and discharge summaries are exchanged. | 2005 | All ED visits |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Foldy, 200784 | 30 Organizations contacted, 27 (90%) responded | eHealth board, staff, consultants, workgroup members and survey respondents all nominated the survey recipients | NR | NA |
| Fontaine, *et al.,*  201085 | Unclear | NA | NA | NA |
| Frisse, *et al.,*  201244 | 15,798 visits in which HIE was accessed; matched comparison group of 15,798 cases | ED visit to 1 of the participating hospitals. Visit only in HIE or no HIE subset. | Patients in both the HIE and no HIE subset (932) HIE accessed in non ED setting (3,555) | Encounters with vs. without HIE |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Foldy, 200784 | -Status of projects operation vs. planned  -Stage of development  -Description of information users  -Organization, funding, governance  -Scope  -Standards  -Drivers  -Challenges  -Recommendations | NA | NA | **Quantitative**  Descriptive Stats |
| Fontaine, *et al.,*  201085 | -Use of EHR  -What data elements are being sent/received | NA | NA | **Qualitative**  Descriptive statistics |
| Frisse, *et al.,*  201244 | -Financial consequences based on ED- originated hospital admissions  -Admissions for observation, lab tests, head or body CT, ankle or chest radiographs, echocardiograms | HIE accessed during ED visit | -Admission type  -Length of stay  -Charlson comorbidity index  -Patients matched on age, gender, race, site of ED, diagnosis and payer | **Quantitative Multivariate Analysis**  Generalized estimating equation logistic regression |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Foldy, 200784 | -27 responded, 21 judged to be HIE organizations, 21 respondents had 16 operational projects, 11 planned projects  -Rating of most advanced HIE project had 40% of respondents in implementation and 40% in operational  -44% deliver data only to central registries, 50% deliver to providers and registries and only 1 to providers only  -62.5% are based in government organizations  -73% started with only public funds, 20% exclusively private, 75 used both  -For continued operations 57% rely entirely on public funds, 21% only on private and 21% a combo  -Governance all have multiple stakeholders  -14 are statewide, 7 southeast Wisconsin, 2 south, central and north and west.  -Standards 46% of projects have specific vocabulary or data standards | Moderate |
| Fontaine, *et al.,*  201085 | -8/9 practices uses EHR  -Only 1 practice was able to transmit/receive patient health records  -All 9 practices shared information with department of health immunization registry though not through any of the EHRs in the practices  -Labs were next most common Several practices were receiving data directly into EHRs  -None were sharing data with nonaffiliated practices  -HIE motivations themes: External - government mandates, payer mandates, quality reporting; Internal - cost savings, quality/patient safety, efficiency  -HIE barriers: lack of interoperability, lack of buy-in, competition, security, costs, creating business model, limited success and large time investment, limited technical support  -No practice was fully involved in a regional HIE; HIE was not part of most practices’ short-term strategic plans. | Moderate |
| Frisse, *et al.,*  201244 | HIE accessed: 6.8% of ED visits (in 12 EDs)  **Admissions when HIE used**  Adjusted OR 0.27; 95% CI, 0.210 to 0.351, p<0.0001  191 fewer admissions with HIE vs. without HIE  -In 11 EDs directly accessing HIE data only through a secure Web browser, access was associated with a decrease in hospital admissions (adjusted OR 0.27; p<0001)  -In 12th ED relying on print summaries, HIE access was associated with a decrease in hospital admissions (OR 0.48; p<0001) and statistically significant decreases in head CT use, body CT use, and laboratory test ordering  -HIE access associated with annual cost savings of  $1.9 million, with hospital admission reductions accounting for 97.6% of total cost reductions | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Furukawa, *et al.,*  2013111 | Time Series | Describe extent of HIE in U.S. hospitals | All 50 states and the District of Columbia | Hospital | **Survey**  Health IT supplements to the American Hospital Association Annual survey of hospitals, 2008- 2012. 63% response rates.  2,805 hospitals in 2008, 2,836 hospitals in 2012. nonfederal acute care hospitals | 2008-2012 |
| Furukawa, *et al.,*  2014110 | Cross-sectional | NAMCS Survey, How have rates of EHR changed since HITECH? What % of MDs are engaged in HIE in 2013? What % are using PHR in 2013? How did these things vary by physician and practice characteristics? | U.S. | U.S. ambulatory providers | **Surveys** | 2009-2013 |
| Gadd, *et al.,*  201186 | Cross-sectional | To assess the usability of an HIE in a densely populated metropolitan region | 3 counties around Memphis, Tennessee | ED and outpatient clinics | **Survey**  Email survey responses from 165/ 237 health care professionals (70% response rate) | June-November 2009 |
| Genes, *et al.,*  2011145 | Cross-sectional | What are perceptions of ED users of HIE? | New York City | ED | **Interviews**  Semi-structured interviews of users and nonusers | NR |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Furukawa, *et al.,*  2013111 | NA | NA | NA | U.S. acute care nonfederal hospitals |
| Furukawa, *et al.,*  2014110 | NA | NA | NA | Ambulatory physicians not radiologists, pathology, or anesthesia |
| Gadd, *et al.,*  201186 | MidSouth e-Health Alliance (MSeHA)  A rapid deployment HIE that consolidated data from several sources | Consolidated data from multiple hospital EDs and community- based ambulatory clinics. Decentralized, query-based exchange.  Consent was opt-out. | 2004 in 3 counties | Medical staff (Physicians, Nurse Practitioners, Physicians assistants, nurses, and other) at organizations participating in the HIE |
| Genes, *et al.,*  2011145 | New York Clinical Information Exchange (NYCLIX) | All data from 10 academic medical centers | 2009 | ED physicians |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Furukawa, *et al.,*  2013111 | 2,805 hospitals in 2008 and 2,836 in 2012 Various HIEs | NA | NA | NA |
| Furukawa, *et al.,*  2014110 | NR | NA | NA | NA |
| Gadd, *et al.,*  201186 | 162 responses analyzed  Details on sample: 345 people identified; 269 valid contacts; 237 surveys distributed; 165 responses (69.6%); 3 excluded for missing responses on satisfaction items. | NR other than list of roles included | People who were no longer employed by the system were not contacted | The impact of usability on use of HIE |
| Genes, *et al.,*  2011145 | 18 users of NYCLIX ED pilot | All users | NA | -For users, was HIE data useful?  -For nonusers, why not using? |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Furukawa, *et al.,*  2013111 | Any exchange activity with outside providers outside the organizations | NA | -Provider type  -Organizational affiliation  -Type of clinical information  -Hospital characteristics  -Area characteristics | **Qualitative**  Descriptive statistics |
| Furukawa, *et al.,*  2014110 | Descriptive statistics | NA | NA | **Quantitative**  Descriptive statistics and logistic regression |
| Gadd, *et al.,*  201186 | -Use  -Questionnaire for User Interaction Satisfaction (QUIS 7.0)  -Trust | None | None | **Quantitative, multivariable analysis**  -Wilcoxon rank sum test  -Descriptive statistics  -Ordinal logistic regression |
| Genes, *et al.,*  2011145 | -For users, was HIE data useful?  -For nonusers, why not using? | Semi-structured interviews | None | **Qualitative** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Furukawa, *et al.,*  2013111 | -58% of hospitals exchanging in 2012, 41% increase of 2008, p<0.01  -2012 51% hospitals exchanged with unaffiliated ambulatory providers, 36% with other hospitals outside their organization  -2012 52%, 53%, 35% and 33% exchanging radiology reports, labs, care summaries and prescription lists with outside providers, respectively. That is a 39%, 51%, 40%, 55% increase, respectively.  -After adjusting for hospital and area characteristics hospitals with basic EHR and participation in Health information organizations had highest rates of exchange activity in 2012, 80% of hospital with EHR and HIO were exchanging, 71% with HIO but no EHR were exchanging 60% of hospitals with EHR but no HIO were exchanging, all consistent across different providers types and clinical information types  -Hospital characteristics associated with lower exchange rates, rural, for-profit, locations with greater Medicare part A spending | Low |
| Furukawa, *et al.,*  2014110 | -Broad HIE definition (39% of office-based physicians reported having an HIE with other providers or hospitals). Increased odds of HIE both within and outside of their organization with larger practice, health-system owned practice and multispecialty practice. Very few characteristics associated with HIE outside of the practice, significantly lower outside HIE with community health centers and practice outside of metropolitan statistical centers  -35 % HIE inside, and 13% HIE outside | Low |
| Gadd, *et al.,*  201186 | 151 users (93%), 11 non users  **Average usage per week**  <1 hour: 65 (43%)  1 hour to <4 hours: 58 (39%)  ≥4 hours: 27 (18%)  Mean usability scale: 6.5 SD 1.4 (>5 is favorable, out of 9)  **Association of Scales with higher use (ORs)**  Overall reactions: 1.50, p<0.01 Learning: 1.32, p<0.05  System functionality: 1.34, p<0.01  Trust not predictive of usage. Users commented that HIE needs more tech support and could use more types of data | Low |
| Genes, *et al.,*  2011145 | -Half of users reported usage affecting patient care on ≥1 occasion  -nonusers reporting forgotten login credentials | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Goldwater, *et al.,*  2014146 | Cross-sectional | Evaluate the progress of the HIE, how many providers and hospitals were participating in the program, and what benefits were being realized through the use of the HIE. | Washington, District of Columbia | 6 acute care hospitals | **Interviews, focus groups, survey**  Demographic, inpatient, encounter notifications, lab testing, electronic prescribing services, integration with public health and Medicaid providers. | July 1, 2013-January  6, 2014. Survey of  148 individuals and stakeholders released October 1, 2013 and  closed November 4,  2013. |
| Greenhalgh, *et al.,* 2010121 | Mixed-method; multi-level case study of England's Summary Care Record (SCR) | 1. What is usability, use, functionality, and impact of SCR; 2. What explains variation in its adoption and use; 3. How has the programme been constrained by influences at the macro, meso, micro level; 4. What are the transferable lessons for practice and policy? | 3 districts within the English National Health Service | ED and unscheduled care | **Qualitative data:**  140 interviews of policy makers, managers, clinicians, software suppliers;  2,000 pages of ethnographic field notes;  Observation of 214 clinical consultations;  3,000 pages of documents. **Quantitative Data:** 416,325 encounters in 3 participating clinics | 2009-2010?  Not quite clear |
| Grossman, Kushner, and November, 2008160 | Multiple case studies | Compare differences in success and barriers for HIEs | Indiana, Cincinnati, Northeast Tennessee, Tampa Bay | Any | **Interviews of stakeholders** | February-August 2007 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Goldwater, *et al.,*  2014146 | The 6 acute care hospitals chose the Chesapeake Regional Information System for our Patients | Demographic, inpatient, encounter notifications, lab testing, electronic prescribing services, Integration with public health and Medicaid providers. | Launched February 2012 | Survey sent to 148, 30 completed 20% response rate |
| Greenhalgh, *et al.,* 2010121 | SCR, which was comprised of 3 data fields - medications, allergies and adverse reactions | Not specified | 2007-2010 | 2007-two early adopter clinics; 2010 - 113 of 152 primary care trusts in England had committed to participating; by 2010, 16 had begun to create SCRs;  By 2010, 1.5 million records had been created. |
| Grossman, Kushner, and November, 2008160 | IHIE, HealthBridge, CareSpark, Tampa Bay RHIO | All types | Varying | Stakeholders in 4 HIEs |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Goldwater, *et al.,*  2014146 | NR | NR | NR | NA |
| Greenhalgh, *et al.,* 2010121 | 1.5 million records in 2010 | 3 districts who were implementing SCRs | Not specified | None |
| Grossman, Kushner, and November, 2008160 | 2 mature and 2 newer | NA | None | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Goldwater, *et al.,*  2014146 | Descriptive narrative only | NA | NA | **Mixed Methods** |
| Greenhalgh, *et al.,* 2010121 | What is usability, use, functionality and impact of the SCR;  What explains variation in adoption and use;  How does context play in;  What are the lessons to practice and policy | None | None | **Qualitative**  Interpreted and themed  **Quantitative**  Descriptive statistics and logistic regression |
| Grossman, Kushner, and November, 2008160 | Success, barriers, sustainability | NA | NA | **Qualitative** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Goldwater, *et al.,*  2014146 | "HIE is used to electronically capture and report immunization data; and in requiring electronic lab reporting and results as part of the Meaningful Use Requirement—which can assist in detecting HIV/AIDS and providing better care for the district’s high population of individuals with HIV/AIDS. Electronic lab reporting and electronic prescribing within the HIE can assist the Department of Health and providers in identifying specific diseases, such as tuberculosis and viral hepatitis, before they affect a significant part of the population. ' | Moderate |
| Greenhalgh, *et al.,* 2010121 | Adoption was complex, technically challenging, labour intensive; Went more slowly than planned;  SCR accessed in 4% of all encounters;  SCR accessed in 21% of encounters where an SCR was available;  Main determinant of success was clinician characteristics (which were not specified); When available, clinicians accessed SCR 0% to 84% of time;  SCR supported better quality care and increased clinician confidence; No direct evidence of improved safety;  SCR not associated with shorter clinical consultations;  Successful implementation hinged on successful interactions among multiple stakeholders (clinical, technical, political) | Low |
| Grossman, Kushner, and November, 2008160 | Stakeholder buy-in essential for success, offering hospitals value to reduce costs important, hospitals concerned about controlling access to data, employers and health plans not buying in | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Gutteridge, *et al.,*  2014112 | Cross-sectional | To describe the development and use of a CEN system based on an HIE. | New York metropolitan are | ED, hospital, and outpatient | **Subscription lists and reports generated** | March 11, 2013-  March 2, 2014 |
| Hamann and Bezboruah, 2013113 | Secondary analysis of cross- sectional survey | To examine ownership differences (for-profit; nonprofit) in the use of technology in long term care facilities | U.S. | Nursing homes and residential care | **Surveys**  2004 National Nursing Home Survey; 2010 National Survey of Residential Care Facilities | Nursing home: August 2004-January 2005  Residential care: 2010 |
| Herwehe, *et al.,*  2012124 | Cross-sectional | To conduct a formative evaluation of an HIE for HIV that integrates public health and clinical information | Louisiana | Health department, hospital, outpatient | **Interviews, focus groups, log data** | February 1, 2009 and  January 31, 2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Gutteridge, *et al.,*  2014112 | Healthix | A federated architecture for data sharing. Log in is via a standalone web portal  -Healthix included a total of 107 organizations with 383 facilities, 9.2 million patients, and >6,500 users performing  >10,000 patient searches per month as of January 2014 | 2004 was initial funding  CEN system March 2013 | Geriatric patients seen in ED and admitted to hospitals |
| Hamann and Bezboruah, 2013113 | Varies, NR | Varies, NR | Varies | Long term care Facilities Nursing home is U.S. Residential Care (aka Assisted Living in U.S.) |
| Herwehe, *et al.,*  2012124 | The Louisiana Public Health Information Exchange (LaPHIE) | A secure bi-directional public health informatics application (an HIE in a broad sense, as defined by Dixon et al.), linking statewide public health surveillance data with patient-level EMR data. | Started February 2009 and in all participating hospitals by September 2009 | Patients with HIV seen for non HIV services at 7 Louisiana Hospitals; 442 clinicians (206 physicians and 236 nurses) trained on system to serve as peer trainers |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Gutteridge, *et al.,*  2014112 | These patient who are enrolled in the system | NA | NA | None |
| Hamann and Bezboruah, 2013113 | Nursing home Sample: 1,174 response rate 81% Residential care Sample: 2,302 response rate 81% Various HIEs | NR | NR | Nonprofit vs. for profit use of health IT including HIE |
| Herwehe, *et al.,*  2012124 | 16 focus groups n=149; and 23 key informant interviews with patients | NA | NA | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Gutteridge, *et al.,*  2014112 | -Enrollment of patients  -Number of notifications sent | NA | NA | **Counts** |
| Hamann and Bezboruah, 2013113 | Whether facility shares information electronically with other care partners and the extent of HIE defined as the number of entities with which the facility shares information | Nonprofit or for-profit ownership | -Chain ownership  -Size of facility and type of residents  -Use of volunteers  -% revenue from Medicaid and Medicare | **Quantitative**  -Chi2  -Ordered Logit regression |
| Herwehe, *et al.,*  2012124 | Patients identified and matched providers responses to alerts | NA | NA | **Mixed methods**  -Description  -Counts of alerts and responses |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Gutteridge, *et al.,*  2014112 | -5,722 patients enrolled (612 notifications sent)  -Without duplications 497 event notifications about 206 unique patients  -Notifications originated from 23 separate institutions, ED visits comprised 44% (219 of the 497 notifications), 98 notifications were for inpatient admissions  -121 of 497 (55%) during normal business hours  -Hospital admissions resulted from 45% of ED visits; 17.8% of these lasted <48 hours, suggesting they were avoidable  -70% of notifications were received within 1 hour of the event, during the study year; in following year 71% were received within 15 minutes | NA |
| Hamann and Bezboruah, 2013113 | **For Profit/Nonprofit (corrected F)**  % Residential care using HIE: 0.14/0.21 (10.29), p=0.00 Number of partners in HIE: 0.32/0.42 (2.56), p=0.02  **Regression results:** for profits less likely to participate in HIE OR 0.663, p<0.001  Supports hypothesis and proposed framework for why nonprofits are more likely to use health IT NOTE: NH survey did not have HIE question | Low |
| Herwehe, *et al.,*  2012124 | **In the 2 year period 2/1/2009 to 1/31/2011:**  -488 registrations of patient (345 unique patients) with HIV identified  -Clinicians responded to 73% of alerts and documented actions on note that was shared with public health  -Results include statement that 'no negative feedback has been received from providers' with no detail  -Summary of patient interviews found general acceptance of data sharing as long as there was patient benefit and a preference for care in the healthcare verses the public health system  -Challenges: concerns about data ownership and ethics and disparate data systems, but these are reported as challenges they were able to address | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Hessler, *et al.,*  200987 | Cross-sectional | To understand assessment of HIE by RHIO and state and local public health department representatives | U.S. | RHIOs and State and Local Health Departments | **Survey**  Online survey created by researchers | late February 2007-  March 25, 2007 |
| Hincapie, *et al.,*  2011132 | Cross-sectional | Assess perceptions of physicians users of HIE | Arizona | All physician use | Focus group meetings of 29 physicians on HIE quality of care, workflow and cost | NR |
| Hyppönen, *et al.,*  2014133 | Cross-sectional | To compare usability of different regional health information exchange system (RHIE) types as well as the factors related to the experienced level of success | Finland | Varies as this includes sites with RHIE | Survey | 2010 |
| Jha, *et al.,*  2008117 | Cross-sectional, mixed modes | To assess health IT, including HIE adoption in 7 countries | U.S., U.K.,  Canada, Germany, Netherlands, Australia, New Zealand | Physicians and hospitals | Literature review, available surveys, (Medline and Google) and interviews with governmental and nongovernmental experts | Literature review: 2000 -2006 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Hessler, *et al.,*  200987 | Varies, NR | Varies, NR | Varies | 164 RHIOs  540 health agencies |
| Hincapie, *et al.,*  2011132 | Arizona Medical Information Exchange (AMIE) | Medication history, lab test results, and discharge summaries | October 2008 | Physicians who agreed to participate in focus groups |
| Hyppönen, *et al.,*  2014133 | Regional Health Information Exchange | Varies depending on type of RHIE system. Type 1: master patient index required separate login to centralized database. Type 2: web distribution model. Limited group of referring physicians could see hospital info. Type 3: regional virtual model. If patient grants permission, clinician uses integrated system that includes all inpatient and outpatient information. | Before 2010 | Inpatients and outpatients of physicians working in public sector in 13 regions of Finland where RHIE systems were in use. |
| Jha, *et al.,*  2008117 | Varies, NR | Varies, NR | Varies | Developed countries |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Hessler, *et al.,*  200987 | N=44 RHIOs (27% response); 20 non-governmental N=138 Health agencies (26% response); 41 state and 97 local public health agencies | RHIOs: listed in 1 of 7 sources Public Health: on list from national associations | Missing or invalid email addresses or an exchange specific to 1 disease | RHIOs vs. state vs. local health officials |
| Hincapie, *et al.,*  2011132 | 29 physicians | Physicians who agreed to use system and participate in focus groups | None | None |
| Hyppönen, *et al.,*  2014133 | 1,693 physician respondents aged less than 65 years. 1,079 specialize care; 614 primary care | Physicians working in public sector in 13 regions of Finland where RHIE systems were in use. | Physicians in the private sector or in regions where RHIE not in use whole region or was unavailable | Comparison of HIE usability by type of RHIE and EHR |
| Jha, *et al.,*  2008117 | 7 selected for data availability | NA | NA | HIE use across countries |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Hessler, *et al.,*  200987 | -Sharing of data  -Challenges  -Unique resources  -Minimal requirements | Type of respondent | Characteristic reported but not used in analysis | **Mixed Methods**  -Descriptive statistics, no significance tests  -Qualitative assessment of open- ended responses |
| Hincapie, *et al.,*  2011132 | Benefits and disadvantages of HIE | Transcripts | NA | **Qualitative**  Thematic analysis from transcripts |
| Hyppönen, *et al.,*  2014133 | Levels of agreement to 11 statements about HIE success | RHIE type used, local EHR system used, working sector and primary means of HIE | Managed multi-collinearity | **Quantitative, multivariable analysis**  Models to predict successful HIE, stratified by type of clinician user (specialized or primary care).  Results were broken out by function of HIE. |
| Jha, *et al.,*  2008117 | -HIE existence  -Use  -Policies promoting development | Country | NR | **Descriptive, qualitative** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Hessler, *et al.,*  200987 | Public Health: 50 (36%) no RHIO in jurisdiction; 16 (12%) no relationship with RHIO; 26 (40% responding to item) are exchanging information  RHIOs: 12 (60%) are exchanging info; 7 (35% with public health); lab data shared most frequently (86% of the time)  **Challenges (RHIO/Local/State % endorsing)**  Lack of standards: 33/12/15 Limited resources: 17/67/45  **Unique resources Public Health brings**  Perspective: 41/45/30 Data: 35/16/39  **Minimum Public Health must bring** Commitment: 50/31/23 Funding/sweat equity: 33/43/47  More dialogue about needs and expectations could increase HIE; early successes with lab data could encourage future use. | High |
