130BEvidence Tables for Chapter 20. Preventing In-Facility Delirium

Table 1, Chapter 20. Risk factors for delirium

| **Author/Year/ Country** | **Study Design** | **Patient Population** | **Description of Organization** | **Diagnosis of Delirium** | **Type of Analysis and factors adjusted for** | **Risk Factors** | **Modifiable risk factors**  | **Overall risk of bias** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Slor et al. 20113The Netherlands | Secondary analysis of RCT526 patients | Adults aged 70 years or older undergoing acute or elective hip surgery, without delirium at admission (or profound dementia precluding communication) | Academic hospital (915 beds) | Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria and Confusion Assessment Measure (CAM) | Univariate analyses followed by multivariable logistic regression; factors controlled for include age, APACHE II score, MMSE score, Snellen test score, benzodiazepines, anticholinergics, opioids, type of anesthesia | No significant risk factors for delirium were identified. | None | High |
| Burkhart et al. 20104Switzerland | Cohort study (post-hoc analysis of RCT)113 patients | Adults aged 65 years or older undergoing cardiac surgery with cardio-pulmonary bypass (CPB); patients with Mini-Mental State Exam (MMSE) score <15/30 were excluded | Academic hospital | CAM | Univariate and multivariable logistic regression with stepwise backward elimination; factors adjusted for include C-reactive protein (CRP), intraoperative fentanyl, and duration of mechanical ventilation | **Multivariable logistic regression analyses:**Maximum value of C‑reactive protein measured post-op:OR: 1.1(95% CI: 1.01-1.16)P = 0.02Fentanyl intraoperatively: OR: 4.9(95% CI: 1.72-13.8)P = 0.003Duration of mechanical ventilation:OR: 1.1(95% CI: 1.04-1.21)P = 0.004 | Fentanyl amount, duration of mechanical ventilation | High |
| Hudetz et al. 20105USA | Prospective cohort study40 patients | Adult males aged 55 years or older scheduled for elective CABG and/or valve replacement/ repair procedures with CPB. Patients with prior documented cognitive deficits or vascular dementia were excluded. | Veterans Affairs (VA) medical center | Intensive Care Delirium Screening Checklist (ICDSC) | Univariate and multiple logistic regression; factors adjusted for include psychosocial variables (dispositional optimism, perceived social support, perceived stress level, and depression) | **Incidence of post‑op delirium within 5 days of surgery was reduced by:**dispositional optimism: OR: 0.57(95% CI: 0.35-0.92)p<0.02 | None | Moderate |
| Kazmierski et al. 20106Poland | Prospective cohort study563 patients | Adult patients admitted for cardiac surgery with cardiopulmonary bypass; patients with preop dementia were excluded. | Academic hospital | DSM-IV criteria | Univariate analyses followed by multivariate backward stepwise logistic regression; factors adjusted for include age, MMSE score, major depression, anemia, atrial fibrillation (AF), intubation time, and pO2 level. | **Risk factors for delirium:**Age ≥65 years: OR: 4.23(95% CI: 2.24-7.96)MMSE <25:OR: 6.14(95% CI: 3.31-11.39)Intubation >24 hr:OR 5.29(95% CI: 2.14-13.06)pO2 <60 mmHg:OR: 3.24(95% CI: 1.77-5.94)Major depression:OR: 4.69(95% CI 1.84-11.93)Anemia:OR: 4.77(95% CI: 1.35-16.82)AF:OR: 3.67(95% CI: 1.40-9.60) | Cognitive impairment, depression, anemia, and AF could be treated prior to surgery | Moderate |
| Koebrugge et al. 20107The Netherlands | Retrospective cohort study107 patients | Patients aged 65 years or older undergoing aortoiliac surgery; patients with Alzheimer’s disease or dementia were excluded. | Suburban teaching hospital | DSM-IV criteria | Univariate and multivariate step forward logistic regression; factors adjusted for include age and urgency of surgery (emergency vs. elective) | **Post-op delirium:**Age ≥70 years:OR: 7.7(95% CI: 1.9-30.4)P<0.01Emergency (vs. elective) surgery: OR: 5.3(95% CI: 1.3-21.2)P<0.01 | None | High |