| Hincapie, *et al.,*  2011132 | Benefits included identification of "doctor shopping", avoiding duplicate testing, and increased efficacy for gathering information; disadvantage was limited availability of data | Moderate |
| Hyppönen, *et al.,*  2014133 | Users of three local EHR systems preferred electronic HIE to paper to a larger extend than users of other EHR systems. Experiences with an integrated RHIE system (type 3) were more positive than those with other types or RHIE systems. | Low |
| Jha, *et al.,*  2008117 | **Australia:** early pilots, but no major investment. Lack of unified patient identification an issue  **Canada:** province-wide efforts, particularly Alberta; national--early development of Health Infoway but little info exchanged **Germany:** most computers with records not connected; Germans have smart cards, but only admin data now  **The Netherlands:** National SwithPoint pilot with 20% of population, plan full implementation in 2008  **New Zealand:** planning stage, have unified patient Id, focus of discharge, lab and path reports to GPs  **U.K.:** National Program, but mostly small amount of data exchanged in more minor programs  **U.S.:** RHIOs, but <12% of organizations exchanging data and <1% of population involved | High |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Johnson, *et al.,*  200899 | Multiple site case studies | To assess first year of MidSouth eHealth Alliance | Memphis, Tennessee | EDs | **Audit logs, database (administrative), comments by users** | Implied 1 year after May 2006; but data on use in January 2008 |
| Johnson, *et al.,*  2011118 | Multiple site case studies | To explore characteristics of use and uses of a regional HIE | Memphis, Tennessee | EDs, ambulatory groups | **Audit logs, database administrative data, observations, comment cards, feedback in system, interviews, observations** | Interviews 1 month, 1 year after system in use in all sites  Audit data and ED visits January 2008-  June 2008 |
| Jones, Friedberg, and Schneider, *et al.,* 201168 | Cross-sectional | To evaluate the association between hospitals’ HIE and health IT use and 30-day risk adjusted readmission | U.S. | Hospitals | **Database**  2007 AHA Survey  2009 September Hospital Compare | June 2005-June 2008 for Hospital Compare |
| Kaelber, *et al.,*  2013120 | Cross-sectional | What is use and perceived value of HIE? | Northeast Ohio | Public healthcare system | **Usage logs, survey of users** | November 2010-  December 2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Johnson, *et al.,*  200899 | MidSouth eHealth Alliance (MSeHA) | Multiple hospital emergency departments and community- based ambulatory clinics. Decentralized, query-based exchange.  Data Exchanged: demographics, ICD-9 discharge codes, lab results, encounter data, and dictated reports.  These are in a vault controlled by the hospital, but accessed when a query is made, unless patient opts out. | May 2006 | ED staff in 5 participating sites |
| Johnson, *et al.,*  2011118 | MidSouth eHealth Alliance (MSeHA) | Data Exchanged: demographics, ICD-9 discharge codes, lab results, encounter data, and dictated reports.  Multiple hospital emergency departments and community- based ambulatory clinics. Decentralized.  These are in a vault controlled by the hospital, but accessed when a query is made, unless patient opts out. | May 2006 in EDs later in clinics (NR) | 6 ED sites and 9 clinics for interviews  All visits records and usage logs |
| Jones, Friedberg, and Schneider, *et al.,* 201168 | Varied. As defined by hospital | Varied. As defined by hospital | Varied. As defined by hospital | Hospitals in U.S. |
| Kaelber, *et al.,*  2013120 | HIE in Northeast Ohio | 10 hospitals and affiliated practices using Care Everywhere | November 2010 | Not stated for patient population, 412 physician users |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Johnson, *et al.,*  200899 | 5 sites; number of users varies by site | NR | NR | HIE use across sites and overall |
| Johnson, *et al.,*  2011118 | Number of people interviewed NR 369 comments (12% of all visits) | NA | NA | NA |
| Jones, Friedberg, and Schneider, *et al.,* 201168 | 2,406 hospitals (58% of eligible hospitals responded to AHA survey) | General acute care non federally owned U.S. hospitals | Not specified. Specialty and federal implied by inclusion criteria | Hospitals that self report exchanging any information with ambulatory providers outside their system vs., hospitals who say they do not participate in this type of HIE |
| Kaelber, *et al.,*  2013120 | 74 (18%) of physicians who replied to survey | All users | NA | -Measurement of usage  -Perceptions of users |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Johnson, *et al.,*  200899 | -% of ED visits with HIE use  -% of users who logged in  -Theme from comments: perception that HIE reduces redundant testing was most common | NA | Role (Nurse, MD, registrar, unit clerk) | **Quantitative, descriptive statistics**  Counts and percentages |
| Johnson, *et al.,*  2011118 | -HIE Access  -Type of data accessed  -Provider log on rates | NA | -Profession (Doctors or nurse/clerk)  -Type of visit | **Mixed Methods**  -quantitative, descriptive data  -qualitative analysis  -Counts and percentages |
| Jones, Friedberg, and Schneider, *et al.,* 201168 | All- cause 30-day risk-standardized readmission rates for patients initially admitted with acute myocardial infarction, heart failure, or pneumonia. | HIE Participation (also use of health IT) | Hospital characteristics (ownership, critical access status, trauma status, number of beds, teaching status, system membership, core-based statistical area type, U.S. census division, long term care unit, critical care unit) | **Quantitative**  -Unadjusted mean differences  -Propensity score matching  -Linear regression |
| Kaelber, *et al.,*  2013120 | -Measurement of usage  -Perceptions of users | -Usage of HIE  -Survey of users | None | **Quantitative**  Descriptive and Multivariate |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Johnson, *et al.,*  200899 | HIE viewed in 2.6% of all visits and 9.5% of visits where patient had visit to other site in past 30 days.  % of total users who logged on ranged from 0 in one site where the high was 12% to 75% by unit clerks in a site that had high use by other professions  -MSeHA was used for 3% of all visits  -The site with the highest usage had registrars looking up HIE data when patient arrived at the ED  -The site that mostly serves pediatric patients used MSeHA the least vs. other sites | NA |
| Johnson, *et al.,*  2011118 | **HIE access**  Patient encounters increased over 24 months: 4% to 6.5% (range: 1 to 16 % across sites) 14.6% for return ED visits and 18.7% for return clinic visits (p<0.001)  Higher where nurses and clerks involved and lowest where MD only access Patient opt out rates: 1% to 3%  Primary user reported consequence of HIE: provided additional history (29%), prevented repeat test or procedure (19.8%) | NA |
| Jones, Friedberg, and Schneider, *et al.,* 201168 | **Unadjusted readmission rates (no HIE vs. HIE)** Acute myocardial infarction: 20.0 vs. 19.8, p=0.14 Heart failure: 24.6 vs. 24.3, p=0.003  Pneumonia: 18.2 vs. 18.1, p=0.68  **Hospitals did not participate in HIE:** 58.7% **Adjusted readmission rates (no HIE vs. HIE)** Acute myocardial infarction: 19.9 vs. 19.8, p=0.18 Heart failure: 24.4 vs. 24.2, p=0.11  Pneumonia: 18.2 vs. 18.1, p=0.68 | Low |
| Kaelber, *et al.,*  2013120 | Usage of HIE ED: 31% to 35%  Primary care: 18% to 22%  Specialty care: 9% to 11%  -Usage highest among patients who were older, with more comorbid illness, Medicare/Medicaid insured, and black  -Self-reported impact was more efficient care (93%), time savings (85%), prevented admissions (15%), decreased tests ordered (84%), decreased imaging ordered (74%), and improved care in other ways (82%) | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Kaushal, *et al.,*  201060 | Cross-sectional | To assess users experiences with an HIE project that provided medications information to EDs. | Massachusetts | 5 Massachusetts Emergency Rooms | **Survey**  Semi-structured interview covering need for intervention, history, personal use, induction, current us, completeness and accuracy, value added, rollout to other hospitals and evaluation Pharmacy benefit claims data | December 2005 |
| Kern, *et al.,*  2011171  Same as Kern, *et al.,* 2009173 | Prospective cohort | To determine predictors of sustainability among community- based organizations implementing health IT including HIE in a state with significant funding of such organizations. | New York | Varies (setting was part of analysis) | **Survey and administrative data** Baseline assessment and New York State Department of Health information on awarded grants | Phone Interviews January-February 2007 (same as baseline for Kern, 2009).  New York State Department of Health data: March 2008 |
| Kern, *et al.,*  2009173 | Time series | To identify lessons for state- based initiatives that can be learned from HEAL NY | New York | NR | **Organizational assessment** Baseline and followup assessments | Baseline: January- February 2007 Followup: July-August 2008 |
| Kern, *et al.,*  201245 | Retrospective cohort | To determine the effect of HIE on ambulatory quality | Hudson Valley region, New York | Physician small group practices | **Log file**  From Portal for usage, MVP Health Care Quality Reports including HEDIS measures and satisfaction | January 2005-June 2006 (split into 3 6- month periods) |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Kaushal, *et al.,*  201060 | MedsInfo-ED, a project Massachusetts Health Data Consortium (MHDC) | Claims data from pharmacy benefit managers (PBMs) were made available at the point of care to clinicians in the EDs | 2004 | Staff at participating sites |
| Kern, *et al.,*  2011171  Same as Kern, *et al.,* 2009173 | Varies | NR | Varies | HEAL 1 Grantees given awarded funds for health IT |
| Kern, *et al.,*  2009173 | Varies | NR | Varies | HEAL Grantees given awarded funds for health IT |
| Kern, *et al.,*  201245 | MedAllies Portal  covers 2 counties, 5 hospitals, and  2 labs | Internet-based with secure log-in from any computer. Providers can view tests and results order by themselves or others. | 2001 | Taconic Independent Practice Association MDs |

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| **Author, Year** | **N Sample Description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Kaushal, *et al.,*  201060 | N=12 interviewed of 15 contacted | 3 EDs that were pilot sites; 2 more added in expansion.  Agreement to participate from MassHealth and 5 health plans. | Patients not covered by participating plans | Comparisons across the 3 initial pilot sites |
| Kern, *et al.,*  2011171  Same as Kern, *et al.,* 2009173 | 26 Phase I grantees (100%) | HEAL 1 Grantee | NA | Organizations that received further funding vs. those that did not |
| Kern, *et al.,*  2009173 | 26 HEAL grantees | NA | NA | NA |
| Kern, *et al.,*  201245 | 138 MDs with quality information (out of 168, 82%) 79 nonusers and 59 users of the HIE portal | ≥150 patients with MVP Health Care | No quality of care data | Physicians who used portal vs. those who did not |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Kaushal, *et al.,*  201060 | Descriptive narrative only | NA | NA | **Thematic analysis**  Coding of interview transcripts by tow investigators |
| Kern, *et al.,*  2011171  Same as Kern, *et al.,* 2009173 | Receipt of HEAL 5 funds | -Responses to 26 questions covering 9 areas  -Type of organization that was the lead application (health care or health information) | NA | **Quantitative multivariate analysis**  -Bivariate and multivariate logistic regression  -Backward stepwise elimination |
| Kern, *et al.,*  2009173 | -Grantee still in operation  -Exchanging data or implementing other IT  -Met definition of RHIO | NA | None reported | **Quantitative**  -Counts and proportions  -McNemar 2-sample test for binomial proportions for matched- pair data for comparison between baseline and followup |
| Kern, *et al.,*  201245 | -Rate of portal use  -Quality of care | Any portal use | -Physician characteristics  -Case mix | **Quantitative**  -Chi2  -t-tests  -Fischer exact tests  -Generalized estimating equation regression |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Kaushal, *et al.,*  201060 | **Need:** respondents believed gaps in medical information are an important problem and this system could help Information was perceived as accurate, range of estimate of patients with information 15% to 80%  **Perception:** system improved knowledge but did not decrease time and did not improve care enough to justify hospital paying for system  **Barriers:** need for patient consent, difficulty matching patients  **Suggestions:** increasing the types of information included (e.g., psychiatric, HIV, and mail order medications) and improving the format of the output | High |
| Kern, *et al.,*  2011171  Same as Kern, *et al.,* 2009173 | **Predictors of funding from bivariate (OR, 95%CI)**  Lead by health information organization: 11.4, 1.7 to 78.4, p=0.01 Performed community-based needs assessment: 5.1, 0.8 to 32.3, p=0.08 Targeting long term care settings: 0.14, 0.02 to 0.79, p=0.03  **Predictors of funding from multivariate (OR, 95%CI)**  Lead by health information organization: 6.4, 0.8 to 52.6, p=-.08 | High |
| Kern, *et al.,*  2009173 | -All grantees still existed at followup  -Half decreased number of planned projects (3 possible: HIE EHR, electronic prescriptions)  -HIE all grantees planning at baseline, 85% at followup (22 of 26)  -9 (35%) had users ranging from 5 to 1600. HIE was most common project.  -13 baseline/20 followup met definition of RHIO  -Expected interventions (not just HIE) to save money: 65% baseline, 35% followup p=0.02  -Concern about financial and technical barriers increased by followup | Moderate |
| Kern, *et al.,*  201245 | -% of MDs using portal: 33% months 1-6 vs. 42% months 7-12 vs. 43% months 13-18  -Mean days logged in per month by MD: 8 (SD 6)  -Quality score at followup: 49 for nonusers vs. 64 for users, p<0.0001  -OR for higher quality use of portal: 1.42 (95% CI, 1.04 to 1.95)  -Average ambulatory quality of care for composite of 15 measures, stratified by time and use of HIE showed difference between non-users vs. users (49% vs. 64%, p<0.0001) at followup and among users between baseline vs. follow-up (57% vs. 64%, p<0.001) | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Kern, *et al.,*  2012147 | Cross-sectional | To understand which components of EHRs and HIE are most likely to drive financial savings in the ambulatory, inpatient, and ED settings. | NA | Ambulatory, inpatient, and ED settings. | **Literature and expert consensus**  Literature search results, input of 28 national experts, analysis of Stage 1 of Meaningful Use | April 2007 (expert review) |
| Kho, *et al.,* 201388 | Prospective cohort | To describe the use of an HIE for tracking patients with antimicrobial resistance | Indianapolis, Indiana | Hospital and associated clinics | **Survey, log data** | June 2007-June 2010 |
| Kierkegaard, Kaushal, and Vest, 2014127 | Multiple site case studies | To investigate how HIE can better meet the needs of care practitioners | 3 communities (RHIOs) in New York State | ED and outpatients | **Observations, interviews**  2 day site visits, onsite and telephone interviews with HIE users and nonusers, observations of workflow | May-June 2013 |
| Lammers, Adler- Milstein, and Kocher, 201469 | Cross-sectional | To evaluate whether HIE is associated with decreases in repeat imaging in EDs | California and Florida | EDs | **Database**  State ED databases, Health Information Management Systems Society data, AHA annual survey | 2007-2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Kern, *et al.,*  2012147 | NA | NA | NA | HIE functions by settings |
| Kho, *et al.,* 201388 | Indiana Network for Patient Care (INPC) | 5 hospital systems (17 hospitals) | May 2007 for this tracking function | Infection preventionists at all hospitals; patients with MRSA or VRE |
| Kierkegaard, Kaushal, and Vest, 2014127 | NA | 2 federated model, 1 centralized model. All required login to standalone web portal  2 provided automated delivery of imaging and lab results 1 included patient portal and iPhone app  1 included secure messaging and event notification.  Query- based but also provided direct exchange of CCD | NR | 11 RHIOs in NY and users and non users of HIE |
| Lammers, Adler- Milstein, and Kocher, 201469 | Varies, not a single HIE | Varies | Varies | ED visits in California and Florida |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Kern, *et al.,*  2012147 | Top 10 functions based on researcher ratings | In top 10 for function based on:  1) probability of achieving a benefit, 2) time to benefit, 3) probability of measuring a benefit for initial framework. Experts added 3 additional criteria  4) complexity, 5) likelihood of usage, and 6) expected magnitude of impact | Rating below top 10 | High rated functions across setting and between HIE and EHRs |
| Kho, *et al.,* 201388 | NR | NA | NA | NA |
| Kierkegaard, Kaushal, and Vest, 2014127 | N= 38 interviews  3 sites (13, 15, 10)  3 EDs, 7 outpatient  3 types of respondents: MDs, other clinical users, administrative users | Received HEAL NY funding and been in existence for ≥7 years, and distinct. | NA | Themes across sites |
| Lammers, Adler- Milstein, and Kocher, 201469 | Patients at HIE adopters: 33,084 (11%) Patients at non adopters: 274,640 | ED visits with data in State and HIMSS, patient had another ED visit in prior 30 days in different EDs, or selected imaging in index visit | ED visits that resulted in admissions | 37 EDs that participated in HIE vs. 410 that did not |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Kern, *et al.,*  2012147 | Rating of function | Setting type (HIE, EHRs) | NA | **Quantitative**  ANOVA for scores across settings  t-tests for HIE, EHRs comparisons |
| Kho, *et al.,* 201388 | -Number of alerts generated  -Number of patients admitted to multiple hospitals  -User satisfaction/ burden  -Coordinated antibiotic-resistant infection tracking, alerting and prevention | NA | NA | **Counts** |
| Kierkegaard, Kaushal, and Vest, 2014127 | Themes related to use of HIE | Site and type of setting | NA | **Qualitative**  -Thematic analysis from transcripts  -Dual coding of interviews  -Iterative coding, grouping of themes in categories continued until saturation |
| Lammers, Adler- Milstein, and Kocher, 201469 | Repeat CT, ultrasound or chest x-ray in same body region within 30 days at unaffiliated EDs | HIE participation in each year | -Patient demographics  -Number of days between ED visits  -comorbidities  -Total annual ED discharges  -ED characteristics | **Quantitative**  Regression with fixed effects and trends |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Kern, *et al.,*  2012147 | -73 setting-HIE function pairs were identified  -Mean function score (range 6 to 18): 13.0 EHR vs. 11.3 HIE, p<0.0001  -No difference in scores across setting (p=0.33)  -High scoring HIE functions: transferring imaging reports (all settings), receiving lab results (outpatient and ED), enabling structured medication reconciliation  -HIE functions were considered more difficult to implement (complexity and time) vs. EHRs  -HIE is most likely to generate a positive financial effect through its ability to coordinate care among providers. Based on assessment for EHRs adding decision support to HIE could potentially yield even greater financial returns |  |
| Kho, *et al.,* 201388 | **Over 3 years**  -12,748 email alerts on 6,270 unique patients  -23% (MSRA) and 22% (VRE) had previous history identified at a different hospital system  **10 Infection Preventionists surveyed**  -All reported email alerts were useful  -Estimated receiving 5 alerts per day; half already known; alerts used to identify patients requiring intervention  -3 said system added time, 1 saved time, 6 neutral  -Most comment recommendation was to add automate capture of lab data | Low |
| Kierkegaard, Kaushal, and Vest, 2014127 | Availability of information varied based on patient consent (required in New York State) and healthcare organization participation.  **USE**  -MDs had low tolerance for search failures.  -Practice staff are important to obtaining patient consent. Where clerks were not trained or supported, fewer patients consented.  -Patients saw providers covered by other exchanges, suggesting need for larger areas  -Physician use HIE less than other clinical users; MDs often delegate the task.  **USABILTY**  -Login process perceived as a burden  -Slow system response times | Moderate |
| Lammers, Adler- Milstein, and Kocher, 201469 | **Probability of repeat ED imaging (percentage points [95% CI]), relative reduction**  CT: -8.7 (-14.7 to -2.7), 59%  Ultrasound: -9.1 (-17.2 to -1.1), 44%  Chest x-ray: -13.0 (-18.3 to -7.7), 67%  -Repeat tests more likely in large EDs | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Lang, *et al.,*  200665 | RCT | Impact of sending family physicians electronic vs. mailed reports of ED visits for their patients | Montreal, Canada | ED and family physician practices | **Database**  Surveys and determination of patient outcomes | June 2001-April 2002 |
| Lee, *et al.,* 201289 | Pre-post implementation survey | To understand MD perception prior to HIE implementation and post implementation use and evaluation | South Korea | Hospital and ambulatory clinics | **Survey, audit logs** | June 2008 Week 1 and 2 (pre survey) Post: NR |
| Lobach, *et al.,*  2007100 | Cross-sectional | To describe use of an HIE for population health management | Durham County, North Carolina | Outpatient | **Audit logs** | September 2006-  February 2007 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Lang, *et al.,*  200665 | Adult university teaching hospital in Montreal | Report of ED visit sent to family physicians | NR | Patients visiting ED during 0800-2200 |
| Lee, *et al.,* 201289 | Seoul National University Bundag Hospital and 35 clinics | Federated architecture model with ebXML RS and ebSML RIM standards  Included demographics, diagnoses, medications, lab results, imaging, treatment, care plans, vital signs, history and summaries. | June 2008 with updates October 2009 | MDs in hospital (50) and clinics (147) for pre; MDs using the HIE for post |
| Lobach, *et al.,*  2007100 | Northern Piedmont Community Care Network set up a system called COACH (Community- Oriented Approach to Coordinated Healthcare) includes 32 private practices, 3 federally qualified health centers, 4 community hospitals, 9 government agencies (county health departments and departments of social services), 1 academic medical center, and 2 care management teams: Durham County, North Carolina, Medicaid | The 4 types of data collected by the system include\*: 1) administrative (demographics and identifiers, services used, provider associations, audit trails); 2) care management (care management encounters, health risk and environment assessment, socio-economic data, special needs, and care management plans); 3) clinical (encounters, problems/procedures, missed appointments, medications, allergies, laboratory results, disease-specific care plans); and  4) communication (messages and alerts, referrals, notices of new information). | 2001 | Patients in program |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Lang, *et al.,*  200665 | 2,022 (out of 3,168) patients visiting ED | Patients visiting ED | Patients in altered mental state (129), state of agitation (21), or with language barrier (29) | ED visit summary provided electronically vs. on paper sent by mail |
| Lee, *et al.,* 201289 | 23 from hospital and 48 from 20 clinics (46% and 33% response) for pre; 15 from hospital and 25 from clinics for post out of all MDs using the system | MD at pilot site | <50% of items completed | Hospital vs. clinic based MDs |
| Lobach, *et al.,*  2007100 | 11,899 patients in Durham County in Medicaid | NA | NA | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Lang, *et al.,*  200665 | -Physician satisfaction  -Return visits at 14 and 28 days  -Duplication of requests for diagnostic tests  -Duplication of specialty consult requests  - Economic | -Physician satisfaction  -Return visits at 14 and 28 days  -Duplication of requests for diagnostic tests  -Duplication of specialty consult requests | Physicians already are sent carbon copies of first page of ED note; self- report of followup data | **Quantitative**  Survey, analysis of followup care |
| Lee, *et al.,* 201289 | -Pre: Perceptions  -Post: Information transmission rate Information utilization rate | Setting (hospital vs. clinic based) | -Gender  -Age  -Specialty | **Quantitative**  Fischer exact tests |
| Lobach, *et al.,*  2007100 | Sentinel events: resource utilization by patients (events of commission) that were considered excessive (e.g., 3 ED visits in 90 days) or potentially avoidable (e.g., ED visit for asthma) and that could potentially be modified by the involvement of care managers and other providers | None | None | **Quantitative**  Counts, observation |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Lang, *et al.,*  200665 | -Reports found to be received, especially in timely manner, and were more likely to be legible, comprehensive, and useful.  -No difference in return visits within 14 and 28 days, although near significance for fewer visits for patients >65 years within 28 days.  -No difference in duplicate test ordering but greater subspecialty consult requests in intervention group. | Moderate |
| Lee, *et al.,* 201289 | **Pre HIE**  -Mean Likert scale that HIE is needed (5 strongly agree): 4.2, p=0.8888 for all and by setting. Similar responses about the need for HIE for specific items (e.g., lab reports) and perceived benefits of HIE.  -Hospital based MDs had higher levels of agreement about concerns related to HIE than clinic based MDs  **Post HIE**  *Most commonly transmitted information differed by setting*  From hospital was working diagnosis: 99.5% vs . 70.5% for clinic, p<0.0001 From clinic it was clinical findings: 79.8%, but this did not differ from hospital  The most useful was lab or imaging in both settings but it was more frequently rated as useful by hospitals (88.2% and 72.9% of cased p<0.0001) | High |
| Lobach, *et al.,*  2007100 | In an analysis of 11,899 continuously enrolled patients from a single county over a six-month period 19.3% (2,285 unique patients) had 7,226 sentinel health events  **Frequency of types of events** Hospital admit asthma: 43 Hospital admit diabetes: 76 Low-severity ED: 2, 546  ≥2 missed appointments in 60 days: 1,728  **Implementation lessons**  -Political issues are more challenging than technical issues  -Perceived value of notices was dependent on timeliness and completeness of underlying HIE dataset.  -Difficult to determine who should be notified of these events, how many notices should be resent and how to prioritize them. | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Maass, *et al.,*  200861 | Cross-sectional | Ascertain benefits of HIE when they occurred | Finland | Regional information system for exchange of clinical data between hospital and primary care offices | **Survey**  Time-motion study of diabetic patients in a health center | NR |
| Machan, Ammenwerth, and Schabetsberger, 200662 | Cross-sectional | Assess value of different aspects of regional network of hospitals and physician practices | Tyrol region of Austria | Regional information system for exchange of clinical data between hospital and primary care offices | **Survey, interviews**  Initial qualitative development of survey followed by quantitative evaluation of responses | May-August 2004 |
| Mäenpää, *et al.,*  201146 | Retrospective cohort | What is impact of a regional health information system on test ordering and referrals? | Tampere, Finland | Hospital district that includes 1 hospital district and its community health system.  Outpatient | **Log file**  Usage of HIE and ordering of laboratory and radiology tests as well as specialty referrals | Data collected 2004-  2008 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Maass, *et al.,*  200861 | Regional information system in Finland | Transmission of patient data into physician EHR | NR | Physicians in health centers in Finland |
| Machan, Ammenwerth, and Schabetsberger, 200662 | Tiroler Landeskrankenanstaleten (TILAK) | Transmission of discharge letters and clinical findings from hospitals to general practitioners. Direct exchange via email. | June 2003 | General practitioners in Tyrol, Austria |
| Mäenpää, *et al.,*  201146 | Regional information system in Finland | Full medical record in regional information system | 2004 | About 234,000 inhabitants in hospital district and associated clinics |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Maass, *et al.,*  200861 | 20 visits by patients with diabetes | NR | NR | Use of information system and description of benefits |
| Machan, Ammenwerth, and Schabetsberger, 200662 | 4 providers followed by cross-sectional survey of 104 of 242 (43%) providers. | All general practitioners in Tyrol | None | None |
| Mäenpää, *et al.,*  201146 | NR | NA | NA | Appointments, ED visits, laboratory and radiology tests for primary and specialty care |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Maass, *et al.,*  200861 | Use of information system and description of benefits | System used and benefits described | NA | **Thematic analysis**  Time-motion study |
| Machan, Ammenwerth, and Schabetsberger, 200662 | -Measurement of overall satisfaction  -Desirability for receiving reports electronically  -Reduced work for filing and archiving  -Leading to improved quality of care | Survey | NA | **Mixed methods**  -Quantitative, descriptive data  -Qualitative, content analysis |
| Mäenpää, *et al.,*  201146 | -Rates of laboratory and radiology test ordering  -ED visits and primary care referrals | None | Use of HIE not correlated specifically with outcomes | **Quantitative**  Log analysis |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Maass, *et al.,*  200861 | 20 visits, 4 involved use of information system, with 1 allowing faster treatment decision and 3 providing access to latest test results | High |
| Machan, Ammenwerth, and Schabetsberger, 200662 | **Satisfaction with HIE**  Positive: 66.4%  Agreeing desirable for receiving all reports electronically: 83.7% Reporting less work for filing and archiving: 82.7%  Agreeing it led to improved quality of care: 78.8% | Low |
| Mäenpää, *et al.,*  201146 | **Change in rates of ordering over time (primary vs. specialty care)**  Laboratory tests per appointment: 19.0% vs. 7.0% Laboratory tests per inhabitant: 19.0%, 17.9%  Clinical chemistry ordering per appointment: 6.6% overall Clinical chemistry ordering per inhabitant: 17.5% overall Radiology exams per appointment: -16.4% vs. -11.0% Radiology exams per inhabitant: -18.9% vs. -1.9%  ED visits: -1%, -16.2%  Primary care referral to specialist per appointment: 43.6% Primary care referral to specialist per inhabitant: 35.2% | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Mäenpää, *et al.,*  2012115 | Retrospective cohort | What is usage of a regional health information system for different amounts of test ordering and referrals? | Tampere, Finland | Hospital district that includes 1 hospital district and its community health system | **Audit logs**  Usage of HIE and ordering of laboratory and radiology tests as well as specialty referrals | Data collected 2004-  2008 |
| Magnus, *et al.,*  201247; Herwehe,  *et al.,* 2012124 | Retrospective cohort | To describe patients identified by the LaPHIE system and HIV- related outcomes associated with LaPHIE over 2 years. | Louisiana | HIV specialty, inpatient and outpatient care within Louisiana State University Health Care Division system. Includes 7 safety net hospitals | **Log file**  Alerts for HIV patients that continue to appear until patients receive CD4 or VL testing; actions taken by the provider are documented within the structured EMR | February 1, 2009-July  31, 2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Mäenpää, *et al.,*  2012115 | Regional information system in Finland | Full medical record in regional information system | 2004 | 10 municipalities;  About 234,000 inhabitants in hospital district and associated clinics |
| Magnus, *et al.,*  201247; Herwehe,  *et al.,* 2012124 | Seven safety-net hospitals; | LaPHIE is a secure bi-directional public health informatics application linking statewide public health surveillance data with patient-level EMR data. The exchange functions in real- time throughout the integrated data networks emergency departments, primary care and specialty ambulatory clinics, and inpatient units. | February-September 2009 (Herewhe,  2012) | HIV patients coming to Louisiana State University Health Care Services division clinics or ED. |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Mäenpää, *et al.,*  2012115 | NR | NA | NA | Usage of HIE by physicians, nurses, and department secretaries, and number of appointments, ED visits, and laboratory and radiology tests |
| Magnus, *et al.,*  201247; Herwehe,  *et al.,* 2012124 | 419 patients in 60 clinics; alerts to 223 clinicians | HIV persons identified by LaPHIE with no CD4 or VL monitoring in >1 year, were followed in 6-month intervals for retention in HIV specialty care, inpatient and outpatient healthcare utilization | HIV patients who had been seen within past year and had no break in care of >1 year since diagnosis | Time-matched random sample of HIV-infected persons who had been seen for HIV care within the Louisiana State University Health Care Services Division integrated data network ≥1 within the past 5 years at the time of comparison. |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Mäenpää, *et al.,*  2012115 | -Rates of laboratory and radiology test ordering  -ED visits and primary care referrals | Usage of HIE | Use of HIE not correlated specifically with outcomes | **Quantitative**  Descriptive statistics and negative binomial regression |
| Magnus, *et al.,*  201247; Herwehe,  *et al.,* 2012124 | -CD4 <200 cells/mm3  -VL >10,000 RNA copies/mL  -Having been prescribed antiretroviral treatment during each 6-month interval | Use of LaPHIE | Adjusted for demographic and clinical characteristics  and timing of entry into the cohort | **Quantitative**  -Chi2 tests, unadjusted logistic regression, and adjusted logistic regression  -Generalized estimating equations using an exchangeable correlation matrix |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Mäenpää, *et al.,*  2012115 | **Usage of HIE (views per year)**  Physicians: 1,333  Nurses: 758  Department secretaries: 497  -No associations detected between use of HIE and test ordering outcomes  **References (means one view of the HIE) viewed in primary health care in 2004–2008:**  By physicians from n=486 to n=3581 By nurses from n=59 to n=2,3535  By department secretaries from n=26 to n=13,542 **References viewed in special care in 2004–2008:** By physicians from n=1,496 to n=25,051  By nurses from n=284 to n=20,587  By department secretaries from n=1,156 to n=6,958  -The HIE utilization rates increased annually in all 10 federations of municipalities, and the viewing of reference information increased steadily in each professional group over the 5-year study period. In these federations, a significant connection was found to the number of laboratory tests and radiology examinations, with a statistically significant increase in the number of viewed references and use of HIE. The higher the numbers of emergency visits and appointments, the higher the numbers of emergency referrals to specialized care, viewed references, and HIE usage among the groups of different health care professionals. | NA |
| Magnus, *et al.,*  201247; Herwehe,  *et al.,* 2012124 | "After adjustment for demographic and clinical characteristics and timing of entry into the cohort, the LaPHIE-identified group remained significantly more likely to be immunocompromised (CD4 < 200 cells/mm3) than their counterparts (OR 3.22, 95% CI 1.72 to 6.04, p<0.001). However, there was improvement over time, with a decrease in odds of having a CD4 < 200 cells/mm3 at each successive six- month interval (OR 0.91, 95% CI 0.83 to 0.99, p<0.05). VL proved more responsive to changes in treatment and care; LaPHIE-identified persons rapidly became similar to their in-care counterparts, with no significant differences between VL, and again, decreased odds of having a VL > 10,000 copies/mL at each successive interval (OR 0.83, 95% CI 0.73 to 0.93, p<0.01)."  24% of those identified had not had a CD4 count or VL since initial diagnosis. Of remaining 76% who had been in care previously, 55% had been out of care for ≥18 months. Following LaPHIE identification, 42% had CD4 counts < 200 cells/mm3 and 62% had VL >10,000 RNA copies/mL. Of 344 patients with at least 6 months of followup, 85% had ≥1 CD4 and/or VL after being identified. | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Massy-Westropp,  *et al.,* 2005134 | Cross-sectional | Pilot the effectiveness of electronic data linking tools to assist in the transfer of information between an acute care hospital and the main regional provider of home-based care. | Adelaide, South Australia | Link patient health information between the hospital and community services sector | **Survey, focus group**  Email alert to community; remote access to hospital reports; flag community patients; web access to community reports. | Piloted over 6 months 2002-2003 |
| McCarthy, *et al.,*  2014161 | Multiple case studies | Factors influencing technical architecture, clinical outcomes, and challenges for Beacon- funded HIEs | Regions within Maine, Indiana, Ohio, Washington, Pennsylvania, Oklahoma, New York | Any | **Interviews**  Written and telephone interviews of implementers of 7 HIEs | NR |
| McCullough, *et al.,* 2014135 | Cross-sectional | To assess barriers and benefits to HIE participation in 2 underserved settings | San Gabriel Valley, California and Minneapolis St. Paul, Minnesota | Outpatient small practices (California) and federally qualified health centers (Minnesota) | Interviews of clinicians, administrators and office staff users | NR |
| McGowan, *et al.,*  2007148 | Cross-sectional | To ascertain lessons learned in the development of Vermont's RHIO | Vermont | NR | Interviews and documents and presentations about the development of VTMEDNET | NR |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Massy-Westropp,  *et al.,* 2005134 | Public teaching hospital, ED and aged home-based care community services organization. | Email alert to community; remote access to hospital reports; flag community patients; web access to community reports. | Piloted over 6 months 2002-2003 | Medical, nursing, and allied- health staff across the organizations |
| McCarthy, *et al.,*  2014161 | Beacon Communities within Maine, Indiana, Ohio, Washington, Pennsylvania, Oklahoma, New York | Varied from hybrid-federated to centralized | 1994-2009,  depending on HIE | Operational, technical, and clinical leaders of each HIE |
| McCullough, *et al.,* 2014135 | Citrus Valley Health Partners Federally Qualified Health Center Urban Health Network (FUHN) | California: Collaborate system. a web-based tool enabling all providers to view data exchanged from 3 hospitals, an anticipated 90 providers, and laboratories in the community and to securely message other providers.  Data are available to be viewed by all participating providers, regardless of whether a physician is contributing data to the system.  Minnesota: CentraHealth aimed at enabling electronic exchange between FQHCs and the hospitals serving  their Accountable Care Organization patients. This system was in implementation at time of study | NR | Independent practices serving predominately Hispanic patients and federally qualified health centers developing an accountable care organization |
| McGowan, *et al.,*  2007148 | VTMEDNET (early HIE) and more recent statewide RHIO | Federally funded (NLM and AHRQ) initiated by hospitals, but developed by a coalition. No other detail provided | NR | NA |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Massy-Westropp,  *et al.,* 2005134 | 82 medical, nursing and allied-health staff. HIE included up to 4,000 patients.  Satisfaction survey responses from 55 or 132 nurses, clinicians and allied health staff. | NR | NR | 82 respondents of HIE project vs. 50 care providers outside of the HIE project |
| McCarthy, *et al.,*  2014161 | 7 HIEs funded by Beacon Community grants | NA | None | Compared various factors across hybrid-federated vs. centralized HIEs |
| McCullough, *et al.,* 2014135 | N=24 providers, administrators, and office staff in 16 sites | Individuals who would be involved in adoption decisions and integration of HIE into workflows at each organization | None | None |
| McGowan, *et al.,*  2007148 | 5 interviews: 2 CIO of hospitals and 3 key leaders | NA | NA | Description of 2 efforts. Some limited comparison of the 2 |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Massy-Westropp,  *et al.,* 2005134 | Satisfaction with electronic data linking | NA | NA | **Mixed methods**  -Quantitative, descriptive statistics  -Qualitative, content analysis |
| McCarthy, *et al.,*  2014161 | -Trust  -EHR context  -Clinical transformation  -Clinical research | Qualitative | NA | **Qualitative**  Interviews |
| McCullough, *et al.,* 2014135 | Benefits and barriers to HIE use | NA | NA | **Qualitative**  Thematic analysis from transcripts |
| McGowan, *et al.,*  2007148 | Facilitators and barriers to creation and implementation | NA | NA | **Qualitative**  Simple summary of interviews |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Massy-Westropp,  *et al.,* 2005134 | Provided bar graphs (figures 2 and 3) but not specific quantitative results except for a statement about use and satisfaction. Those who had embraced the use of the Integration tools were significantly more likely to rate integration higher than those who were not using it as often (p<0.001). In the discussion they estimated a 20% savings in staff time. | High |
| McCarthy, *et al.,*  2014161 | Hybrid-federated models maintain autonomy, accommodate disparate EHRs, and build incrementally, while centralized models require trust fabric, leverage common EHRs, and while providing long-run cost-efficiency may require larger upfront investment. Hybrid-federated models provide most functionality at individual organization level while centralized models leverage value of communitywide data and usage. | Moderate |
| McCullough, *et al.,* 2014135 | Barriers  -Lack of well-functioning area-level exchange  -Market characteristics  -Relationships or previous experiences with exchange partners  -Challenge achieving a critical mass of users  -Health IT used  -Data ownership and provider liability concerns Benefits  -Improved productivity at initial visit  -Improved completeness of records  -Avoidance of duplicative services/patient financial risk  -Improved nonvisit consults | Low |
| McGowan, *et al.,*  2007148 | **Major facilitators for success**  -Public awareness  -Provider buy-in  -Benefits understood in terms of patient safety and quality of care  **Barriers**  -Perceived public perception of privacy issues  -Providers lack working knowledge of HIE concepts  -Need for a sustainable business model is recognized but not solved  -Need for health information to cross state lines | High |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Merrill, *et al.,*  2013174 | Time series | Evaluate the complex dynamics involved in implementing electronic HIE for public health reporting at a state health department, and to identify policy implications to inform similar implementations | New York | State health department, 3 RHIOs | **Interviews, documents**  Lab results and other information for rapid and efficient identification, monitoring, investigation, and treatment of communicable and emerging diseases | 2010-2011 |
| Messer, *et al.,*  2012138 | Before-after | 1. Assess and   enhance organizational readiness to adopt information technology,   1. develop a RHIO to share electronic data between medical and ancillary care providers, (3) implement the RHIO   and begin active information exchange and (4) evaluate the effect of the intervention on provider-related attitudes and satisfaction with information exchange | North Carolina | Ambulatory HIV providers and ancillary care providers | **Interviews**  **-**Pre-post survey  -HIV patient data and lab results | 2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Merrill, *et al.,*  2013174 | 3 RHIOs and New York State Department of Health. | Lab results and other information for rapid and efficient identification, monitoring, investigation, and treatment of communicable and emerging diseases | August 2007-August 2011 | Not described but patients who would be reported to the health department for risk and disease. |
| Messer, *et al.,*  2012138 | Carolina HIV information cooperative regional health information organization (CHIC RHIO) | 1 large academic medical center and 5 AIDS service organizations. Used CAREWare from HRSA. Federated, query-based exchange. | 2008 organization begun | HIV care providers and ancillary service providers |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Merrill, *et al.,*  2013174 | NR | NR | NR | NA |
| Messer, *et al.,*  2012138 | 1 large academic medical center and 5 AIDS service organizations mostly providing case management. Interviews and assessment with 39 stakeholders; pre and post survey of 29 providers' satisfaction with HIE, relationships with other providers, barriers. | Leaders of the individual organizations, HIV providers | NA | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Merrill, *et al.,*  2013174 | Descriptive narrative only | NA | NA | **Qualitative** |
| Messer, *et al.,*  2012138 | -Organization readiness for Charge measure  -Qualitative process summary  -Provider surveys of effectiveness | NA | NA | **Mixed Methods**  -Quantitative, descriptive data  -Qualitative, theme analysis from transcripts. |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Merrill, *et al.,*  2013174 | Three casual loop diagrams captured well recognized system dynamics: Sliding Goals, Project Rework, and Maturity of Resources. The findings were associated with specific policies that address funding, leadership, ensuring expertise, planning for rework, communication, and timeline management. | Low |
| Messer, *et al.,*  2012138 | -Organizational readiness assessment found organizations were well prepared to adopt new technology, in the 4 domains (motivation, adequacy of resources, staff attributes, and org climate) only motivation was slightly below nationally determined levels. Results were consistent by agency type and respondent type  -Largely positive response to quality process. Improved sense of mission, more contact with other agencies, better awareness of other agency roles.  -Providers found increased case manager knowledge of medical care  -Concerns: Initial concerns about confidentiality dismissed over time as trust was built; Respondents noted it is important to manage expectations upfront; Clinic staff must use 2 systems the EHR and CAREWare which takes effort and increases errors; There was an unmet need for training for report generation  -Quantitative provider survey: AIDS service organizations and medical providers generally both felt increased ease of data exchanged and that patient care improved. For AIDS service organizations 7/8 satisfaction related questions improved statistically from pre-post, in clinic survey 4/8 improved statistically | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Miller, 2012162 | Multiple case studies | Assessed how well 5 diverse California health care entities’ HIE capabilities, policies, and procedures satisfied the patient and consumer principles as of early 2011. | California | A captivated integrated delivery system (Kaiser); a physician management service organization (Nautilus); a large public hospital; a large Medicaid HMO; a regional HIE organization | **Interviews**  EHR, Patient portal, HIE, administrative, inpatient, outpatient. Patients’ medications, allergies, chronic disease diagnoses, history, and lab results. Providers could also view hospital radiology reports. | August 2010-April 2011 |