| Lin et al. 20108USA | Retrospective cohort study26,057,988 hospitaliza­tions | Hospitalizations recorded in the National Inpatient Sample (NIS) for DRG categories pneumonia, orthopedic surgery of the lower extremity, congestive heart failure, and urinary tract/ kidney infections | NIS database from 1998‑2005 | ICD-9 codes for delirium with dementia, drug-induced delirium, and non-dementia, non-drug (NDND) delirium | Multivariate stepwise forward logistic regression; factors adjusted for include age, gender, logarithm base e, length of stay, payor, DRG, cerebrovascular disease, dementia, adverse drug effect, sodium imbalance, volume depletion, anemia, atrial fibrillation, respiratory intervention, and diabetes mellitus | Dementia-associated delirium:Age, logarithm base e, length of stay, cerebrovascular disease, dementia, adverse drug effect, sodium imbalance, volume depletion, atrial fibrillation were all significant risk factors for delirium. Female gender, Medicaid as payor, congestive heart failure DRG, pneumonia DRG, anemia, and diabetes were associated with significantly lower risk of delirium.Drug-induced delirium:Age, logarithm base e, length of stay, cerebrovascular disease, orthopedic DRG, dementia, adverse drug effect, were all significant risk factors for delirium.Female gender, Medicaid as payor, congestive heart failure DRG, pneumonia DRG, sodium imbalance, anemia, and diabetes were associated with significantly lower risk of delirium.Non-dementia, non-drug delirium:Age, logarithm base e, length of stay, cerebrovascular disease, adverse drug effect, sodium imbalance, volume depletion, atrial fibrillation, and respiratory intervention were all significant risk factors for delirium.Female gender, Medicaid as payor, orthopedic DRG, congestive heart failure DRG, pneumonia DRG, anemia, and diabetes were associated with significantly lower risk of delirium. | Sodium imbalance, volume depletion, atrial fibrillation, and anemia | High |
| Lin et al. 20109USA | Retrospective cohort study1,968,527 hospitaliza­tions | Acute care hospitalizations (for pneumonia, lower extremity orthopedic surgery, congestive heart failure [CHF], and kidney/ urinary tract infection [UTI]) of patients aged 18 years or older in New York State (1998‑2007). | De-identified inpatient data obtained from the New York State Dept of Health Statewide Planning for Research Cooperative System (SPARCS) database | ICD-9 codes used to identify delirium cases; original diagnostic criteria not reported | Forward stepwise logistic regression; factors adjusted for include comorbidities, DRG categories, adverse drug effects (ADEs), dementia, mechanical ventilation/ ventilator assistance, gender, age (in decade), year of discharge, Caucasian ethnicity, Medicaid reimburse­ment, and elective admission status | **Any delirium after admission:**Decade of age:OR: 1.53(95% CI: 1.49-1.58)Female:OR: 0.70(95% CI: 0.66-0.75)Caucasian:OR: 1.45(95% CI: 1.29-1.62)Elective admission:OR: 0.87(95% CI: 0.80-0.94)Medicaid:OR: 0.74(95% CI: 0.66-0.82)CHF DRG:OR: 0.76(95% CI: 0.64-0.89)Lower extremity orthopedic surgery DRGs:OR: 7.36(95% CI: 6.38-8.50)Any ADE:OR: 22.19(95% CI: 20.72-23.76)Dementia:OR: 1.26(95% CI: 1.12-1.41)Respiratory intervention: OR: 1.96(95% CI: 1.62-2.36)Cerebrovascular disease:OR: 1.18(95% CI: 1.01-1.39)Atrial fibrillation:OR: 1.24(95% CI: 1.15-1.34)Diabetes mellitus:OR: 1.14(95% CI: 1.06-1.23)Volume depletion:OR: 1.41(95% CI: 1.28-1.57)Anemia:OR: 1.15(95% CI: 1.05-1.25)Hyponatremia:OR: 1.42(95% CI: 1.25-1.60) | None | High |