| Miller and Tucker 2014149 | Cross-sectional | How does size of user (hospital health system or network) affect HIE usage? | U.S. | Health systems and networks | **Survey**  Hospital Electronic Health Record Adoption Database (AHA, funded by ONC and is intended to be the most comprehensive and representative survey of the state of healthcare IT) | 2007-2009 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Miller, 2012162 | 1 capitated integrated delivery system (Kaiser); a physician management service organization (Nautilus); a large public hospital; a large Medicaid HMO; a regional health information exchange organization | Each of the 5 systems had their own HIE. Some used EPIC, Next Gen, Siemen's NetAccess, Axoloti's Elysium HIE software | NR | NR |
| Miller and Tucker 2014149 | Various | Various, within-system and out-of-system HIE | Various | U.S. |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Miller, 2012162 | N=5 organizations; 23 interviews with 18 people | NR | NR | They compared against 9 principles e.g., important benefits for individual health; important benefits for population health; inclusivity and equality; etc. |
| Miller and Tucker 2014149 | 430 hospital systems, 4,060 hospitals; average system contains 6 hospitals and operates in just under 4 regional markets | NR | None | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Miller, 2012162 | Discussed each principle and how well it was met | NA | NA | **Qualitative**  Descriptive |
| Miller and Tucker 2014149 | Self reported internal or external exchange of data by hospitals | System's size, defined as the number of hospitals owned, leased, sponsored or contract-managed by a central organization | Patient flow, insurance status (Medicaid, Medicare fractions) per capita payroll, physician relationship (independent practice association, group practice, integrated salary model); profit/nonprofit status; specialty vs. general; IT vendor (HIE capability), EMR age | **Quantitative multivariate analysis**  Unit of analysis is hospital, logistic regression p (exchange) = system size, etc. |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Miller, 2012162 | Discussed each principle. Also discussed challenges and barriers. | Moderate |
| Miller and Tucker 2014149 | **68% do internal exchange:** HIE increases with system size; each additional hospital in system increases likelihood by 2 percentage points; increase if nonprofits, decrease w/ more Medicaid, Medicare, unaffected by location in U.S., age of technology, vendor  **17% do external exchange:** larger hospital systems are less likely to exchange information externally. Each additional hospital in a system lowers the chance of external data exchange from hospitals in that system by 0.7 percentage points. Not affected by relative number of outside hospitals; more sharing with number of beds, number of doctors, % Medicare, per capita payroll; regardless of age of system or size of vendor  -Robust to type of data (demographic or clinical);  -No relation to HMO, PPO, etc.;  -Same effects stronger with higher per capita salaries, suggesting some strategic benefit | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Moore, *et al.,*  2012106 | Cross-sectional | To describe the status and lessons learned from the development and establishment of an HIE based system to alert ambulatory providers when their patients are admitted or discharged from the hospital or ED. | New York City | Hospital, ED, and out patient | **System logs** | November 1, 2010-  April 30, 2011 (6  months) |
| Myers, *et al.,*  2012128 | Multiple site case studies | Describe how members of HIV patients’ care teams perceived usefulness and ease of use of newly implemented, innovative HIEs in diverse HIV treatment settings. | Urban settings and 1 suburban setting in New York, New Jersey, Louisiana, California, North Carolina | Hospital specialty clinics, support services, primary care clinics, testing sites, ED, outpatient and inpatient clinics, Office of Public Health, insurers, laboratory and pharmacy services | Survey and interviews during site visits.  Laboratory, diagnostic, medical, and service utilization; referrals; and ancillary care support, such as case management, counseling and testing, transportation, and substance use and mental health services | July 2008-December 2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Moore, *et al.,*  2012106 | New York Clinical Information Exchange (NYCLIX) | -An event detection and notification system based on a RHIO including major medical centers, primary care  physicians, a home health care agency, long-term care facilities and a Medicaid managed care plan  -NYCLIX uses a federated architecture in which the clinical repository is spread over a collection of “edge servers” that reside in each of the members’ data centers.  -Alerts are considered 1-to-1 communication between providers and are limited to name, date and location of service, so patient consent was not required | November 2009 | 63,305 patients enrolled from 3 hospitals |
| Myers, *et al.,*  2012128 | 5† HIEs that were part of the Information Technology Networks of Care Initiative that included Bronx-Lebanon Hospital Center, Duke university; hospitals, the city of Paterson, Louisiana State University Health Care Services Division, NY Presbyterian Hospital, St. Mary Medical Center Foundation. Query-based | 5 HIEs, each site designed, tailored, and implemented enhancements to existing HIEs according to local needs | NR | Members of HIV patient care teams |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Moore, *et al.,*  2012106 | NR | NA | NA | NA |
| Myers, *et al.,*  2012128 | 60 case workers, medical providers, nonclinical staff. 62 of 102 responded (62%) | Medical providers, case managers and nonclinical members of the participating HIE organizations | NR | Comparison by type of responder |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Moore, *et al.,*  2012106 | Number of events detected overall and per patient | NA | NA | **Quantitative**  Descriptive statistics |
| Myers, *et al.,*  2012128 | -10-item perceived ease of use  -10-item perceived usefulness | Role | NR | **Mixed methods Quantitative:** Descriptive statistics stratified by role and  analysis of variance comparison by role  **Qualitative: Thematic** analysis of the qualitative data interviews were organized |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Moore, *et al.,*  2012106 | -42,818 events detected, on average 238 per day  -≥1 event: 6,913 patients  -1 event: 1,879 patients  -≥10 events: 623 patients  -Mean events of inpatients who had an event: 7.7 events  -Mean events of all patients: 0.7 events | Moderate |
| Myers, *et al.,*  2012128 | Quantitative: vs. medical providers (57%) and case managers (39%) nonclinical staff members (12%) were significantly less likely to report that they provided input into the design of the HIE (p <0.008). Mean composite for ease of use was high (3.9/5.0) and no difference by role. Mean composite for usefulness was also high (4.0/5.0) and no differences by role.  Qualitative: adoption of the HIEs and perceptions of its use and usefulness varied by occupational role of the patient-care team. Also noticed that case workers outside the clinic used the HIE routinely. Those within clinics used HIE sporadically. | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Nagykaldi, *et al.,*  201448 | Retrospective cohort | Describe a pilot study on a more sophisticated architecture that may provide a preliminary roadmap for building HIE with intelligence. | Central Oklahoma | 30 primary care practices, several specialty practices, and the Norman Physician Hospital Organization including an academic hospital and 11 other major hospitals. | **Log file**  Specialty referrals, hospital admissions, prescriptions, laboratory imaging results, and emergency care | March 2010-June 2012 |
| Morris, *et al.,*  2012163 | Multiple Case Studies | To understand the lessons learned from HIE organizations and projects that have succeed and those that have failed. | U.S. States | Multiple | Interviews and Surveys | Not reported |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Nagykaldi, *et al.,*  201448 | exHUB  SMRTnet is a statewide network that includes 120 healthcare organizations. | Comprehensive patient registry and clinical decision support tool and reminder system for preventive care and chronic disease management. Preventive Services Reminder System | NR | 346 patients from 6 primary practices. Average age 66.3 years, 67.1% female, 20% ethnic minority |
| Morris, *et al.,*  2012163 | Closed HIOs include CareSpark. Consolidated HIOs include Minnesota HIE (MN HIE) and Galveston County HIE. Additional HIOs were studied but declined to be included in the public report. Successful HIOs include: Chesapeake Regional Information System for Our Patients (CRISP), Delaware Health Information Network (DHIN), HealthInfoNet, Indiana Health Information Exchange (IHIE), Michiana Health Information Exchange, and Rochester RHIO. | All query based | Varies | Query based HIE project in U.S. |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Nagykaldi, *et al.,*  201448 | 346 patients | NR | NR | Before and after HIE |
| Morris, *et al.,*  2012163 | 9 HIEs provided data that they permitted to be reported publicly. | HIE organizations that ceased operations, merged or continued to operate at the time of the study | HIE organizations that refused to have their information made public | Successful to failed HIE organizations |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Nagykaldi, *et al.,*  201448 | -Time-motion studies  -Complete documentation on preventive screenings and flu vaccinations  -Medication reconciliation | Before and after SMARTnet employed | NR | **Quantitative**  Descriptive |
| Morris, *et al.,*  2012163 | Whether the HIE organization continued to operate | Ability to make changes to technology Ambulatory practices participation Payers participation  Months to deployment Months to live data Months to live clinical data | NA | Qualitative |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Nagykaldi, *et al.,*  201448 | **All increased significantly (p<0.001 from pre to post)**  Completed mammograms: 22.1% to 57.1%  Recommended colonoscopies: 31.7% to 53.8%  Pneumococcal immunization: 39.1% to 50.6%  Influenza immunization: 22.7% to 41.7%  Medication reconciliation (defined as the ratio of matching practice records and patient reports before and after the HIE implementation): 35.3% (370 of 1047) to 44.9% (468 of 1043)  **Barriers included:** delays and difficulties in collaborating with commercial technology vendors who gave innovation a low priority  **Facilitators included**: strategic planning, shared goals, and establishing communication methods | Moderate |
| Morris, *et al.,*  2012163 | Facilitators:  Key to successful implementation is abilities to move beyond pilot to have volume and breadth of data: id early adopters who find value and get to a high number of queries, records returned.  Successful HIE projects seem to be those that have some level of control over the technology they use.  Sustainability is related to the ability of HIE organizations to innovate and react quickly to changes in markets. This requires a combination of leadership and technology. | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Nøhr, *et al.,*  2001139 | Before-after | Compare expectations with experiences after HIE launched | Denmark | Hospitals and primary care | **Survey, interviews** | 1999 |
| Nykänen and Karimaa, 2006150 | Cross-sectional | Factors of success and failure for a regional IS network of hospital and physician offices | Finland | Regional information system for exchange of clinical data between hospital and primary care offices | **Interviews and documents** Study of HIE documents and processes; interviews of users in pilot phase | NR |
| Onyile, *et al.,*  2013125 | Cross-sectional | Determine the geographic distribution of patients using the New York metro RHIO | New York | Multiple settings | **Database and Audit logs** Ambulatory physician groups, long-term care facilities, a Medicaid managed care plan, the nation’s largest home health- care provider and academic medical centers that serve as major referral centers with a total of 7,503 inpatient beds, 341,065 annual inpatient discharge and 540,854 annual ED visits | Cumulative: 2009-  2011 (patients entered by time of study, 2011) |
| Overhage, Evans, and Marchibroda, 2005151 | Cross-sectional | Community readiness for HIE. | U.S. | Various | **Survey**  Web based survey for Connecting Communities for Better Health | 2004 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Nøhr, *et al.,*  2001139 | Varies as this was a national effort in Denmark | Four types were described:  Common database  EDI: copies of data are transferred between systems Middle ware: software between application and database Internet technology: data communicated via browser | 1998 to 1999 | Not reported |
| Nykänen and Karimaa, 2006150 | Regional information system in Finland | Not well-described | NR | Pilot users of system |
| Onyile, *et al.,*  2013125 | New York Clinical Information Exchange (NYCLIX) - Manhattan based RHIO | NYCLIX - Manhattan based RHIO, ambulatory groups, long term care, home health care, academic health centers, Medicaid managed care plan | March 2009 | Patients who visited a NYCLIX facility |
| Overhage, Evans, and Marchibroda, 2005151 | Various | Various | NA | Organizations and individuals who might be interested: 839 (national associations: 110,  government agencies: 57,  individuals: 117, national  organizations: 354, state-  focused organizations: 201) |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Nøhr, *et al.,*  2001139 | Survey respondents: Expected benefits in 1998 (n=102); Experiences in benefits in 1999 (n=57); Expected barriers in 1998 (n=101); Experiences in barriers in 99 (n=99) | Seven persons involved in each HIE project. | NR | Expectation vs. Experience. Also comparison to paper systems at times. |
| Nykänen and Karimaa, 2006150 | Unspecified number | NA | None | None |
| Onyile, *et al.,*  2013125 | 3,980,016 patients (after excluding 26,589 with invalid zip code) | In RHIO master patient index | Invalid zip code | NA |
| Overhage, Evans, and Marchibroda, 2005151 | 134 | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Nøhr, *et al.,*  2001139 | Expected benefits and barriers. Experienced benefits and barriers. | NA | NA | **Mixed Methods**  -Quantitative, descriptive data  -Qualitative analysis |
| Nykänen and Karimaa, 2006150 | Perform work tasks and how the HIE changes them | Qualitative | NA | **Qualitative**  Interviews, observations, usability, and analysis |
| Onyile, *et al.,*  2013125 | Visited RHIO facility (in master patient index) | Calculated distance from Times Square | NR | **Quantitative**  Mapped the most current zip code for each unique patient to the appropriate U.S. county, calculated the distance from each zip code to Times Square, mapped with EpiInfo v3.5.3, spatial regressions with SatScan v9.1.1 and RR of visit by spatial cluster |
| Overhage, Evans, and Marchibroda, 2005151 | None | NA | NA | **Quantitative**  Descriptive - provide only percentages |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Nøhr, *et al.,*  2001139 | "What was expected, but not found, was resistance to EPR, as a result of changes in skills and power. The most obvious benefits are increased data accessibility and improved decision making. The most considerable disadvantage is an enormous growth in discontent with the systems performance and the fact, that all the projects are delayed. Many different types of integration solutions are chosen, because of a lack of a common model for integration. Generally the projects find, that EPJ yields increased security, but logistical problems arise in having the systems running 24 hours 7 days a week" | Moderate |
| Nykänen and Karimaa, 2006150 | Quality of design process deemed a success factor. General statement that users experienced better planning of patient care and access to data, but no details given. | Moderate |
| Onyile, *et al.,*  2013125 | NYCLIX has representation in all 50 U.S. states, 4 U.S. territories and 57 International standards organization countries. 12.1 visits/ 100 within 30 miles; 0.4 visits/ 100 at 100 miles; 87.7% live within 30 miles of Times Square; "inflection point" where visits are less than 1 per 100 is 80 miles from Times Square; for cluster counties, RR for visit is 14.4; 77.7% of entire U.S. counties represented; more patients from outer boroughs than from Manhattan | Low |
| Overhage, Evans, and Marchibroda, 2005151 | -22% in beta stage, 28% in pilot, 28% operational, 22% conceptual; of 64 self-reported operational, only 9 could be verified  -5% no organizational structure; 28% "loose affiliation"; 29% had corporate structure; of these 23% hospitals, 16% provider organizations, 10% academic medical centers, 9% dedicated community HIE, 2% public health  -Long lists of organizations to be involved, without actual details of roles; clinicians heavily involved in all, leading the way in 24%; architectures 2% PHR, 20% peer to peer, 3% federated, 54% centralized database; 18% not decided; most planned centralized; broad functionality and data inclusion proposed by participants, without specifics about implementation  -Standards proposed: 82% ICD-9, 73% CPT4, 38% LOINC, 41% SNOMED, 48% NDC  -One third had identified funding; planned funding over 60% external, 45% subscribers | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Overhage, Grannis, and McDonald, 200849 | Retrospective cohort | Compare the completeness and timeliness of laboratory reporting for public health in manual and electronic systems | Marion County, Indiana | Marion County, Indiana (public health system) | **Log file**  Indiana Network for Patient Care: 9 of 13 hospitals in county, physician practices, laboratories, radiology centers, public health departments | First quarter of 2001 |
| Ozkaynak and Brennan, 2013129 | Multiple site case studies | To describe sociotechnical system in terms of social structure determination of technical forms: "how social systems define technology and its usefulness." | Madison, Wisconsin | 3 EDs in different systems in same metropolitan area | **Observations, interviews**  210 hours direct observations, varied across shifts, in 5 rounds, by 1 or 2 observers (industrial/ systems engineers, nurses,), with informal conversations to enquire and followup, plus 13 open ended HIE interviews | 2008-2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Overhage, Grannis, and McDonald, 200849 | Indiana Network for Patient Care (INPC) automated public health reporting based on LOINC codes | Indiana Network for Patient Care: 24 hospitals, physician practices, laboratories, radiology centers, public health departments in Indiana | NR | County wide public health |
| Ozkaynak and Brennan, 2013129 | NR | Clinicians choose when to use HIE, which is always available | NR | ED clinicians |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Overhage, Grannis, and McDonald, 200849 | Marion county population | Notifiable condition in eHIE system or in manual system(s) | No match of identifiers | Manual public health reporting by physician offices, laboratories (in and out of Indiana) to state and local public health departments, case finding |
| Ozkaynak and Brennan, 2013129 | 184 patient care episodes | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Overhage, Grannis, and McDonald, 200849 | -Completeness  -Timeliness of public health laboratory reporting | Electronic or manual reporting system | NR | **Quantitative**  Number identified in eHIE vs. number identified by manual reporting, time to reporting |
| Ozkaynak and Brennan, 2013129 | -Use of HIE  -Views of clinician-users | NA | NA | **Mixed methods**  -Quantitative descriptive  -Qualitative analysis  -Inductive iterative analysis, systems engineers, nurses, physician |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Overhage, Grannis, and McDonald, 200849 | Overwhelming positive effect: 4,635 found by eHIE, 944 by manual; for 818 identified by both, eHIE reported 7.9 days earlier on average, across 53 conditions, eHIE found more for all but 3 conditions; 5/18 data items more often present in manual, 10/18 more often present in eHIE; but false matches (4 Ebola); nondisease positives (rubella screen); repeat testing known positives; delayed report till confirmed or typed (Shigella) | Low |
| Ozkaynak and Brennan, 2013129 | -184 patient care episodes (10 use the HIE system, about 5%)  -2 unexpected uses of the HIE: (1) The HIE was being used mostly for patients only with specific characteristics. (2) The information from the HIE could be used to confront with the patients.  -System used mainly for patients with chronic pain to check previous visits (and prescribing); workflow issues interfered; extra time and effort expended when needed,  -When the observers asked the reason of use of the system, the reason mentioned by the majority of the interviewed clinicians was to detect drug-seeking behavior | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Pagliari, Gilmour, and Sullivan, 2004122 | Multiple case studies | To explore the processes and outcomes of implementation, barriers and facilitators to system adoption and benefits and drawbacks for professional users. | Scotland | Primary and Secondary Care | **Survey responses from users and project managers, interviews, and document review** | November 2001 - May 2003;  (August 2002-May 2003 for minimum dataset) |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Pagliari, Gilmour, and Sullivan, 2004122 | Electronic Clinical Communication Implementation Program (ECCI) | The ECCI is a program initiated as part of the Scottish National health Service Information Management and Technology strategy. It targets six electronic deliverables relating to direct hospital outpatient appointment booking from primary care, referral from primary to secondary care, results reporting from secondary care laboratories to primary care, transfer of hospital discharge and clinic letters to primary care and clinical email. | 2000 | 16 Scottish Health Board areas included in minimum dataset;  Survey - in-depth studies of 7 regional sites, chosen to represent the others in terms of geographic and demographic spread and initial IM & T maturity. |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Pagliari, Gilmour, and Sullivan, 2004122 | 16 Scottish Health Board areas included in minimum dataset;  Survey - in-depth studies of 7 regional sites, chosen to represent the others in terms of geographic and demographic spread and initial IM & T maturity;  64% survey response rate for primary care; 34% for specialty care.  Survey sample represents 17% of Scottish practices; therefore respondents represent 11%. | Minimum dataset: all 16 areas; surveys - limited to 7 regions | see inclusion criteria | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Pagliari, Gilmour, and Sullivan, 2004122 | 6 electronic deliverables:   1. direct hospital outpatient appointment booking from primary care; 2. referral from primary to secondary care; 3. results reporting from secondary care labs to primary care; 4. transfer of hospital discharge and clinic letters to primary care;   clinical email (second opinion correspondence) | NA | NA | Qualitative  Minimum dataset: descriptive statistics  Surveys: mailed or email |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Pagliari, Gilmour, and Sullivan, 2004122 | From the minimum dataset:  GP practices with access to e-results reporting software: 37% GP practices using e-RR: 36%;  GP practices with access to e-OP appointment booking system: 3%; GP practices using e-OP system: 2%;  GP practices with access to e-referral system: 47%; Referral letters e-transmitted: 18%;  GP practices using clinical email: 9%;  Consultant led departments using clinical email: 5%; Hospital wards able to send e-discharges: 10%; Wards generating and sending e-discharges: 7%; Specialties able to generate e-clinic letters: 11%; Specialties generating and sending e-clinic letters: 3%. Surveys - of responding practices:  93% used e-Lab results; 58% e-referrals;  42% e-discharges;  16% e-OP booking;  Percent reporting daily or weekly use:  90% e-results; 96% e-discharges; 92% e-referrals; 28% e-OP booking.  Clinicians most common users of e-reporting/e-referrals; admin/clerical staff most common users of e-discharge/e-OP booking. Implementation was facilitated by successful engagement of stakeholders that focused on proactive methods. Other facilitators were ease of use, good training, communication and commitment from staff. Barriers included differences in IT and system bugs or problems and slow system development. | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Park, *et al.,*  201363 | Cross-sectional | To assess patients’ perception of an HIE which includes patients’ preferences regarding information exchange operations, endorsement of the technology, and expected and perceived benefits and concerns about the technology, and to examine the influence of demographic characteristics and HIE experience on patients’ perceptions. | South Korea | Tertiary care and affiliated clinics | **Survey**  interview pre-, telephone post- | 2008-2009 |