| Radtke et al. 201010Germany | Cohort study910 patients | Patients received elective general anesthesia and were observed in recovery room and hospital ward on first postoperative day | Academic hospital | Nursing delirium screening scale (Nu‑DESC) | Univariate and multivariate logistic regression with delirium as the response. Regression analyses were supplemented with a feature selection process using backward elimination. Factors adjusted for include age, gender, duration of surgery, site, intraop opioids, anesthetic, preop fasting (solids and fluids) | Multiple logistic regression analyses:Longer preoperative fluid fasting time (>6 hr) was the only significant risk factor for delirium in both the recovery room(OR: 2.69,95% CI: 1.38-5.24) and the ward (OR: 10.57, 95% CI: 1.42-78.62). Older age (OR: 1.02, 95% CI: 1.01-1.03) and surgical site (intraabdominal or intrathoracic vs. other sites) (OR: 1.83, 95% CI: 1.09-3.07) were significant risk factors in the recovery room. Intraoperative opioid choice (fentanyl vs. remifentanil) was a significant risk factor in the ward (OR: 2.27, 95% CI: 1.01-5.06). | Preoperative fluid fasting time, choice of intraoperative opioid | Moderate |
| Rigney 201011USA | Prospective cohort study44 patients | Patients aged 65 or older who spoke and understood English; Patients with prevalent delirium or moderate to severe cognitive dysfunction were excluded. | Academic hospital (365 beds) | CAM | Univariate and bivariate analyses followed by logistic regression; factors adjusted for include total allostatic load (AL) scores, primary mediators score, secondary outcomes score, and individual AL parameters | Primary mediators score was the only significant factor predicting delirium. | None | Moderate |
| Sieber et al. 201012USA | Double-blind randomized controlled trial (RCT)114 patients | Patients aged 65 or older undergoing hip fracture repair under spinal anesthesia with propofol sedation; patients with “mental… barriers that would preclude data collection” were excluded. | Academic medical center | CAM | Univariate and multivariate regression; factors adjusted for include deep sedation, dementia, units of packed erythrocytes transfused, and admission to the ICU | **Multivariate regression significant risk factors:**Deep sedation:OR: 2.69(95% CI: 1.04-6.93)p = 0.04preoperative dementia:OR: 3.97(95% CI: 1.54-10.2)p = 0.004), units of packed erythrocytes transfused:OR: 1.62(95% CI: 1.10-2.38)p = 0.01), and admission to the ICU: OR: 3.69(95% CI: 1.17-11.7)p = 0.02). | Sedation | Moderate |
| Bo et al. 200913Italy | Prospective cohort study252 patients | Patients aged ≥70 years admitted from emergency dept (ED) to an acute geriatric ward (AGW) or an acute general medical ward (AGMW); patients with delirium during ED stay or at ward entry were excluded. | Academic hospital | CAM | Univariate analyses, then multivariate forward stepwise modeling of variables associated with incident delirium; factors adjusted for include APACHE II score, SPMSQ score, stressful events, AGW hospitalization (vs. AGMW hospitalization) | **Risk of incident delirium:**APACHE II:RR: 1.30(95% CI: 1.11-1.51)P = 0.001SPMSQ:RR: 2.06(95% CI: 1.62-2.64)P<0.001Stressful events:RR: 3.36(95% CI: 2.86-5.44)P = 0.001AGW hospitalization:RR: 0.04(95% CI: 0.01-0.21)P<0.001 | More patients can be admitted to AGW vs. AGMW, some stressful events might be reduced | Moderate |
| Greene et al. 200914USA | Prospective cohort study100 patients | Patients aged 50 years or older admitted for major elective noncardiac surgery with at least a 2-day postop stay | Academic medical center | CAM | Bivariate analyses then multivariate analysis: factors adjusted for include Geriatric Depression Score-Short Form, Trails B time, Digit Symbol Test, and Symbol Search Test | Geriatric Depression Score-Short Form: OR per unit: 1.53(95% CI: 1.22-2.05)P = 0.0001);Trails B time:OR: 1.02(95% CI: 1.01-1.04) | Depression | Moderate |
| Hattori et al. 200915Japan | Prospective cohort study160 patients | Patients aged ≥75 years admitted for abdominal surgery, vascular surgery, or orthopedic surgery (all non‑emergency); patients with severe dementia were excluded. | 4 hospitals (1 academic), bed size ranged from 300 to 887 | NEECHAM Confusion Scale | Univariate and multivariate analyses; factors adjusted for include age, gender, department, anesthesia, MMSE, and preop NEECHAM score | **Risk of postop delirium:**Age >80 years:OR: 3.14(95% CI: 1.35-7.26)Male:OR: 2.86(95% CI: 1.09-7.47)Preop MMSE <25:OR: 3.96(95% CI: 1.52-10.39)Preop NEECHAM <27:OR: 5.33(95% CI: 1.84-15.31) | None | Moderate |
| Katznelson et al. 200916Canada | Prospective cohort study1,059 patients | Patients undergoing cardiac surgery with CPB | Academic hospital | CAM-ICU | Univariate analysis then multivariate logistic regression with backward and stepwise selection; factors adjusted for include older age, gender, preop depression, preop renal dysfunction, hypertension, peripheral vascular disease, New York Heart Association (NYHA) class >2, preop anemia, diabetes, preop history of cerebrovascular accident/TIA, prolonged CPB, intraop anemia and hyperglycemia, complex cardiac surgery, perioperative intraortic balloon pump support, and massive blood transfusion | **Risk of postop delirium:**Red blood cell transfusion (>5 units): OR: 3.29(95% CI: 2.09-5.19)Perioperative intraaortic balloon pump support:OR: 3.84(95% CI: 1.72-8.56)Preop depression:OR: 3.06(95% CI: 1.36-6.90)Preop creatinine >150 mM:OR: 2.96(95% CI: 1.9-4.63)Age ≥60 years:OR: 2.47(95% CI: 1.43-4.23)Combined CABG and valvular surgery:OR: 1.86(95% CI: 1.16-2.98)Preop administration of statins:OR: 0.54(95% CI: 0.35-0.84) | Preop administration of statins, preop depression, preop creatinine | High |
| Maldonado et al. 200917USA | RCT118 patients were randomized to three different sedatives | Patients aged 18-90 years admitted to the ICU following elective cardiac surgery. Patients with prior diagnosis of dementia were excluded. | Academic medical center and a VA medical center | DSM-IV criteria applied by a neuro­psychiatrist | Univariate followed by multiple logistic regression; factors adjusted for include age, gender, ASA class, baseline MMSE score, Midazolam (vs. Dexmedetomidine), and Propofol (vs. Dexmedetomidine) | **Post-op sedation:**Midazolam vs. Dexmedetomidine:OR: 28.6(95% CI: 3.7-262.5)p = 0.01propofol vs. dexmedetomidine:OR: 29.6(95% CI: 4.8-280.6)p = 0.01Age (increasing 10 years):OR: 1.3(95% CI: 1.1-1.5)p = 0.01 | Post-op sedation | High |
| Pisani et al. 200918USA | Prospective cohort study304 patients | Patients aged ≥60 years admitted to ICU | Academic hospital (900 beds, with 14‑bed ICU) | CAM-ICU | Bivariate analyses, then multivariate forward selection regression of variables associated with delirium (P<0.20); factors adjusted for include benzodiazepine or opioid use, Haloperidol use, steroid use, ADL impairment, history of depression, dementia, ICU diagnosis of respiratory disease, APACHE II score (minus Glasgow Coma Scale), Alanine aminotransferase level, intubated during ICU stay, restraint use during ICU stay | Benzodiazepine or opioid use: Rate Ratio: 1.64(95% CI: 1.27-2.10)Dementia: Rate Ratio: 1.19(95% CI: 1.07-1.33)Haloperidol:Rate Ratio: 1.35(95% CI: 1.21-1.50)APACHE II score:Rate Ratio:1.01(95% CI: 1.00-1.02)Other models showed: Benzodiazepines or opioids are a significant risk for delirium when dementia is absent, but not when it is present.Haloperidol is a significant risk for delirium when dementia is absent, but not when it is present. | Medication use | Moderate |