| Patel, *et al.,*  201391 | Cross-sectional | To provide national estimates of physician capability to electronically share clinical information with other providers and to describe variation in exchange capability across states and EHR vendor. | U.S. | Out patient | **Survey**  -2011 National Ambulatory Medical Care Survey  -Electronic medical record supplement | 2011 |
| Phillips, *et al.,*  2014164 | Multiple case studies | Study 3 RHIOs implementing a public health use case | New York | Any, but this study focused on public health reporting and querying | **Interviews and documents** Semi-structured interviews and review of documentation of RHIO | NR |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Park, *et al.,*  201363 | Korean HIE pilot | Federated architecture, stores and transfers HL7 CDAs CDA exchanges between referring providers and SUNBH | June 2008 | All patients visiting tertiary hospital and affiliated clinics |
| Patel, *et al.,*  201391 | Several | Varies | Varies | Nonfederal office–based physicians  who provide direct patient care |
| Phillips, *et al.,*  2014164 | 3 RHIOs in New York state | All types | Varying | Interviews with leaders of the 3 HIEs |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Park, *et al.,*  201363 | Pre: 322 hospital + 408 clinic; Post: 306 of 536 HIE  participants, 180 offline information exchange, 208 referral letter only | Not explicitly stated (visited hospital or clinic) | Not explicitly stated | 1) paper based, offline (USB stick) and online (HIE); 2) participants and non participants,3) before and after implementation |
| Patel, *et al.,*  201391 | 4,326 respondents (61% weighted response rate) | Out patient MDs | Federal physicians | NA |
| Phillips, *et al.,*  2014164 | NA | NA | None | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Park, *et al.,*  201363 | -Need for HIE  -Experience with HIE  -Preferences  -Endorsement  -Perceived benefits and concerns  -Satisfaction | HIE exposure status (pre, post, offline, letter) | Demographics | **Quantitative**  Descriptive, MANOVA |
| Patel, *et al.,*  201391 | Reported capacity for exchange of pharmacy, lab and clinical summary information | -State  -Physician demographics  -Physician use of EHR  -Practice characteristics  -EHR vendor | NA | **Quantitative**  '-t-tests  -Profit regression models |
| Phillips, *et al.,*  2014164 | Certification and becoming operational for public health use case | Qualitative | NA | Qualitative |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Park, *et al.,*  201363 | -Group A (offline 'HIE') older, more likely to have operation, inpatient care; 14% used USB, etc., 10% paper HIE; only 23% concerned MD do not know about prior care; all preferred consent based HIE, 80% in HIE, 55-59 in non-HIE;  -Post: satisfied, would recommend: 92% of HIE, 88% of non HIE; HIE and offline 'HIE' equally cited convenience, expedited care; all endorsed HIE, HIE group most strongly; all cited convenience, expedited care, HIE group most strongly; HIE group less concerned about privacy, complexity, inconvenience  - A higher percentage of HIE patients (80%) compared with A(55%) & B(59%) reported their preferred method of information exchange was HIE  -In general those who experienced HIE had statistically higher rates of agreement with survey questions regarding need for HIE | Low |
| Patel, *et al.,*  201391 | **Overall:** 31% could share clinical summaries, of these 76% could both send and receive, 64% of these exchanges were through an EHR vendor and 28% through a hospital-based system. 55% could e- prescribe, 67% could view lab results, 42% could incorporate lab results into EHR.  **State differences:** the capacity to electronically exchange clinical summaries with patients varied from 55% (Minnesota) to 18% (Louisiana). The proportion of physicians who exchange clinical summaries with other providers varied from 61% (Wisconsin) to 15% (Alabama).  -Adoption of EHR is strongest practice characteristic associated with exchange capacity, p<.001  -EHR vendors have a wide range of capacities for exchange: 24% to 77% of MDs report exchange capacity by vendor  -Primary care providers were more likely to exchange vs. specialists, age of MD was NS | Low |
| Phillips, *et al.,*  2014164 | 2 common factors influenced risk management and implementation success: leadership capable of agile decision-making and commitment to a strong organizational vision | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Pirnejad, Bal, and Berg, 2008152 | Cross-sectional | How are data integration and data integrity attained in a communication network? | Almere, the Netherlands | Community - hospital interface | **Interviews, observations, documents**  Interviews (pharmacist focus); documents, observations of pharmacist work after implementation | 2005-2006 |
| Poulidi, 1999165 | Multiple Case Study | To review the lessons learned in the context of HIE related to collaboration among stakeholders | United Kingdom | National Health Care system wide | In depth interviews used to create a stakeholder analysis; comparison to an analysis complete in the U.S. | Post 1996, but not reported |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Pirnejad, Bal, and Berg, 2008152 | Trans-mural exchange of medication data in Almere (TUMA) | Medication information exchange community GP/pharmacist with hospital pharmacy; same vendor, different systems, shared server | 2005 | Hospitalized people in Almere, Netherlands |
| Poulidi, 1999165 | NHSnet | Wide area networking was set up to facilitate the exchange of administrative, purchasing and clinical data. | 1993 | UK, sub areas not specified |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Pirnejad, Bal, and Berg, 2008152 | 0 of 115 GPs, 2 of 17 community pharmacists, 4 hospital pharmacists in 1 hospital pharmacy; project lead and 2 managers | None given | None given | Pre-post |
| Poulidi, 1999165 | NR | NR | NR | Greater Dayton Area Community Patient health Information Network in the U.S. |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Pirnejad, Bal, and Berg, 2008152 | Second stage: changes in work, improvement, problems; after network tested, reasons for problems in test results | First stage: study context, medication data communication, information gaps | NA | **Qualitative**  -Grounded theory  -Semi quantitative, formative |
| Poulidi, 1999165 | Stakeholder perceptions and attitudes | NA | NA | Qualitative |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Pirnejad, Bal, and Berg, 2008152 | -Pitfalls and information gaps in the old medication data communication: missing medication information on admission, delay in information at discharge, dependence on patients for prescription information  -TUMA effect on bridging the information gaps and improving the communication, focusing on the test results and their analysis.  -Important unforeseen problems: (a) technical challenges in system interface (though same vendor); (b) data integrity problems (59 errors in 32/100 records before fix, 55 items in 14/100 records after fix); (c) problems with coding system and its application, with software and its application, (d) and conflicts related to the articulation work and responsibility distribution between the involved parties - e.g. coding differences by GPs and pharmacists  -Aim was to replace patient as weakest link - learned that instead "contribution of patients in saving the integrity of data and in integrating medication data is valuable" | Moderate |
| Poulidi, 1999165 | Confidentiality was a major concern for physicians and a barrier that slowed implementation.  The NHS case is more complex than the regional US case in that more types of stakeholders are involved, more settings are involved in the NHS implementation and the scope of the data exchanged is greater. | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Ross, *et al.,*  2010167 | Multiple case studies | Elucidate perspectives of clinical and administrative leaders in smaller ambulatory practices regarding desired HIE functions, key motivators, barriers to and potential incentives for adoption. | Colorado | SNOCAP-USA  Practice-based Research Networks;  small to medium- sized practices (<20 providers) in primary care practices | **Interviews**  -Topic guide created based on literature  -Telephone and on-site guided discussions | November 2008-April 2009 |
| Ross, *et al.,*  201350 | Retrospective cohort | Does HIE affect laboratory and radiology test ordering | Mesa County, Colorado | Physician offices - outpatient | **Log file**  Claims data | April 2005-December 2010 |
| Rudin, *et al.,*  2009153 | Cross-sectional | What are providers' decision- making processes in implementing HIE? | Massachusetts | Physician offices | **Interviews**  Semi-structured interviews | Summer-Fall 2007 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Ross, *et al.,*  2010167 | 1. Community-wide HIE - currently exchanged information, but could use paper or electronic medical records; 2. Paper charts only - No use of community-wide HIE; 3. EMR only - No use of community- wide HIE. | 2 types of community-HIE: 1) traditional RHIO that provides limited EMR functionality that includes storage and retrieval of tests, dictations, meds, allergies, e-prescribing (2 urban (1 indigent clinic; 1 private clinic), 1 rural site (private clinic); 22 providers total).  2) nontraditional HIE-one EMR across multiples sites in an independent practice association (still met investigators definition of HIE); (1 suburban site; private; 16 providers). Patterns included: 1) bulk of info exchanged was related to ordering tests and studies and receiving results from hospitals and independent labs; 2) vital to exchange info with hospitals and specialty practices (consultation reports and discharge summaries). | NR | Family practice sites participating in SNOCAP-USA practice based research network |
| Ross, *et al.,*  201350 | Quality Health Network | Query-based and directed | 2005 | Claims for 34,818 patients served by 306 providers in 69 practices who had access to the HIE |
| Rudin, *et al.,*  2009153 | Massachusetts eHealth Collaborative (MAeHC) | Hybrid HIE | NR | Members of MAeHC collaborative and physician users |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Ross, *et al.,*  2010167 | Purposeful sampling | Family practice sites participating in SNOCAP-USA practice based research network | None listed | Paper chart only practices and EMR only practices vs. community HIE practices |
| Ross, *et al.,*  201350 | Claims for 34,818 patients | All having access to HIE | None | Rates of laboratory and radiology testing for primary care and specialist care physicians |
| Rudin, *et al.,*  2009153 | 14 key informants | All interviewed | NA | Technical HIE architecture chosen |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Ross, *et al.,*  2010167 | -Desired HIE functions  -Key motivators  -Barriers to and potential incentives for adoption | Practice group | None listed | **Qualitative**  Qualitative analysis was iterative, allowing for investigator corroboration, triangulation, and checking; then coding and theming, creation of briefing sheet, then use of modified Delphi method to finalize analysis. Sites also reviewed and corrected reports prior to final report creation. |
| Ross, *et al.,*  201350 | -Rates of laboratory and radiology testing  -Economic | Rates of laboratory and radiology testing | None | **Quantitative**  Mixed effects regression model |
| Rudin, *et al.,*  2009153 | Technical HIE architecture chosen | NA | None | **Qualitative** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Ross, *et al.,*  2010167 | Desired functions of HIE: Universally valued was improved ability to receive and review clinical info from outside the practice; this much more so than improved ability to send or make available info from inside the practice. Paper- and EMR-only anticipated little value in sharing their data with others, but HIE practices realized the value of having their data available anytime/from anywhere. There was consensus that community hospitals and independent lab info would be essential. Also highly desirable to include exchange with specialists. Test results considered most important; followed by discharge summaries.  Mean ranking of potential HIE functions (1=highest; 5=lowest rank): looking up info 1.9; delivering results 2.2; e-prescribing 2.5 (lack of computers in exam rooms was a barrier for this one); placing nonprescription orders 3.8; creating reports 4.7; secure email was a lower priority.  Essential attributes of HIE: solid reliability and responsive service; live and direct technical support; comprehensive policies and systems for privacy, security and data use  Motivations for adopting HIE: motivated to gain uniformity in workflow; improved efficiency (even though did not anticipate monetary benefit; improved quality of care through better coordination and information;  Barriers and facilitators:   1. Barrier: technical-need to interface with existing systems 2. Barrier: workflow issues-most sites did not want to re-engineer workflow 3. Best facilitator: technical assistance for implementation & maintenance; and training 4. Barrier: financial issues; secondary, but important; capital costs were barrier; not concerned with loss of revenue 5. Facilitators: solidarity & trust were important (easier in smaller cities); wanted involvement by practice leaders, NOT health plans; neutral about government, foundations 6. Practices thought they could education patients to have trust | Moderate |
| Ross, *et al.,*  201350 | For PCPs, rate of laboratory testing increased over the time span (baseline 1041 tests/1000 patients/quarter, increasing by 13.9 each quarter) and shifted downward with HIE adoption (downward shift of 83, p<0.01). For specialist providers (baseline 718 tests/1000 patients/quarter, increasing by 19.1 each quarter, with HIE adoption associated with a downward shift of 119, p<0.01). Imputed charges for laboratory tests did not shift downward significantly in either provider group. For radiology testing, HIE adoption was not associated with significant changes in rates or imputed charges in either provider group. | Low |
| Rudin, *et al.,*  2009153 | To become established, HIE efforts must foster trust, appeal to strategic interests of the medical community as a whole, and meet stakeholder expectations of benefits from quality measurements and population health interventions. | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Rudin, *et al.,*  2011136 | Cross-sectional | What affects clinician use of HIE | Massachusetts | Hospitals and physician offices | **Interviews of clinician users and HIE staff** | October 2009-  February 2010 |
| Saff, *et al.,*  2010154 | Cross-sectional | Description of motivation, implementation and use of San Francisco Bay Area HIE | San Francisco Bay Area | 5 health organizations; 2,800 MDs;  900,000 patients; numerous labs; several IT vendors | **Database**  Varying types of clinical and administrative data - varies by site | Each medical center joined the HIE at a different time, dating from 2002 |
| Schabetsberger,  *et al.,* 2006172 | Prospective cohort | Describe evolution and use of system, problems. | Tyrol, Austria | Tiroler Landeskrankenan stalten, 6 hospital,  6,000 staff, 1,000  physician, 300,000  outpatient, 70,000  inpatient, 400 medical student health system | **Audit logs** | June 2003 and  October 2004 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Rudin, *et al.,*  2011136 | Massachusetts eHealth Collaborative (MAeHC) | All nontext portions of medical record. Could link directly from the EHR to existing HIE. Query-based exchange. Consent was 'opt-in'. | Mid-2007 | Clinician users and staff who implemented HIE |
| Saff, *et al.,*  2010154 | NR | Each medical center valued the HIE for different reasons; descriptions are provided | NR | 900,000 patients in the San Francisco and the East Bay |
| Schabetsberger,  *et al.,* 2006172 | Various | 1. Discharge summaries push to GP EHRs as text documents, 92+% electronically 2. Standalone web-based archive of hospital documents for nonaffiliated physician access | May 2002-October 2004 | Tyrol, Austria physicians |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Rudin, *et al.,*  2011136 | 15 clinicians and 2 HIE staff and 3 administrators | NA | None | None |
| Saff, *et al.,*  2010154 | 900,000 patients in San Francisco and the East Bay | None specifically stated; all patients included | None specifically stated; all patients included | None |
| Schabetsberger,  *et al.,* 2006172 | NR | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Rudin, *et al.,*  2011136 | Motivators and moderators of use | Qualitative | NA | **Qualitative C**ontent analysis |
| Saff, *et al.,*  2010154 | Lessons learned | Characteristics of each health system; this is a descriptive case study | NA | **Quantitative**  Descriptive |
| Schabetsberger,  *et al.,* 2006172 | System use | NA | NA | **Quantitative**  Descriptive |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Rudin, *et al.,*  2011136 | -Motivators were belief in improved quality of care, time savings, and reduced need to answer questions. Cost of care was not listed as a motivator.  -Motivation was moderated by missing data, workflow issues, and usability issues (too many clicks required to get to information).  -Missing data was attributed contributing providers not "locking their notes" on their EHR.  -Patient-related moderators were those who had trouble communicating, multiple comorbid illnesses, and who received care at multiple sites within but not outside HIE.  -Clinician-related moderators varied by specialty, use of paper and fax, and integration into workflow.  -HIE-related moderators were gaps in data from local nonparticipants, poor usability, and downtimes.  -Clinicians varied in how quickly they "locked" data for transfer into HIE. | Low |
| Saff, *et al.,*  2010154 | **Lessons learned**  -Moved from a competitive to collaborative model  -EMR/PHR integration  -Extensive testing required to ensure quality of data fit for use  -Physician education and engagement required/important | High |
| Schabetsberger,  *et al.,* 2006172 | -6% to 8% of approximately 40,200 discharge letters were sent out electronically  -Problems: corrupt data in physician database; differing implementations of standards (EDIFACT standard); independent, nonfederated patient index; 4 GPs and the psych ward had security concerns | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Schoen, *et al.,*  201295 | Cross-sectional | To explore the experiences of physicians in primary care with health reform policies. | Australia, Canada, France, Germany the Netherlands, New Zealand, Norway, Switzerland, The United Kingdom and the U.S. | Primary Care Practices | **Survey responses** | March - July 2012 |
| Shapiro, *et al.,*  201351 | Retrospective cohort | Measure incremental increase in number of frequent ED users identified when data from all EDs (using HIE) were compared with use of site-specific data only | New York City | 10 hospitals that participated in NYCLIX | **Log file**  NYCLIX data (which also included data from site-specific EMRs) | June 1, 2010-May 31,  2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Schoen, *et al.,*  201295 | NR | Electronic exchange of patient summaries and test results with doctors outside their practice. | NR | General practice and family practice physicians in all countries, as well as general internists and pediatricians in Germany and the U.S. |
| Shapiro, *et al.,*  201351 | 10 hospitals that participated in New York Clinical Information Exchange (NYCLIX); NYCLIX is a RHIO in NY City; data sent to NYCLIX by each participant organizations; master patient index links each patient across sites; NYCLIX staff was 'honest broker' and provided data. | New York Clinical Information Exchange (NYCLIX) | NR | All patients with ≥1 instance of  ≥4 ED visits within 30 days during study period |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Schoen, *et al.,*  201295 | **Primary Care Physicians Surveyed**  Australia: 500  Canada: 2,124  France: 501  Germany: 909  The Netherlands: 522  New Zealand: 500  Norway: 869  Switzerland: 1,025  United Kingdom: 500  U.S.: 1,012  Overall: 8,462 | Practicing physicians were randomly selected from public and private lists typically used in each country | NR | NR |
| Shapiro, *et al.,*  201351 | 924,675 ED visits by 591,632;  920,507 ED visits by 591,632 patients | All patients with ≥1 instance of  ≥4 ED visits within 30 days during study period | 4,168 visits because they occurred within 6 hours of a previous ED visit, which investigators decided a priori might represent clerical errors | EMR use without accessing HIE |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Schoen, *et al.,*  201295 | Ability to electronically exchange patient summaries and test results with doctors outside their practice | NA | NA | **Quantitative**  Survey, Chi2 tests |
| Shapiro, *et al.,*  201351 | -Number ED visits  -Number of patients experiencing these visits  -Average number ED visits per patient during 12 months  -Number patients frequent ED users (per definition)  -Number of ED visits accounted for by frequent users  -Average number visits per frequent user  -Increase in number of frequent users when estimated across HIE (vs. within each site) | -Gender  -Age | Cross-over visits (different EDs) | **Quantitative**  -Chi2  -Wilcoxon sign rank test |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Schoen, *et al.,*  201295 | **% of primary care physicians reporting HIE capabilities:**  Australia: 27  Canada: 14  France: 39  Germany: 22  The Netherlands: 49  New Zealand: 55  Norway: 45  Switzerland: 49  United Kingdom: 38  U.S.: 31  In the U.S. capacity for electronic exchange of patient information was concentrated in larger practices and those in integrated health systems (50% of physicians reported HIE vs. 23% of physicians not part of integrated practices p<0.05) | High |
| Shapiro, *et al.,*  201351 | Total visits: 924,675 (591,632 unique patients) After exclusion: 920,507 visits by 591,632 patients Mean ED visits/year: 1.6  When used only site-specific data only: 4,786 patients met criteria of frequent user (represented 0.8% of all users) Number of ED visits: 45,771  Mean visits/years: 9.6 (accounted for 5% of ED visits)  **HIE-wide results**  5,756 frequent ED users  20% increase in number of frequent user events identified 53,031 visits (6% of all ED visits)  Thus HIE data produced 16% increase in number ED visits that could be identified Frequent users more likely to be male: 51% vs. 45%, p<0.0001  Mean age higher: 40.7 vs. 37.9 years, p<0.0001 More had cross-over visits: 28.8% vs. 3%, p<0.0001 | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Sicotte and Paré, 2010168 | Multiple case studies | Describe the implementation and deployment of 2 large HIE projects. | Quebec, Canada | Case 1: 3 pediatric hospitals.  Case 2: Primary care network linking a public hospital to 10 private clinics. | **Interviews, observations, documents**  52 interviews (27 for Case 1, 25 for Case 2); all documents from the HIE project team, HIE organizations and vendors; and observations at HIE project meetings | January 2001 + 42 months (Case 1); May 2001 + 32 months  (Case 2) |
| Silvester and Carr, 2009114 | Before and after | Description of implementation - use of system. | Brisbane & Northern Territories of Australia | 239 GPs from 66 practices,  2 major public  hospitals, 3 large private hospitals, 11 allied health/ community based partners | **Database**  Registration, communication, and clinical database.  Clinical database contains socioeconomic status, medications, diagnosis, allergies, medical history, diagnostic results, care team members, unstructured documents | April 30, 2007-July  2008 |