| Rudolph et al. 200919USA | Prospective cohort study122 patients (derivation set), 109 patients (validation set) | Patients aged ≥60 years who underwent cardiac surgery under general anesthesia; patients with delirium prior to surgery were excluded. | Two academic medical centers and a VA hospital | CAM | Multivariate modeling with bootstrap resampling was used to develop a prediction rule. | Mini mental state examination (MMSE) ≤23, prior stroke/TIA, abnormal albumin, and geriatric depression scale >4 were included in the prediction rule. Both cohorts showed increasing risk of delirium with increasing risk score (C-statistic = 0.74). | Depression, cognitive impairment, abnormal albumin | Moderate |
| Smith et al. 200920USA | Retrospective cohort study998 patients | Adults aged ≥18 years undergoing non‑cardiac surgery, with a minimum of 2 days inpatient stay. Patients with history of dementia or MMSE score ≤23 were excluded. | Academic hospital | Retrospective chart review and/or CAM | General linear modeling and logistic regression with all covariates entered simultaneously. Factors adjusted for include age, years of education, Charlson comorbidity scale, alcohol consumption (drinks per week), pain, and depressive symptoms | After adjustment for covariates, older age: OR: 1.85(95% CI: 1.11-3.09)P = 0.019greater medical comorbidities:OR: 1.38(95% CI: 1.02-1.86)P = 0.036)higher levels of depressive symptoms:OR: 1.37(95% CI: 1.00-1.88)P = 0.049 and poorer executive function: OR: 1.23(95% CI: 1.06-1.43)P = 0.007continued to predict postoperative delirium.In a post-hoc multivariate analysis, Stroop task was the only index of executive function that predicted postoperative delirium:OR: 1.56(95% CI: 1.14-2.14)P = 0.006 | Depressive symptoms are modifiable with treatment | High |
| Van Rompaey et al. 200921Belgium | Prospective cohort study523 patients | Patients aged ≥18 years were in the ICU for at least 24 hours. | One academic hospital, one private hospital, and two community hospitals | Neelon and Champagne Confusion Scale | Univariate logistic regression followed by multivariate forward conditional regression analysis; factors adjusted for include daily alcohol use, cognitive impairment, admission for internal medicine, psychoactive medication, endotracheal tube or tracheostomy, more than 3 perfusions, isolation, no visible daylight, and no visit | Daily use of more than 3 units of alcohol:OR: 3.23(95% CI: 1.30-7.98)predisposing cognitive impairment:OR: 2.41(95% CI: 1.21-4.79)admission for internal medicine:OR: 4.01(95% CI: 1.46-11.01)psychoactive medication: OR: 3.3495% CI: 1.50-11.23endotracheal tube or tracheostomy:OR: 8.07(95% CI: 1.18-55.06)more than 3 perfusions:OR: 2.74(95% CI: 1.07-7.05)isolation:OR: 2.89(95% CI: 1.00-8.36)no visible daylight:OR: 2.39(95% CI: 1.28-4.45)and no visit:OR: 3.73(95% CI: 1.75-7.93) | Alcohol intake, psychoactive medication dose, isolation, daylight, allowing visitors | Moderate |
| Vidan et al. 200922Spain | Controlled clinical trial542 patients | Patients aged ≥70 years admitted to the geriatric acute care unit and two internal medicine wards. Patients had to be free of delirium yet have risk factors for delirium at time of admission. | Academic hospital | CAM | Logistic regression with adjustment for confounders; these included age (per decade), dementia, baseline ADL independence, in‑hospital stay (per day), intervention group | Dementia:OR: 2.14(95% CI: 1.15-3.99)P = 0.02Baseline ADL independence:OR: 0.78(95% CI: 0.69-0.89)P = 0.001In-hospital stay (per day): OR: 1.02(95% CI: 1.00-1.05)P = 0.05Intervention group:OR: 0.43(95% CI: 0.24-0.77)P = 0.005 | Intervention | Moderate |
| Voyer et al. 200923Canada | Cross-sectional study155 patients | Patients aged ≥65 years with a prior diagnosis of dementia | Three long-term care (LTC) facilities and one LTC unit of a large regional hospital | CAM | Bivariate analyses then multivariate regression; factors adjusted for include age, severity of dementia, and risk factor scores | Severity of dementia:OR: 1.04(95% CI: 1.02-1.06)risk factor scores:OR: 1.67(95% CI: 1.11-2.51)Risk factor scores based on number of predisposing factors for each patient. | Dehydration, fever, number of medications, depression were modifiable factors associated with higher risk scores | Moderate |
| Koster et al. 200824The Netherlands | Prospective cohort study112 patients | Patients aged ≥45 years who underwent elective cardiac surgery (with or without CPB). Patients with preop delirium were excluded. | Hospital | DSM-IV criteria | Univariate and multivariate analysis; factors adjusted for include age, type of operation, anxiety score, disturbed sodium/potassium, diabetes mellitus, use of CPB, and EuroSCORE | EuroSCORE:OR: 1.12(95% CI: 1.05-1.19)P = 0.001Electrolytes disturbance:OR: 3.29(95% CI: 1.16-9.34)P = 0.025 | Electrolytes disturbance | High |
| Lin et al. 200825Taiwan | Prospective cohort study151 patients | Mechanically-ventilated adult patients admitted to ICU; delirium assessed for first 5 days; history of dementia was an exclusion criterion | Academic medical center | CAM-ICU | Univariate analyses, then multivariate stepwise regression using selected variables (P<0.1); factors adjusted for include diabetes mellitus, sepsis, and hypoalbuminemia | Sepsis:OR: 3.65(95% CI: 1.03-12.90)Hypoalbuminemia:OR: 5.94(95% CI: 1.23-28.77)Note: Medications were not associated with delirium in univariate analyses. | None | Moderate |
| Oh et al. 200826Korea | Retrospective cohort study224 | All patients aged ≥70 years who had undergone neurosurgery during a 2-year period | Academic medical center | MMSE and CAM | Univariate analyses followed by multivariate regression of significant factors; factors adjusted for include prior dementia/ delirium, abnormal preop serum glucose, diabetes, local or regional anesthesia, duration of surgery, recovery room stay, VAS score (>6.8), and analgesics usage | **Multivariate model risk factors:**Previous dementia/delirium:OR: 630.4(95% CI: 289.2-852.4)P<0.0001Pre-existent diabetes:OR: 1.47(95% CI: 1.17-2.45)P = 0.012Local or regional anesthesia:OR: 2.21(95% CI: 1.34-3.47)P<0.001VAS score (>6.8):OR: 1.99(95% CI: 1.45-4.16)P<0.001Analgesics usage:OR: 1.38(95% CI: 1.06-2.14)P = 0.038 | Preop serum glucose, type of anesthesia, analgesics usage | High |
| Redelmeier et al. 200827Canada | Retrospective cohort study284,158 patients | All patients aged ≥65 years who underwent elective surgery | Database representing all Ontario hospitals | ICD codes used to identify cases | Multivariable logistic regression; factors adjusted for include age, sex, neuropsychiatric drug, type of surgery, duration of surgery | Age (per year increase): OR: 1.09(95% CI: 1.09-1.10)Sex (male vs. female):OR: 1.71(95% CI: 1.59-1.86)Cholinesterase inhibitor: OR: 3.99(95% CI: 2.26-7.05)Antipsychotic:OR: 1.57(95% CI: 1.26-1.95)Antidepressant:OR: 2.01(95% CI: 1.75-2.25)Benzodiazepine:OR: 1.40(95% CI: 1.28-1.53)Thoracic surgery:OR: 1.54(95% CI: 1.29-1.84)Neurosurgery:OR: 1.22(95% CI: 1.00-1.49)Vascular surgery:OR: 1.20(95% CI: 1.06-1.36)Musculoskeletal surgery: OR: 1.19(95% CI: 1.08-1.31)Lower urologic and gynecologic:OR: 0.55(95% CI: 0.48-0.62)Breast and skin surgery:OR: 0.46(95% CI: 0.36-0.59)External head and neck surgery:OR: 0.39(95% CI: 0.30-0.50)Opthalmologic surgery:OR: 0.08(95% CI: 0.05-0.13)Duration of surgery (per 30 min increase):OR: 1.20(95% CI: 1.19-1.21) | Neuro­psychiatric drug use | High |