| Soderberg, Laventure, and Minnesota, 201390 | Time Series | To monitor progress toward meeting the legislative requirement that all health care providers have an interoperable EHR by 1/2015. | Minnesota | Clinics | **Survey**  72 survey questions | February 15-March 15, 2013 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Sicotte and Paré, 2010168 | Case 1: 3 pediatric hospitals. Case 2: Primary care network linking a public hospital to 10 private clinics. | Case 1: large pediatric hospital, 2 community pediatric hospital, 4 pediatric clinics.  Case 2: public hospital, over 100 physicians at 10 private clinics.  Access to laboratory and imaging results. | Specific date unclear | Key informants description limited to HIE project staff and HIE users |
| Silvester and Carr, 2009114 | Name NR  239 GPs from 66 practices, 2 major public hospitals,  3 large private hospitals,  11 allied health/community based partners | Software developed by HealthConnect; web services, HL-7 messaging, extracts data from clinician's software package, interfaces seamlessly with clinician's software, uses Medicare Australia's public key infrastructure security certificates for authentication; patients 'opt-in'. | Prior to April 30, 2008; implemented iteratively to ensure success | Registered patients with chronic conditions, cared for at these sites |
| Soderberg, Laventure, and Minnesota, 201390 | Varies | Varies | Varies | 1,623 ambulatory clinics |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Sicotte and Paré, 2010168 | 52 interviews (27 for Case 1, 25 for Case 2) | NR | NR | NA |
| Silvester and Carr, 2009114 | 1,108 patients in population | None, other than stated in population and sample | None, other than stated in population and sample | Before implementation |
| Soderberg, Laventure, and Minnesota, 201390 | The response rate was 79%, with 1,286 clinics responding | Any location where primary or specialty care ambulatory  services are provided for a fee by ≥1 physician | NR | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Sicotte and Paré, 2010168 | Descriptive narrative only | NA | NA | **Qualitative**  Empirical observations were organized into narrative using a risk analysis framework |
| Silvester and Carr, 2009114 | -Frequency of use (number of events uploaded per patient)  -User access logs and patient registration growth rates and connection metrics  -User surveys  -Patient case studies | None | None | **Mixed methods**  -Descriptive summaries  -Qualitative analysis |
| Soderberg, Laventure, and Minnesota, 201390 | Exchanges with affiliated and unaffiliated hospitals | NA | NA | **Quantitative**  Descriptive statistics |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Sicotte and Paré, 2010168 | **Case 1:** 4 stages described: project planning with small part-time team; technical system with risks evolving; testing requiring de-scoping; piloting with user and technical challenges. Overall deliverable not reached, users discouraged and usage was low.  **Case 2:** 4 stages described: project planning with full-time staff, system integrator consultant and clinical champions; solicitation of user views and realistic understanding of context, participant contracts signed; system customization and testing, leveraging super-users; piloting, troubleshooting system performance issues. Overall view was successful with high usage. | Low |
| Silvester and Carr, 2009114 | -Mean events uploaded for each patient record during 12 months: 9.7  -Increased HIE use by nurses  -Number of patients registered increased: 474 (July 2007) to 1,320 (June 2008)  -Increased commitment to use  -Case studies demonstrated use prevented unplanned inpatient admissions  -Interest to adopt by others  **Improved staff perceptions in answers to 3 pre-post questions on 5-point Likert scale**  Improved understanding of system: 2 to 3 Improved sharing of information: 2 to 2.3 Impact on care delivery: 3 to 3.6  -2 patient-specific case studies showed improved use, communication, satisfaction  -Lessons learned included connectivity, interoperability, change management, clinical leadership, targeted patient involvement, information at point-of-care, and governance | High |
| Soderberg, Laventure, and Minnesota, 201390 | -54% exchange data with affiliated hospitals  -36% with unaffiliated hospitals  -Common challenges for HIE: limited capacity of others to exchange, lack of technical support or expertise, competing priorities, cost and privacy concerns | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Steward, *et al.,*  2012169 | Multiple case studies | Understand the dynamic capabilities that enabled the 6 demonstration projects of the Information Technology Networks of Care Initiative to implement HIE. | New York, New Jersey, California, Louisiana, New York | Hospital specialty clinics, support services, primary care clinics, testing sites, ED, outpatient and inpatient clinics, Office of Public Health, insurers, laboratory and pharmacy services | **Interviews**  Laboratory, diagnostic, medical, and service utilization; referrals; and ancillary care support, such as case management, counseling and testing, transportation, and substance use and mental health services. | NR explicitly but at 2 points in time: as the HIE were being developed and 1-2 years after the HIE became operational. |
| Swain, *et al.,*  201526 | ONC Data Brief | Summarize trends in HIE use in non-federal acute care hospitals from 2008-2014 | NA | NA | Data are from the American Hospital Association (AHA) Information Technology (IT) Supplement to the AHA Annual Survey. Since 2008, ONC has partnered with the AHA to measure the adoption and use of health IT in U.S. hospitals. | 2014 update |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Steward, *et al.,*  2012169 | 6 HIEs that were part of the Information Technology Networks of Care Initiative that included Bronx-Lebanon Hospital Center, Duke university; hospitals, the city of Paterson, Louisiana State University Health Care Services Division, NY Presbyterian Hospital, St. Mary Medical Center Foundation | Each of 6 projects implemented a different HIE. | NR | 111 project staff and IT specialists; staff from community-based organizations and public health organizations; users of HIE. |
| Swain, *et al.,*  201526 | Varies, as these data are from the AHA survey | Varies, as these data are from the AHA survey | NA | The survey was administered to 4,451 non-federal acute care hospitals, with a response rate of 60%. |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Steward, *et al.,*  2012169 | NR | NR | NR | Cross-site evaluation |
| Swain, *et al.,*  201526 | The survey was administered to 4,451 non-federal acute care hospitals, with a response rate of 60%. | The survey was administered to 4,451 non-federal acute care hospitals, with a response rate of 60%. | Federal and non-acute care hospitals | prior years |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Steward, *et al.,*  2012169 | Implementation outcomes | NA | NA | **Qualitative**  -Developed 16 coding topics  -Convergent and divergent perspectives examined within and across sites |
| Swain, *et al.,*  201526 | HIE use between hospitals and hospitals; HIE use between hospitals and outside providers;  Types of data exchanged (Labs, radiology, meds, clinical care summaries) | NA | A logistic regression model was used to predict the propensity of survey response as a function of hospital characteristics, including size, ownership, teaching status, system membership, availability of a cardiac intensive care unit, urban status, and region. Hospital-level weights were derived by the inverse of the predicted propensity. | Estimates considered unreliable had a relative standard error adjusted for finite populations greater than 0.49. Responses with missing values were assigned zero values. Significant differences were tested using p <  0.05 as the threshold. |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Steward, *et al.,*  2012169 | Found evidence for importance of 3 dynamic capabilities: information systems, reconfiguration capacity, and organization size and human resources. Reconfiguration capacity was most important. | Moderate |
| Swain, *et al.,*  201526 | Hospitals’ electronic health information exchange with hospitals or ambulatory care providers outside their organization increased by 85% from 2008 to 2014, and increased by 23% since last year (2013).  In 2014, 47 states and the District of Columbia had at least 60% or more of their hospitals electronically exchange key clinical data with outside providers. In contrast, in 2010, 10 states had 60% or more of their hospitals electronically exchange key clinical data with outside providers.  In 2014, state rates of hospitals’ electronic exchange of key clinical data with outside providers ranged from 42% to 100%; whereas in 2010, hospitals’ health information exchange with outside providers ranged from 24% to 67%  Approximately two-thirds of hospitals electronically exchanged laboratory results (69%), radiology reports (65%) and clinical care summaries (64%) with outside providers in 2014.  Close to six in ten (58%) hospitals exchanged medication history with outside providers. This is an increase of 176% since 2008 and an increase of 57% since 2013.  Summary:  More than three-quarters (76%) of non-federal acute care hospitals electronically exchanged laboratory results, radiology reports, clinical care summaries, and/or medication lists with any outside providers. This represents an 85% increase since 2008 and a 23% increase since last year. Close to seven in ten hospitals (69%) electronically exchanged health information with ambulatory providers outside of their organization, representing a 92% increase since 2008 and a 21% increase since 2013. | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Thorn, Carter, and Bailey, 2014130 | Multiple site case studies | To explore views of emergency physicians having access to HIE, about their access of and use of HIE data | NR | ED in 4 hospitals, private and public settings | **Interviews**  Individual unstructured interviews, audio recorded and transcribed | NR |
| Tripathi, *et al.,*  2009123 | Multiple case studies | Description of initiative, collaborative design and lessons learned;  also includes opt in data by consumer | Massachusetts | 3 communities chosen to pilot HIE, Brockton (diverse community), Newburyport (affluent), North Adams (rural) | **Focus groups, documents** Community steering committees, MAeHC, stakeholders; consumer focus groups | Began in 2005 Duration not clear |
| Tzeel, Lawnicki, and Pemble, 201152 | Retrospective cohort | Assess the association of HIE use on health care costs | S.E. Wisconsin (Milwaukee County) | EDs in 5 health systems in a county | **Log file**  WHIE data - health plan member with ED encounter when HIE access occurred.  Humana claims data - costs and utilization of ED encounter. | December 2008-  March 2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Thorn, Carter, and Bailey, 2014130 | HIE name NR but may be MSeHA Regional HIE operational for 4 years, linking over 450 providers in 15 clinics and 9 major hospitals serving a population of 1 million | Data in HIE NR  Decentralized, query-based exchange. Consent was 'opt-out' | NR | ED physicians in 3 urban settings |
| Tripathi, *et al.,*  2009123 | Massachusetts eHealth Collaborative (MAeHC) | NR | NR | Number of participants in committees and stakeholders involved not stated |
| Tzeel, Lawnicki, and Pemble, 201152 | Wisconsin Health Information Exchange (WHIE) | Links 5 health systems in the county. Access to patient demographics, chief complaint, allergy, primary care provider, diagnosis, meds, procedures, encounter date & location. | December 2008 | Commercial, fully insured members of Humana health plan (denominator); members in the WHIE database having  ≥2 ED visits |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Thorn, Carter, and Bailey, 2014130 | N=15 physicians from 4 urban hospital systems having  <10% usage of HIE. Cross section of public and private hospitals. 1 Level I Trauma center. 2 of 4 settings had not implemented EHRs | Full or part-time physicians working regularly scheduled ED shifts. Purposeful selection of 2 because of a 4-year history of HIE use. Rest recruited with "theoretical sampling" | NR | NA |
| Tripathi, *et al.,*  2009123 | NA | NA | NA | NA |
| Tzeel, Lawnicki, and Pemble, 201152 | Test group: 428 members with ED visits having an HIE query  Control group: 1,054 members with ED visits with no HIE query.  Propensity score matching for test group (N=326) with HIE database query in all ED visits vs. control group (N=325) with HIE database not queried in any ED visit. | ≥1 year continuous insurance coverage with health plan | <6 months coverage before program started or <3 months after start of program | Pairs matched for age, gender, and costs for net care per participant per month prescriptions, inpatient, outpatient, ED, and physician. |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Thorn, Carter, and Bailey, 2014130 | Descriptive narrative only | NA | NA | **Qualitative**  Thematic, constant comparative analysis of narrative |
| Tripathi, *et al.,*  2009123 | -Descriptive narrative only  -Type of patient consent  -Type of data to share | NA | NA | **Qualitative** |
| Tzeel, Lawnicki, and Pemble, 201152 | -Comparison of net costs and ED costs per participant  -Comparison of top 5 ED procedures in test group vs. matched control 1 year before and 1 year after the first ED visit | Pairs matched for age, gender, and costs for net care per participant per month prescriptions, inpatient, outpatient, ED, and physician | NR | **Quantitative**  Matched pairs t-tests |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Thorn, Carter, and Bailey, 2014130 | **Themes**  -Users varied in their HIE use. Stated influencers including trouble accessing system, acuity of patient or history not available, team members' ability to access.  -HIE use affected decisions sometimes, for specific cases (e.g. drug seekers); often HIE use did not affect decisions  -Use was negatively affected by access challenges, separate login, variability in data being pertinent, absence of data types or data on specific patients, user design flaws, and lack of technical support.  -Benefits with usage included reducing redundant testing, more accurate history, reducing faxing, knowledge of primary care provider name  -Barriers to usage included continued practice of defensive medicine, desire for autonomy, changing the culture, belief HIE does not alter decisions, health system competition, and reduced revenue, workflow disruption. | Low |
| Tripathi, *et al.,*  2009123 | **Discussion of experience/lessons learned**  -Decision on consent: opt in chosen due to state law stricter than federal HIPAA law; use of a centralized data repository; and consumer feedback.  -Data shared: 3 communities agreed on what to share - all EHR except text notes, consult letters and scanned reports.  -Consumer focus groups identified themes to drive HIE/opt in: promote convenience and costs, promote with providers, say benefits up front, confront risks, use professional marketing  -Consumer opt In across 2 smaller communities: 88% and 92% | NA |
| Tzeel, Lawnicki, and Pemble, 201152 | **Unadjusted:** ED costs in test group changed $1,068 to $999 from 1st to subsequent visit vs. control group changed $1,043 to $1,157 **Adjusted for propensity matching:** Net costs (per participant per month) in test patients with higher net costs overall in and subcategories  ED costs: $29 less in test patients from first visit vs. subsequent visits.  Top ED procedures: 4 of 5 were reduced in test group (lab, radiology, CT, EKG) | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Tzeel, Lawnicki, and Pemble, 201253 | Retrospective cohort | Assess the association of HIE use on hospital admissions | S.E. Wisconsin (Milwaukee County) | EDs in 5 health systems in a county | **Log file**  WHIE data - health plan member with ED encounter when HIE access occurred.  Humana claims data - costs and utilization of ED encounter. | December 2008-  March 2010 |
| Unertl, *et al.,*  2013170 | Multiple case studies | To investigate how technology and health system coevolve to reduce information fragmentation and improve care coordination (Extension of Unertl 2012 study) | Memphis, Tennessee region | 6 EDs and 8 ambulatory clinics | Interviews, observations Direct observation at 14 sites, informal interviews at sites, 9 semi structured telephone interviews | January-August 2009 |
| Unertl, Johnson, and Lorenzi, 2012119 | Multiple site case studies | To understand the interaction between HIE and workflow. How have sites integrated HIE into existing approaches?  Are there common HIE workflow patterns across sites?  How do providers incorporate HIE into clinical practice? | Memphis, Tennessee region | 6 EDs and 8 ambulatory clinics | **Observations, interviews** Direct observation (180 hours) at 14 sites, informal interviews at sites, 9 semi structured telephone interviews with physicians, nurses and IT management | January-August 2009 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Tzeel, Lawnicki, and Pemble, 201253 | Wisconsin Health Information Exchange (WHIE) | Links 5 health systems in the county. Access to patient demographics, chief complaint, allergy, primary care provider, diagnosis, meds, procedures, encounter date & location. | December 2008 | Commercial, fully insured members of Humana health plan (denominator); Members in the WHIE database having at least 2  Emergency Dept. (numerator) was the study population. |
| Unertl, *et al.,*  2013170 | MidSouth eHealth Alliance (MSeHA), regional HIE around Memphis includes majority of large hospitals and 2 safety net clinic systems. | HIE structure from Vanderbilt University. Data on >1 million patients includes test results, imaging, discharge summaries, diagnosis codes and claims data. Opt out model. | 2004 | NR |
| Unertl, Johnson, and Lorenzi, 2012119 | MidSouth eHealth Alliance (MSeHA), regional HIE around Memphis includes majority of large hospitals and 2 safety net clinic systems. | HIE structure from Vanderbilt University. Consolidated data from multiple hospital emergency departments and community- based ambulatory clinics. Decentralized, query-based exchange. Data on >1 million patients includes test results, imaging, discharge summaries, diagnosis codes and claims data. Opt out model. | 2004 | NR |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Tzeel, Lawnicki, and Pemble, 201253 | Test group: 428 members with ED visits having an HIE query  Control group: 1,054 members with ED visits with no HIE query  Matched pairs: 325 | ≥1 year continuous insurance coverage with health plan | <6 months coverage before program started or <3 months after start of program | Pairs matched for age, gender, and costs for net care per patient per month, prescriptions, inpatient, outpatient, ED, and physician. |
| Unertl, *et al.,*  2013170 | NA | NR | NR | NA |
| Unertl, Johnson, and Lorenzi, 2012119 | NA | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Tzeel, Lawnicki, and Pemble, 201253 | -Admissions per 1,000 members, at time of ED visit (1st, 2nd visit)  -Conditional probability of admission at ED visit (1st, 2nd)  -Bed days per 1,000 members  -Average length of stay | Pairs matched for age, gender, and costs for net care per patient per month, prescriptions, inpatient, outpatient, ED, and physician | NR | **Quantitative**  Chi2 |
| Unertl, *et al.,*  2013170 | Descriptive narrative only | NA | NA | **Qualitative**  Open-ended grounded theory analysis, followed by the application of the Information Ecology Framework to structure additional analysis |
| Unertl, Johnson, and Lorenzi, 2012119 | Descriptive narrative only | NA | NA | **Qualitative**  Grounded method using open coding, and framework-focused axial coding. |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Tzeel, Lawnicki, and Pemble, 201253 | **Adjusted for propensity matching**  Admission/1,000 members (1st to 2nd ED visit): 269 to 664 for test group vs. 321 to 555 for control group Probability of admission higher at 1st ED visit in control group, and higher at 2nd ED visit in test group Test group had 771 fewer bed days/1,000 members and lower length of stay than control group  Post–propensity matching analysis showed that test group had 199 more admissions per 1000 members than control group, these admissions might have been more appropriate. Test group admissions resulted in less time spent as inpatients and by average length of stay (4.27 days per admission for all admissions and 0.95 days per admission when catastrophic cases removed). | Low |
| Unertl, *et al.,*  2013170 | -All sites had coexisting use of HIE and manual processes to access information  -Observations were used to map 5 Info Ecology Framework components to a newly developed "Regional Health Information Ecology": 1. system - HIE to reduce information silos; 2. locality - sites had distinct local context; 3. diversity - staff had varied roles with varied HIE processes; 4. keystone species - info consumers, who used data for varied reasons; info reservoirs, people who played formal and informal roles; exchange facilitators, who assisted others and bridged gap between consumers and reservoirs.  -Paradox observed: providers describe HIE useful, regardless of use frequency ('when we use it, it's great"); but, provider belief that HIE not being used to full potential.  -Examples of impact were identified using their model: a. reduce fragmentation of information; b. reduce time to obtain information; c. increase provider awareness of patient-health system interactions (e.g., drug seeking) | Low |
| Unertl, Johnson, and Lorenzi, 2012119 | **Cross organizational patterns; 2 models identified**   1. Nurse workflow: prompted by patient reporting recent hospitalization event during intake, HIE access by nurse or assistant, printed discharge summary, added to chart 2. Physician workflow: HIE accessed by provider (doctor or nurse practitioner) for greater reasons beyond hospitalization; HIE access occurred at various points of care; HIE review of more information including history   -Other observations: clerks tracked biopsy results; workflow patterns evolved over time, due to factors such as access policies or staffing changes; residents logged into other EMR due to lack of HIE access  -Reasons to access HIE: visit to another hospital; issues of patient trust; communication challenges; referrals | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Vest and Jasperson, 2012103 | Case control | How does HIE access vary by job type and organization in an indigent care HIE in central Texas? | Austin, Texas | Indigent patients and facilities that care for them | Log files from clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, public and private clinics, government agencies (federally qualified health centers) | January 2006-June 2009 |
| Vest, 200954 | Retrospective cohort | Test the hypotheses that HIE information access reduced ED visits and inpatient hospitalizations for ambulatory care sensitive conditions among medically indigent adults. | Central Texas | 18 members in HIE (I-Care):  hospital systems, public and private clinics, and governmental agencies operating federally qualified health centers | **Log file**  Demographic, clinical information, diagnoses, medication orders, prior visits, payer sources for uninsured patients. | January 1, 2005-  June 30, 2007 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Vest and Jasperson, 2012103 | Integrated Care Collaboration (ICC) | Clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, clinics, government agencies (federally qualified health centers) | HIE 1997; I-Care  database 2002, 3.1 million encounters, 600,000 individuals | Indigent people, not Medicare |
| Vest, 200954 | 18 members in HIE: hospital systems, public and private clinics, and governmental agencies operating federally qualified health centers | Each site contributes patient electronic data to I-Care through secure electronic interfaces. In turn, each location may access data from I-Care at a secured website. | HIE 1997; I-Care  database 2002, 3.1 million encounters, 600 thousand individuals | Uninsured 18 to 64 years old and excluded encounters at the public mental health provider and Planned Parenthood |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Vest and Jasperson, 2012103 | 105,705 unique user sessions | User session as all system viewing activity (i.e., screens accessed) by a given user for a given patient on a given date. | Could not classify 35 user sessions (0.03%) and excluded them as too few for meaningful analysis. | None |