| Inouye et al. 200728USA | Prospective cohort study491 patients (development cohort)469 patients (validation cohort) | Patients aged ≥70 years admitted to 6 general medicine units at an academic hospital | Academic medical center | CAM | Bivariable analyses then multivariate model; factors adjusted for include dementia, vision impairment, activities of daily living impairment, Charlson score, and restraint use during delirium | Dementia:OR: 2.3(95% CI: 1.4-3.7)vision impairment:OR: 2.1(95% CI: 1.3-3.2)activities of daily living impairment:OR: 1.7(95% CI: 1.2-3.0)Charlson score ≥4:OR: 1.7(95% CI: 1.1-2.6)restraint use during delirium:OR: 3.2(95% CI: 1.9-5.2) | Restraint use, vision impairment, functional impairment | Moderate |
| Ely et al. 200729USA | Prospective cohort study53 patients | Patients aged ≥18 years admitted to the ICU for >24 hrs | Community teaching hospital (541 beds) | CAM-ICU (intensive care unit) | Ordinal logistic regression (dependent variable was delirium days); factors adjusted for include APOE4, age, APACHE II score, coma days, sepsis/ARDS/ pneumonia, and Lorazepam total dose | APOE4:OR: 7.32(95% CI: 1.82-29.5)P = 0.005Coma days, quintiles:OR: 1.32(95% CI: 1.08-1.60)P = 0.006 | None | High |
| Leung et al. 200730USA | Prospective cohort study203 patients | Patients aged ≥65 years scheduled for major noncardiac surgery requiring anesthesia | Academic medical center | CAM | Univariate analysis then multivariate logistic regression with the most promising factors (APOE, age, history of CNS disorders, education, pain, ADLs, alcohol intake, cognitive status, GDS score) | **Risk factors for delirium:**APOE (with e4 vs. without e4):OR: 3.64(95% CI: 1.51-8.77)Age:OR: 1.08(95% CI: 1.00-1.16)History of CNS disorders (yes vs. no):OR: 3.42(95% CI: 1.44-8.09) | None | High |
| Ouimet et al. 200731Canada | Prospective cohort study203 patients | Patients age ≥18 years admitted for more than 24 hr to an ICU | Academic hospital | Intensive care delirium screening checklist (ICDSC) | Univariate then multivariate stepwise logistic regression on selected variables; factors adjusted for included age, hypertension, tobacco consumption, alcohol consumption, APACHE II score, epidural catheter use, opiate dose, benzodiazepine dose, propofol dose, indomethacin dose, coma, anxiety, and pain | Hypertension:OR: 1.88(95% CI: 1.3-2.6)Alcoholism:OR: 2.03(95% CI: 1.26-3.25)APACHE II score:OR: 1.05(95% CI: 1.03-1.07)Coma:OR: 3.71(95% CI: 2.32-5.9)Anxiety:OR: 1.8(95% CI: 1.04-3.37) | These factors are difficult to modify in the short term in an ICU environment. | Moderate |
| Pisani et al. 200732USA | Prospective cohort study304 patients | Patients ≥60 years old admitted to ICU for at least 24 hrs | Academic hospital (900 beds, with 14‑bed ICU) | CAM-ICU | Univariate analysis then multivariate modeling; factors adjusted for include alcohol, Medicaid status, race, history of depression, medication use, dementia, APACHE II score, admitting diagnosis, admitting laboratory variables, and admitting physiologic variables | Dementia by IQCODE >3.3:OR: 6.3(95% CI: 2.9-13.8)Benzodiazepines before ICU admission:OR: 3.4(95% CI: 1.6-7.0)Creatinine >2 mg/dL:OR: 2.1(95% CI: 1.1-4.0)Arterial pH <7.35:OR: 2.1(95% CI: 1.1-3.9) | Benzodiazepine use, creatinine level, and arterial pH are modifiable | Moderate |
| Rudolph et al. 200733USA | Prospective cohort study1,218 patients | Patients aged ≥60 years undergoing noncardiac surgery. Patients with dementia were excluded. | 13 hospitals in 8 countries (Denmark, France, Germany, the UK, Greece, the Netherlands, Spain, and the USA) | DSM-III criteria | Bivariate analyses, then stepwise backward and forward proportional hazard regression models using the most promising variables; factors adjusted for included age, gender (male), cognitive performance, tobacco exposure, diabetes, prior myocardial infarction (MI), and vascular surgery | Vascular risk factors (tobacco exposure and vascular surgery): Rate Ratio: 3.2(95% CI: 2.1-4.9)Mildly impaired cognitive performance:Rate Ratio: 2.2(95% CI: 1.4-2.7)Age (per year):Rate Ratio: 1.1(95% CI: 1.0-1.1) | Cognitive deficit might be treatable prior to surgery | Moderate |