| Vest, 200954 | 3463 HIE access, 2651 No access; 6,114 included out  of 600,000 individuals, 3.1 million encounters | Uninsured 18 to 64 years old | Encounters at the public mental health provider and Planned Parenthood. Also excluded encounters related to accidents, pregnancy, labor and delivery. | Persons with no information accessed in the HIE vs. those with accessed information |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Vest and Jasperson, 2012103 | Administrative vs. clinical vs. repetitive vs. mixed use | -User types and unique job titles  -Workplaces | Same day, within a week, within a month, within a year, longer than a year, or no encounter | Cross tabulation to compare usage categories with A) job categories, B) workplace categories, and C) timing of usage categories. Associations evaluated between types of usage and these variables using the Pearson chi2 test of independence |
| Vest, 200954 | -ED visits and inpatient hospitalizations due to ambulatory care sensitive hospitalizations  -Logs document the user’s location, the patient viewed, the date accessed, and information screen viewed | -Predictors of HIE use (e.g., demographics, number of chronic conditions, prior ED visits or hospitalizations)  -HIE for predicting ED and hospitalizations | -Clinical, demographic, comorbidity, service measures  -Created a chronic condition index by summing chronic conditions (diabetes, hypertension, asthma, ischemic heart disease, hypercholesterolemia and stroke) | **Quantitative**  -Frequencies and percent  -Multiple logistic regression adjusting for confounders |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Vest and Jasperson, 2012103 | ->6/10 sessions users accessed the system in a minimal fashion  -Average pattern length: 2.89 screens  -Shortest pattern length included only 1 screen and the longest pattern involved 83 screens  -65.7% of all user sessions had a pattern length of only 2 screens  -Use was overwhelmingly (93.9%) administrative, roughly evenly distributed across workplaces but for dominance of hospital accesses (37.6%) and about half same day, a fifth first week, a fifth over the year, 1/10 unassociated with encounter; usage type associated with job category: admin, nurse, pharmacy, physician, public/mental health, social services; most clinical access in ED, and public/mental health  -297 users, 113 unique job titles, collapsed into administration (59% of users), nurse (~6% of users), pharmacy (~1% of users), physician (~12% of users), public health (~6% of users), and social services (~15% of users)  -Workplaces: ambulatory care (~9% of users), ED (~18% of users), children’s ED (3% of users), hospital (53% of users), public health agency (8% of users), or mental health agency (8% of users).  -In more than 6 out of 10 sessions, users accessed the system in a minimal fashion.  -Average pattern length was 2.89 screens (range 1-83 screens); 66% of all user sessions had a pattern length of only two screens. | Low |
| Vest, 200954 | **Adjusted OR of HIE information access**  Increasing age: 1.03; number of chronic conditions: 1.13; ≥1 prior year clinic visit: 1.63; a prior year ED visit: 1.96; and being hospitalized in 2004: 2.02  All levels of HIE information access were associated with increased expected ED visits and ambulatory care sensitive hospitalizations vs. no information access  -HIE was used more for those that used the system more, or were sicker.  -HIE was not accessed for 43% of individuals  -Ultimately, these results imply that HIE information access did not transform care in the ways many would expect. Expectations in utilization reductions, however logical, may have to be reevaluated or postponed.  -Patients with HIE information accessed one time had an 83% higher expected count of ED visits. | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Vest, 2010155 | Cross-sectional | Which nontechnological and technological factors may still hamper the existence of effective HIE even in light of the substantial financial incentives offered via the HITECH Act? | U.S. | U.S. Hospitals | **Surveys**  2008-2009 HIMSS Analytic Database; AHA Annual Survey 2007 | After 2009 |
| Vest and Miller 201164 | Retrospective cohort | Do hospitals using HIE have higher reported communication among health professionals and/or higher patient satisfaction? | U.S. | Hospitals | **Log file**  -2008-2009 HIMSS Analytic Database  -AHA Annual Survey 2007  -Review of all HIE facilitating efforts in U.S., linked to HCAHPS survey | After 2009 |
| Vest, *et al.,*  2011105 | Case control | Do hospitalizations, ED visits, and other factors predict HIE use for indigent adults? | Austin, Texas | Indigent patients and facilities that care for them | Log files from clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, clinics, government agencies (federally qualified health centers) | January 2006-June 2009 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Vest, 2010155 | Various | Various | Various | U.S. |
| Vest and Miller 201164 | Various | Various | Various | U.S |
| Vest, *et al.,*  2011105 | Integrated Care Collaboration (ICC) | Clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, public and private clinics, government agencies (federally qualified health centers) | HIE 1997; I-Care  database 2002, 3.1 million encounters, 600,000 individuals | Indigent people, not Medicare |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Vest, 2010155 | 4,830 hospitals in AHA and HIMSS-AD | In AHA or HIMSS survey | NR | Operational vs. adopted not operational vs. not adopted |
| Vest and Miller 201164 | 3,278 hospitals, 340 adopted, 351 implemented HIE | Participated in AHA or HIMSS survey | Too few observations (HCAHPS survey responses <100) | Adopted vs. implemented vs. none |
| Vest, *et al.,*  2011105 | 271,305 encounters (111,482 unique patients) from 10  facilities; (Vest 2009 was 3,463 HIE access, 2,651 no  access; 6,114 included out of 600,000 individuals, 3.1 million encounters) | All ED encounters among patients ages 18 to 64 that occurred between January 1, 2006 and June 30, 2009 | Excluded any ED encounters occurring at facilities before the hospital had an authorized user of the I-Care system. | None |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Vest, 2010155 | HIE adoption (operational, implementing, nonadapter) | Technological readiness (number of live applications, CCHIT EMR), vertical integration, horizontal integration, high/low information needs, inpatient admissions, market competition, uncompensated care burden, primary care rate, health system/network size | -Classic markers of innovation adoption considered covariates  -Total number of beds (size)  -Average days cash on hand from all sources  -Nonmetropolitan location  -General innovativeness was measured both as academic affiliation and specialization, the standardized total number of professional job categories | **Quantitative multivariate analysis**  -Begins with, or assumes, TOE framework: technological, organizational, and environmental; missing values imputed from earlier versions of AHA Guide and HIMSS-AD  -Logistic regression on adoption, logistic regression on operational |
| Vest and Miller 201164 | -Percentage of patients who reported their doctors and their nurses always communicated well  -Percentage of patients who would definitely recommend the hospital  -Percentage of patients who gave the hospital a high global rating (≥9 on a 10- point scale) | Level of HIE participation: implemented (active sharing); adopted (participating but not yet sharing); or none | Organizational variables associated with HCAHPS outcomes; other AHA organizational characteristics, overall level of automation in hospital, external factors such as state regulations | **Quantitative**  -Least squares regression  -Propensity score adjustment |
| Vest, *et al.,*  2011105 | No usage vs. basic usage vs. novel usage (more screens) | -Familiarity  -Complexity  -Mental/substance use  -Frequency of prior utilization elsewhere  -Time constraints | Assessed with multivariate analysis, otherwise NR | **Quantitative multivariate** Logistic regression with adjustment for by-patient clustering |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Vest, 2010155 | -59 operational and 123 nonoperational exchanges  -453 hospitals operational HIE, 446 adopted HIE, and 3,931 had not adopted HIE; sample includes more general service type and fewer for-profit hospitals than the more nationally representative AHA survey  -Overall, 81.4% of hospitals had not adopted or implemented HIE  -Adjusted regression OR of adoption for not for profit: 8.57; public: 9.53; number operational application: 1.02; physician portals: 1.38; network membership: 1.33; ED visit: 1.01' primary care MD in HRR: 1.03  -Adjusted regression OR of implementation: network membership: 1.96; hi competition: 0.15; primary care MD: NS | Low |
| Vest and Miller 201164 | -10.4% had adopted  -10.7% had implemented HIE  -Implemented hospitals, but not adopted hospitals, had higher nurse communication (0.75 increase [95% CI, 0.13 to 1.38]), global satisfaction (0.82 [95% CI, 0.01 to 1.64]), and would recommend scores (1.34 [95% CI, 0.41 to 2.27]), and a trend toward higher doctor communication scores (NS after controlling for confounders); results attenuated in propensity score analysis  -Communication: higher for smaller hospitals, rural hospitals, fewer Medicaid patients, higher nurse/patient ratios  -Satisfaction: higher for nonprofit, smaller, Midwest or south, fewer Medicaid patients, higher nursing ratios | Low |
| Vest, *et al.,*  2011105 | -No access of system for 97.7% of encounters  -Users accessed the I-Care system for 2.3% of the 271,305 encounters  -Basic usage (2,527) 41.1% of instances  -Sample was predominately Hispanic, younger, and a higher proportion of charity care recipients  -Adjusted OR of access for African American and Hispanic: 0.76 to 0.89; higher for unknown or charity care; but mainly for unknown payer: 4.7 vs. 2.6; access higher for more ED visits; hospitalizations: ~1.25-1.5 (from graph)  -Access lower for alcohol use, injury, poisoning, unfamiliar patient, busier than average day | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Vest, *et al.,*  2011104 | Case control | Do hospitalizations, ED visits, and other factors predict HIE use for indigent children? | Austin, Texas | Indigent patients and facilities that care for them | Log files from clinical data repository (Indigent Care Collaboration of Austin, Texas safety net providers founded 1997); 18 hospitals, clinics, government agencies (federally qualified health centers) | January 2006-June 2009 |
| Vest, *et al.,*  2012103 | Case control | Use of HIE in 2 ambulatory indigent clinics without EHRs, and patient factors associated with this use. | Austin, Texas | 2 ambulatory clinics serving indigent people, part of nonprofit hospital system, 10,550-12,250  encounters/year | Log files from clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, public and private clinics, government agencies (federally qualified health centers) | January 2006-June 2009 |
| Vest, Campion Jr., and Kaushal, 2013156 | Cross-sectional | Identify the strengths and weaknesses of organizational models to achieve exchange, and what can be done to ensure the sustainability and effectiveness o | New York State | HEAL-NY (HIE  promotion legislation), HITEC (academic collaborative performs evaluations) | **Interviews**  Semi structured interviews with selected experts | March - June 2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Vest, *et al.,*  2011104 | Integrated Care Collaboration (ICC) | Clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, clinics, government agencies (federally qualified health centers) | HIE 1997; I-Care  database 2002, 3.1 million encounters, 600,000 individuals | Indigent people, not Medicare |
| Vest, *et al.,*  2012103 | Integrated Care Collaboration (ICC) | Clinical data repository (Indigent Care Collaboration of Austin, Texas safety network providers founded 1997); 18 hospitals, clinics, government agencies (federally qualified health centers) | HIE 1997; I-Care  database 2002, 3.1 million encounters, 600,000 individuals | Indigent people, not Medicare |
| Vest, Campion Jr., and Kaushal, 2013156 | Various | Various | Various | New York State |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Vest, *et al.,*  2011104 | 179,445 encounters | All ED encounters among patients <18 years occurred between January 1, 2006 and  June 30, 2009 and had parental consent | Excluded any ED encounters occurring at facilities before the hospital had an authorized user of the I-Care system. | None |
| Vest, *et al.,*  2012103 | 39,447 encounters 6,393 patients | Age 19-64 years Austin metro area, consent to inclusion | Children (different utilization) or ≥65 years (Medicare) | None |
| Vest, Campion Jr., and Kaushal, 2013156 | 17 of 21 invited HIE experts | Selected to represent public, private, leaders, participators, policymakers | None stated | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Vest, *et al.,*  2011104 | No usage vs. basic usage vs. novel usage (more screens) | 3 factors as indicative of uncertainty that creates an information need: comorbidity, prior utilization, and unfamiliarity with the patient | NR | **Quantitative multivariate** Logistic regression with adjustment for by-patient clustering |
| Vest, *et al.,*  2012103 | Encounter level or retrospective usage | -Age  -Gender  -Race  -ED visits over 3 months  -Hospitalization over 12 months  -Fragmentation (N of clinics -1)  -Payer (Medicaid or not)  -Charlson comorbidity  -Independent mental health/substance abuse comorbidity  -AHRQ chronic conditions indicator definitions | Assessed with multivariate analysis, otherwise NR | **Quantitative multivariate** Primary care encounter: unit of analysis; multinomial regression, clustered to account of unit of analysis, adjusted for confounders |
| Vest, Campion Jr., and Kaushal, 2013156 | NA | NA | NA | **Qualitative**  Semistructured interview exploring issues from literature, open independent coding and comparison by 2 investigators, consensus; [no triangulation of data or analysis, no member check] |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Vest, *et al.,*  2011104 | -System accessed: 15,586 of 179,445 encounters (8.7%)  -OR of basic HIE access for >1 year old vs. ≤1 year old: ~1.5 (from graph); lower for race unknown; higher for payer unknown; PC visits within 12 months: ~1.5 (from graph); ED visits within 12 months: 1.5-2 (from graph); hospitalized: 1.3; number of diagnoses: 1.05; unfamiliar: 0.46; busier than average: 0.65  -OR of novel HIE access for >1 year old vs. ≤1 year old: ~1.3; NS for race unknown; higher for payer unknown; PC visits within 12 months:  ~2 (from graph); NS for ED visits within 12 months; hospitalized: 1.15; number of diagnoses: 1.05; unfamiliar: 0.19; NS busier than average | Low |
| Vest, *et al.,*  2012103 | -Access for 21% of encounters  -7,101 encounter based, 1,227 retrospective  -Adjusted OR for association with access for female: 1.12; >40 years: 1.16; chronic disease: 1.19; ED visit last 3 months: 1.13;  -Retrospective access, same 4 factors plus hospitalized last 4 months OR 1.33 and fragmentation OR 1.52 | Low |
| Vest, Campion Jr., and Kaushal, 2013156 | Themes: **(A) HIE is a public good; (B) challenges** (1) financial challenges include upfront costs, discordance between investors and beneficiaries of technology "how to make that savings accrue to us and not to the payers.”; opportunity cost of lost revenue and lack of ROI "from a business perspective, HIE is kind of a bad idea. Why would we send out patient information elsewhere? We want to do it, we think it’s necessary for better care of the patient, but we’ll lose money by doing it.”" (2) governance because "Federal, state, and private representatives were fairly unanimous in their opinions that the functioning of RHIOs was not a technical issue" and the necessity of trust;  (3) mismatch of geographical model with reality of large integrated multistate delivery systems; **(C) alternative**s include Direct (lightweight, treatment focused, lower organizational overhead; enterprise RHIOs, e.g.. "he hospital systems, they are the RHIO and they don’t want to play with anybody else because they basically have quasi monopolies and cartels.” and don't need outside connection or support; Vendor models likely but suboptimal; any of these not c/w state intent; **(D) Sustainability** quixotic, aims are contrary to market, contradiction of " tension between providing a public good with little market incentives and operating like a private business"; alternatives: grow exchange effort, specify a focus, evolve as an organization | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Vest, *et al.,*  2013102 | Case control | Display and analyze the pattern of radiology report requests among organizations participating in an HIE, and identify the patient and provider factors associated with use of a HIE system to access radiology report | Western New York State | Nonprofit RHIO working with Hospital systems, reference laboratories, radiology groups, insurance providers, and county offices | Log files, RHIO information about job title, job type, and location, and claims data. | The log file was limited to patients 18 years and older and reflected patient encounters from January 2009-March 2011 |
| Vest, *et al.,*  201456 | Retrospective cohort | Examines the hypothesis that usage of an HIE system reduces the odds that a patient in the ED will be hospitalized. | Rochester, New York | HEAL NY  legislation, statewide HIE initiatives | **Log file**  Claims files from 2 health plans that insure more than 60% of the area population, log files of usage, RHIO roster of users | 2009-2010 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Vest, *et al.,*  2013102 | Rochester RHIO | Commercial query-based web portal product, which includes patients’ discharge summaries, prior diagnoses, radiology reports, medication history, and payer information. Both radiology reports and images are accessible within the HIE system and are typically available in near-real time after signoff. Imaging studies are accessible only if the user first views the radiology report. Our analysis is limited to the viewing of reports only. | NR | Patients in health system in western New York |
| Vest, *et al.,*  201456 | Rochester RHIO | >70 organizations in 13 county regions of western New York. Web-based portal that includes discharge summaries, diagnoses, radiology reports and images, medication history, and payer information | Fully operational in March 2009 | 1,318 users accessed patient records in 156 different outpatient, emergency, inpatient, long-term care, and specialty care settings via a web portal. 7 EDs were included; 800,000 patients (>70% of the area's adult population) |

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| **Author, Year** | **N Sample Description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Vest, *et al.,*  2013102 | 29,528 radiology documents originating at 17 different source organizations, including hospitals and radiology practices. A total of 126 different practice locations viewed these documents. | Claims data only covers 60% of population, included consenting patients with ≥1 encounter in 6 months after consent | <18 years, not in health system (included 60% of pop, not the other 40%), had claims (64%, not the other 36%) | NA |
| Vest, *et al.,*  201456 | 1,5645 | Claims files for 65% of patients  ≥18 years with valid consent dates (n=198,067) who had ≥1 encounter with a provider registered to use the HIE system in the 6 months following their consent date. | None reported | HIE access vs. no HIE access (from log files) |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Vest, *et al.,*  2013102 | Radiology report access | -Demographics  -Encounter history  -User characteristics  -Insurance type  -AHRQ CCS ICD-9 codes  -Use of services in 30 days prior to access  -Claims for imaging procedures  -Health professional encounters | NR | **Quantitative multivariate**  Using network/graph analysis assessed the difference between the average number of connections among sources vs. user practice locations, as well as the average number of radiology documents exchanged by data sources vs. data users. Then (2) mixed effects logistic regression on 134,127 sessions, 64% linked to claims files, with some accounting for clustering by patient, user, workplace - report results without control for confounders, multiple comparisons problem |
| Vest, *et al.,*  201456 | Hospital admission via the ED Economic | HIE system use at the time of the ED visit, measured in a yes/no fashion | -Gender  -Age  -Payer  -Disease severity in the 12-month period  -Any primary care, specialty care, or ED visits in the 30 days after the index hospitalization (or up until the date of readmission) | **Quantitative**  Logistic regression models. The full model adjusts for all independent variables with patient age, the count of major aggregated diagnostic groups, and the number of prior hospitalizations treated as continuous variables, 4 sensitivity analyses to explore the robustness including physician effects and patient subgroup (sickest) effects |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Vest, *et al.,*  2013102 | **Network:** each source organization sent on average 971 (range: 6-8,002) documents to 49 (3-106) other organizations. User organizations accessed on average 49 (1-8,444) documents from 6 (1-17) source organizations. Algorithm suggests 11/17 source organizations represent a core set of data providers, including 8 hospitals and 3 stand-alone radiology sites. Thus the overall number of radiology reports retrieved in the outpatient setting was 16.9 times greater than the number of reports retrieved in the ED and inpatient settings combined (23,201 outpatients vs. 1,333 ED and 313 inpatients).  **Factors:** 86,152 user sessions with associated claims files represented the activity of 1,119 different users representing 145 different workplace locations. 86.4% were staff; physicians represented only about 4% of all sessions; overall 11.2% of sessions included access of radiology reports. | Low |
| Vest, *et al.,*  201456 | -ED visit within 6 months of consent: 15,645  -Of ED visits, HIE accessed: 2.4% (n=374)  -16/229 MDs used system  -OR of admission for Medicare: 2.02; Medicaid: 0.61; male: 1.47  -Adjusted OR of HIE access: 0.7; HIE access on same day as ED visit: 0.83 (95% CI, 0.55 to 1.25)  -Odds of an admission were 30% lower when the system was accessed after controlling for confounding (OR 0.70; 95% CI, 0.52 to 0.95)  -Annual savings in the sample was $357,000 | Low |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Vest and Issel, 2014157 | Cross-Sectional | To examine factors related to public health organizations data exchange capabilities | United States | State and local health departments | Surveys | 2007-2008 |
| Vest, *et al.,*  201455 | Retrospective cohort | To determine the association between usage of an HIE system post- discharge and 30-day same- cause hospital readmissions. | Rochester, New York | HEAL NY legislation, statewide HIE initiatives.  Outpatient | **Log file**  Claims files from 2 health plans that insure more than 60% of the area population, log files of usage, RHIO roster of users | 2009-2010 |
| Willis, *et al.,*  201367 | RCT | To evaluate 2 decision support interventions: patient adherence reports to providers and reports to providers and emails to care managers by comparing to usual care. | North Carolina | Outpatient | **Database**  EHR and claims as well as logs of contacts and cost/revenue data | -December 7, 2009-  December 6, 2010 was intervention period  -Followup for outcomes ended August 30, 2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Vest and Issel, 2014157 | Varies, any system that would allow data sharing | Varies | Varies | U.S. states |
| Vest, *et al.,*  201455 | Rochester RHIO | Web based portal that includes discharge summaries, diagnoses, radiology reports and images, medication history, and payer information, 38 healthcare organizations in 11 counties | Fully operational in March 2009 | 800 000 patients (>70% of the area's adult population) |
| Willis, *et al.,*  201367 | Northern Piedmont Community Care Network. Set up a system called COACH (Community- Oriented Approach to Coordinated Healthcare) | -Included 9 clinics and 5 hospitals  -Data collected by the system include: 1) administrative data  2) care management data; 3) claims/billing data ; 4) scheduling data; 5) clinical data; 6) data on communications | NR | Network Medicaid beneficiaries |

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| **Author, Year** | **N Sample Description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Vest and Issel, 2014157 | 44 states with representatives who responded to both surveys | Executive officer of local health department and state health officials | States missing data on either survey | Public health organizations that don't have the capacity to exchange data |
| Vest, *et al.,*  201455 | 196,314 patients, 11 hospitals (2/3 of sample) | ≥18 years, consented during 2009-2010, continuously enrolled in health plan, ≥1 encounter in 6 months following consent, (196,314 patients met these requirements). Only the patient's first hospital admission within the first 5 months after consent. Each patient appears in the dataset only once and each discharge could be followed for  ≥30 days. | <30 observations in the dataset (n=11) | HIE access vs. no HIE access (from log files) |
| Willis, *et al.,*  201367 | N=2219  739 to usual care 744 clinic reports  735 clinic reports and care manager notices | Patients with ≥1 of 6 targeted IOM priority conditions | Not continuously enrolled during the intervention period | Provider report vs. provider report and case manager event vs. usual care in which neither type of alert was delivered |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Vest and Issel, 2014157 | Bidirectional data sharing for childhood immunizations, vital records and reportable conditions | Organizational characteristics including size, structure, processes and IT readiness | None reported | Quantitative Multivariate Analysis |
| Vest, *et al.,*  201455 | Readmission within 30 days of discharge for the same cause as the index hospitalization | HIE system usage | -Gender  -Age  -Payer  -Disease severity in the 12-month period any primary care, specialty care, or ED visits in the 30 days after the index hospitalization (or up until the date of readmission)  -Described the index hospitalization site: hospital bed size, teaching status, affiliation with a multi-hospital healthcare system, and critical access hospital classification, case mix index derived from the relative values of diagnosis-related groups seen at the hospital | **Quantitative**  Random effects logistic regression models, a series of models adjusting for patient characteristics, then adding post- discharge utilization measures, and lastly including hospital-level characteristics. Controlled for potential hospital-level clustering using the index admission hospital as a random intercept. Then 2 sensitivity analyses. |
| Willis, *et al.,*  201367 | -Clinical outcomes including: medical adherence, outpatient, ED visits, and hospitalizations  -Care coordination costs/revenues  -Clinician satisfaction | Group assignment | None reported | **Quantitative**  Generalized estimating equation models that accounted for clustering by family |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Vest and Issel, 2014157 | Data sharing capacity varied by activity. 66% had capacity for Immunizations 30.2% for vital records and  18.9% for reportable conditions | Moderate |
| Vest, *et al.,*  201455 | -Readmitted within 30 days: 9.8% (668/6,807); 29.6% at a different facility; 394 had HIE access within 30 days after discharge, 20 (5.8%) readmitted; p=0.00113  -ED visits within 30 days post discharge: NS  -HIE access associated with lower readmissions: OR 0.43 (95% CI, 0.27 to 0.70)  -Primary care or specialty care associated with lower readmissions rates: ORs 0.48 and 0.67 in final model  -ED visits associated with higher rates: OR 9.3 in final model  -Accessing patient information in the HIE in the 30 days after discharge associated with a 57% lower adjusted odds of readmission (OR 0.43; 95% CI 0.27 to 0.70). Estimated annual savings in the sample from averted readmissions associated with HIE usage was $605,000. | Low |
| Willis, *et al.,*  201367 | **Control vs. reports vs. reports and email**  % medication adherence: 41.3% vs. 41.2% vs. 42.9%, p=NS; no differences between groups at 6 months Encounter rates of outpatient: 46.0 vs. 46.6 vs. 44.5, p=NS  Encounter rates of ED: 0.87 vs. 0.84 vs. 0.89, p=NS  Encounter rates of hospitalizations: 0.19 vs. 0.21 vs. 0.21, p=NS  -15% to 50% of reports were not available to providers at time of patient encounter  -Even when they had reports, clinicians did not always discussion medication adherence with patients | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| Winden, *et al.,*  201471 | Case series | To determine value of Epic Care Everywhere in an ED | Minneapolis, Minnesota | ED | **Observations**  Chart review, focus groups, survey | January-November, 2012 |
| Yeager, *et al.,*  2014137 | Cross-sectional | To examine the barriers and facilitators affecting the decision to participate in an HIE and, separately, which factors are affecting the use of HIE. | Louisiana | NR in this paper | **Interview** | March to April 2013 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| Winden, *et al.,*  201471 | Allina Health and local organizations using Epic | Directed transfer of Epic records to Allina ED | August, 2010 | All patients for whom CE used; focus groups of clinician users |
| Yeager, *et al.,*  2014137 | Louisiana HIE (LaHIE), statewide. Number of centers/settings not presented in this paper. | Louisiana HIE (LaHIE). LaHIE functions as a hybrid centralized and federated model, web-based platform for providers to share patient care continuity documents (commonly referred to as CCDs), laboratory results, and electrocardiogram results. | NR | Patients in Louisiana |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| Winden, *et al.,*  201471 | Focus groups: 49 clinicians in 4 hospitals; Survey: 118 of 408 ED staff; review of 1,488 notes where CE used | Focus groups: clinicians; Survey: ancillary staff; Notes: use of CE | Notes: CE not used | Focus group and survey: value for care; Chart review: tests avoided |
| Yeager, *et al.,*  2014137 | 16 Healthcare representatives from organizations interested in joining LaHIE but not yet enrolled (n=4), not interested in joining (n=4), or already enrolled (n=8) | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| Winden, *et al.,*  201471 | Focus groups: provided value for patient care, especially for avoiding duplicate testing and detecting drug-seeking behavior; Survey: provided value in patient care; Chart review: procedures avoided | Focus groups and survey: value for patient care; Chart review: procedures avoided | None | **Quantitative**  Survey, chart review |
| Yeager, *et al.,*  2014137 | Barriers to implementation of LaHIE as identified by interviews with health care representatives | NA | NA | **Qualitative, content analysis** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| Winden, *et al.,*  201471 | Focus groups: provided value for patient care, especially for avoiding duplicate testing and detecting drug-seeking behavior; Survey: 74% agreed provided value in patient care; Chart review: 560 procedures avoided in 237 notes out of 1,488 assessed | Moderate |
| Yeager, *et al.,*  2014137 | "Findings suggest that Meaningful Use requirements are a critical factor influencing the decision to participate in the HIE, specifically the mandate that hospitals be able to electronically transfer summary of care documents. Creating buy-in within a few large hospital networks legitimized the HIE and hastened interest in those markets. Fees charged by electronic health record (EHR) vendors to develop HIE interfaces have been prohibitive. Funding from the federal incentive program is intended to offset the costs associated with EHR implementation and increase the likelihood that HIEs can provide value to the population; however, costs and time delays of EHR interface development may be key barriers to fully integrated HIEs. State HIEs may benefit from targeted involvement of state health care leaders who can champion the potential value of the HIE" | Moderate |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| eHealth Initiative 2013 Report73 | Cross-sectional | To assess the status of data exchange in the U.S. | Nationwide | Any | **Survey responses** | 2013; comparison to  2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| eHealth Initiative 2013 Report73 | Various | 199 of 315 completed the survey; these were a mix of community data exchanges, statewide efforts, & healthcare delivery organizations. | Varies | 315 data exchange initiatives were identified |

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| **Author, Year** | **N Sample Description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| eHealth Initiative 2013 Report73 | -199 of 315 completed the survey; these were a mix of community data exchanges, statewide efforts, & healthcare (HC) delivery organizations.  -90 organizations self-identified as community-based HIEs; 45 as state; 50 as health care delivery organizations.  -There is no single dominant model for HIE; 125 organizations used a query model, 124 used secure electronic messaging; 111 used end-to-end integration; 84 used a combination of models.  -'Direct' is a standards-based protocol for securely exchanging data; 90 organizations use M117'Direct', mostly in transitions of care.  -Patient consent for data exchange generally remains an 'all-or-nothing' proposition, with 'opt-out' the most common consent model. | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| eHealth Initiative 2013 Report73 | -Number of initiatives reaching 'advanced stages of operation, sustainability or innovation (as defined by eHI's developmental framework)  -Number of years to become operational  -Trends in use since 2011  -Number of organizations self-identifying as community, state-, or HC delivery system  -Types of professionals most commonly providing and using data  -Types of data most commonly provided/viewed  -Number having hired personnel from ONC's Workforce Development Program (WDP)  -Protocol used for securely exchanging information  -Key Findings  -Issues for the future | NR | NR | **NR** |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| eHealth Initiative 2013 Report73 | 84 organizations had reached an 'advanced' stage of operation, sustainability, or innovation. Most took 2 years to become operational.  Among organizations responding in 2011 and 2013, 27 more had reached stages 5, 6, or 7 in 2013.  90 organizations self-identified as community-based HIEs; 45 as state-; 50 as HC delivery organizations.  Hospitals and Am Care providers are stakeholders most commonly providing/viewing data. Labs also commonly provide data. Community public health clinics commonly view data.  24 reported they had hired staff from the ONC's WDP, compared to only 3 in 2011.  'Direct' is a standards-based protocol for securely exchanging data; 90 organizations use 'Direct', mostly in transitions of care.  There is no single dominant model for HIE; 125 organizations used a query model, 124 used secure electronic messaging; 111 used end- to-end integration; 84 used a combination of models.  **Key Findings:**   1. Achieving interoperability with disparate information systems is a major concern; 68 initiatives have had to connect with more than 10 different systems; 2. To overcome interoperability challenges, exchanges would like to see standardized pricing and integration solutions from vendors; 3. Many exchanges are not sharing data with competing organizations; 4. Exchanges are focusing on functionalities to support health reform and advance analytics; 5. Patient engagement remains low amongst organizations exchanging data; 6. Patient consent for data exchange generally remains an 'all-or nothing' proposition, with 'opt-out' the most common consent model; 7. Since 2011, more initiatives have become more financially viable. However, hospitals and payers are still expected to fund most exchange activity; of the 51 that were NOT sustainable, 31 (of 51) receive more than 50% of their funding from the federal government and 22 report they are a state-HIE.   Overall, in 2011, 16 reported they were sustainable; in 2013, 35 reported they were sustainable. Organizations realize the precariousness of government funding and are trying to offer valuable services for a fee.  **Issues for the future:**   1. Interoperability concerns need to be addressed; 2. Health reform provides exchanges an opportunity to show value; 3. Patient engagement remains poor. | NA |

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| **Author, Year** | **Study Design** | **Study Purpose/Research**  **Question** | **Geographic**  **Location** | **Setting** | **Data Source(s)/ Evaluation**  **Data** | **Time Period of Data**  **Collection** |
| eHealth Initiative 2014 Report74 | Cross-sectional | To assess the status of data exchange in the US. | Nationwide | Any | **Survey responses** | 2013; comparison to  2011 |

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| **Author, Year** | **Name of HIE (Intervention)** | **Description of HIE (this will become Types)** | **Date HIE**  **Implemented** | **Population** |
| eHealth Initiative 2014 Report74 | Various | 199 of 315 completed the survey; these were a mix of community data exchanges, statewide efforts, & healthcare delivery organizations. | Varies | 315 data exchange initiatives were identified |

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| **Author, Year** | **N Sample description (if applicable)** | **Inclusion Criteria** | **Exclusion Criteria** | **Comparator or Comparison** |
| eHealth Initiative 2014 Report74 | -199 of 315 completed the survey; these were a mix of community data exchanges, statewide efforts, & healthcare (HC) delivery organizations.  -90 organizations self-identified as community-based HIEs; 45 as state; 50 as health care delivery organizations.  -There is no single dominant model for HIE; 125 organizations used a query model, 124 used secure electronic messaging; 111 used end-to-end integration; 84 used a combination of models.  -'Direct' is a standards-based protocol for securely exchanging data; 90 organizations use M117'Direct', mostly in transitions of care.  -Patient consent for data exchange generally remains an 'all-or-nothing' proposition, with 'opt-out' the most common consent model. | NR | NR | NA |

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| **Author, Year** | **Outcomes Measured** | **Independent Variables** | **Confounding Variables** | **Analysis Methods** |
| eHealth Initiative 2014 Report74 | -Number of initiatives reaching 'advanced stages of operation, sustainability or innovation (as defined by eHI's developmental framework)  -Number of years to become operational  -Trends in use since 2011  -Number of organizations self-identifying as community, state-, or HC delivery system  -Types of professionals most commonly providing and using data  -Types of data most commonly provided/viewed  -Number having hired personnel from ONC's Workforce Development Program (WDP)  -Protocol used for securely exchanging information  -Key Findings  -Issues for the future | NR | NR | NR |

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| **Author, Year** | **Results** | **Risk of**  **Bias** |
| eHealth Initiative 2014 Report74 | Who provides data: 112 hospitals, 100 Am Care providers, 56 labs, 52 community/public health clinics.  Who accesses data: 111 Am Care providers, 104 hospitals, 75 community/public health clinics, 65 behavioral or mental health providers. Key Barriers: 1) Cost and technical challenges are key barriers to interoperability; 2) Regulatory policies appear to have prompted increased use of core HIE services such as 'Direct', care summary exchange, and transitions of care; 3) Advanced initiatives are supporting new payment and advanced delivery models; 4) Sustainable organizations have replaced federal funding with revenue from fees and membership dues.  Key finding 1: Interoperability Challenges include costs of building interfaces, getting consistent and timely response from EMR vendors and interface developers, and technical difficulty of building interfaces. 112 organizations have had to construct multiple interfaces and 18 have had to construct more than 25 interfaces.  Suggestions for overcoming interoperability challenges include: 1) standardized pricing and integration solutions from vendors; 2) 'plug and play' platform; 3) federally mandated standards; 4) cultural changes in willingness to share data; 5) greater use among providers of consensus-based standards.  Key finding 2: Regulatory Policies prompt use of core HIE Services:  101 incorporate secure messaging into their models; 78 offer a 'Direct' address directory; more respondents are using 'Direct' for all given use cases (when compared to last year). 74 have met at least one Stage 2 Meaningful Use criteria. 7 stages of Development are delineated (see slide in report for detail);  Key finding 3: Advanced initiatives are supporting new payment & delivery models: 106 reported they have reached stage 6 (operating) or higher on the eHI's HIE maturity scale (an increase of 11% over 2013).  64 support an ACO; 52 support a PCMH; 21 support a State Innovation Model; 12 support a bundled payment initiative.  Key finding 4: Sustainable groups replace fed funding with fees and membership dues: 45 use fees to completely cover operational expenses; 38 use fees but need additional funding. 41 report that dues or fees are greatest revenue source; 89 believe dues or fees will eventually be their primary revenue stream.  Looking to the future:   1. Data exchange is reaching a point of stability and acceptance. 2. Organizations are settling on a set of core service offerings and a standard approach to sustainability (sub-bullet: despite expiration of large funding sources, radical changes in overall landscape are not evident); 3. As organizations mature, they will offer new and innovative services (public health has already leverages HIE; alert notification services may help ACOs to track patients); 4. Organizations are encouraged to work collaboratively to overcome remaining challenges (especially work with regional/community partners to avoid creating 'pockets' of exchange). | NA |

\* this is from billing data, not EHR

†one site dropped that didn't have comparable qualitative data.

A1c= glycated hemoglobin; AHA= American Hospital Association; AHRQ= Agency for Healthcare Research and Quality; aka= also known as; AMIE= Arizona medical information exchange; ANOVA= analysis of variance; BHIX= Brooklyn Health Information Exchange; CCD= continuity of care document; CCHIT= Certification Commission for Healthcare Information Technology; CCR= community care record; CCS= clinical classification software; CD4= HIV helper cell count; CDA = clinical document architecture; CDC= Centers for Disease Control and Prevention; CE= Care Everywhere; CEN= clinical event notification; CHIC RHIO= Carolina HIV information cooperative regional health information organization; CI= confidence interval; CIO= chief information officer; COACH= Community Oriented Approach to Coordinated Healthcare; CPT4= Current procedure Terminology; CT= computed axial tomography scan; DOD= Department of Defense; e= electronic; e.g.= for example; ebSML RIM= electronic business using extensible markup language registry information model; ebXML RS= electronic business using extensible markup language; ECCI= Electronic Clinical Communication Implementation Program; ED= emergency department; EDI= electronic data interchange; EDIFACT= electronic data interchange for administration, commerce and transport; eHIE= electronic health information exchange; EHR= electronic health records; EKG= electrocardiogram; ELRs = enhanced laboratory reports; EMR= electronic medical records; EMS= emergency medical services; e-OP= electronic outpatient appointment booking; EPIC= electronic privacy information center; et al.= and others; etc.= etcetera; EPR= electronic patient records; e-RR= electronic results reporting; EU27= 27 nations in the European Union; FITT= fit between individuals tasks and technologies; FUHN= Federally Qualified Health Center Urban Health network; FQHCs= federally qualified health centers; GDP= gross domestic product; GP= general practitioner; HC= Health Care; HCAHPS= Hospital Consumer Assessment of Healthcare Providers and Systems; HEAL = Health Care Efficiency and Affordability Law; HEAL NY= Health Care Efficiency and Affordability Law for New York; HEDIS= health care effectiveness data and information set; HIE= health information exchange; HIMSS= healthcare information and management systems society; HIMSS-AD= healthcare information and management systems society analytical database; HIO= Health Insuring Organization; HIPAA= Health Insurance Portability and Accountability Act; HITECH= Health Information Technology for Economic & Clinical Health Act; HL-7= Health Level 7; HL7; HMO= health maintenance organization; HRR= unadjusted hazard ratio; HRSA= `Health Resources and Services Administration; Id = Identifier; i.e.= that is; ICC= integrated care collaboration; ICD-9= Ninth Revision of the International Classification of Diseases; ICD-9-CM= International Classifications of Diseases, Clinical Modification; ICU= intensive care unit; IDS= integrated delivery system; I-EMS= Indianapolis Emergency Medical Services; IHIE= Indiana Health Information Exchange; IM & T=information management & technology; INPC= Indiana Network fro Patient Care; IOM= Institute of Medicine's; IQR= interquartile range; IS = information system; IT= information technology; KP= Kaiser Permanente?; LaHIE=Louisiana HIE; LaPHIE= Louisiana Public Health Information Exchange; LBNH= Long Beach Network for Health; LOINC= Logical Observation Identifiers Names and Codes; MAeHC= Massachusetts eHealth Collaborative; MANOVA= multivariate analysis of variance; MD= Doctor of Medicine; MEGAHIT= Medical Evidence Gathering Through Health IT; MHDC= Massachusetts Health Data Consortium; mL= milliliter; mm= millimeter; MN= Minnesota; MPI= master patient index; MRI= magnetic resonance imaging; MRSA= Methicillin Resistant Staphylococcus Aureus; MSeHA= MidSouth e-Health Alliance; N= sample size; NA= not applicable; NAMCS= National Ambulatory Medical Care Survey; NDC= National Drug Code; NE= northeast; NHIN= Nationwide Health Information Network; NLM= National Library of Medicine; NR= not relevant; NS= not significant; NY= New York; NYCLIX= New York Clinical Information Exchange; OLS= ordinary least squares; ONC= Office of the National Coordinator for Health Information Technology; OR= odds ratio; PBMs= pharmacy benefit managers; PC= primary care; PCP = primary care provider; PDF= portable document format; PHI= personal health information; PHR= personal health record; PPO= preferred provider organization; QUIS= Questionnaire for User Interaction Satisfaction; RCT= randomized, controlled trial; RHIE = regional health information exchange; RHIO= regional health information organization; RLS= record locator service; RNA= ribonucleic acid; RR= relative risk; SCR= summary care record; SD= standard deviation; S.E.= southeast; SF-12= Short Form-12 item survey; SHIN-NY= Statewide Health Information Network for New York; SMRTnet= Secure Medical Records Transfer Network; SNOCAP-USA= State Networks of Colorado Ambulatory Practices & Partners United States of America; SNOMED= Systemized Nomenclature of Medicine; SSA= Social Security Administration; SUNBH = Seoul National University Bundang Hospital; TILAK= Tiroler Landeskrankenanstaleten ; TOE= technological, organizational and environmental; TUMA= Trans-mural exchange of medication data in Almere; U.K.= United Kingdom; U.S.= United States; URL= uniform resource locator; USB= universal serial bus; VA= U.S. Department of Veterans Affairs; VL= viral load; VLER= Veterans Lifetime Electronic Record; VRE= Vancomycin resistant enterococci; vs.= versus; WHIE= Wisconsin Health Information Exchange; XML= extensible markup language.