| Veliz-Reissmuller et al. 200734Sweden | Prospective cohort study107 patients | Patients aged ≥60 years scheduled for CABG, valve surgery or combined procedures; none had dementia | Academic hospital | CAM | Univariate analysis then logistic regression of significant variables; factors adjusted for include age, alcohol consumption, memory complaints, CABG-valve vs. CABG, valve vs. CABG, MMSE score | Memory complaints:OR: 3.37(95% CI: 1.0-11.5)Valve vs. CABG:OR: 3.90(95% CI: 1.0-15.8)MMSE score (≤28 preop):OR: 11.3(95% CI: 2.7-47.7) | Cognitive deficit may be treatable prior to surgery | High |
| Beaussier et al. 200635France | Double-blind RCT59 patients | Patients aged >70 years undergoing surgical resection of cancer of the left colon or rectum; patients with preoperative mental dysfunction were excluded. | Academic hospital | CAM | Comparison of randomized group outcomes, no adjustment for other factors. General anesthesia for colon resection; pre-op intrathecal morphine (0.3 mg) + postop patient-controlled (PCA) intravenous morphine vs. PCA alone | No significant difference in delirium incidence was found between the two groups. | None, since neither intervention showed a difference | Moderate |
| Furlaneto and Garcez-Leme 200636Brazil | Prospective cohort study103 patients | Patients aged ≥65 years admitted to the geriatric orthopedic ward for hip fracture (almost all underwent surgery) | Academic medical center | CAM | Univariate regression prior to logistic regression modeling; factors adjusted for include mental assessment factors (MMSE, clock drawing, blessed), ADL and length of hospital stay | Cognitive deficit:OR: 3.04(95% CI: 1.24-7.41) | Cognitive deficit may be treatable | Moderate |
| Goldenberg et al. 200637USA | Prospective cohort study77 patients | Patients aged >65 years admitted for hip surgery; patients with existing delirium were excluded | Community teaching hospital | CAM | Univariate logistic analysis identified 12 factors as predictors; these were included in a multivariate logistic regression analysis (age, morbidity index, Hct, Alb, MMSE score, set test score, ADL score, dementia, skilled nursing facility (SNF) residence, multiple medications, CNS medications and abnormal laboratory values) | **Risk factors for delirium:**Multiple medications:OR: 33.6(95% CI: 1.9-591.6)Set test score <20:OR: 13.1(95% CI: 2.1-82.7)MMSE score <24:OR: 6.9(95% CI: 1.2-39.5)Albumin <3.5 g/dl:OR: 6.1(95% CI: 1.2-39.5) | Multiple medications and cognitive impairment, but there may not be time before surgery to modify these factors | Moderate |
| Kazmierski et al. 200638Poland | Prospective cohort study260 patients | All patients received cardiac surgery; patients with preop delirium or dementia were excluded | Academic hospital | DSM-IV criteria | Univariate analyses, then significant variables added to multivariate regression model (backward stepwise procedure); factors adjusted for include MMSE score, AF, peripheral vascular disease, major depression, cerebrovascular disease, and age | **Risk factors for delirium:**MMSE ≤24:OR: 10.2(95% CI: 3.7-28.6)AF:OR: 7.2(95% CI: 2.3-22.7)Peripheral vascular disease:OR: 6.4(95% CI: 1.9-21.6)Major depression:OR: 6.3(95% CI: 1.4-29.7)Age ≥65 years:OR: 4.0(95% CI: 1.5-10.4) | Depression, cognitive impairment, AF can be treated prior to surgery | High |
| Leung et al. 200639USA | Blind RCT228 patients | Patients aged ≥65 years undergoing non‑cardiac surgery requiring general anesthesia, expected to remain in the hospital ≥48 hr | Academic hospital | CAM | Bivariate analyses then multivariate logistic regression analysis with variables associated with delirium (P≥0.20); factors adjusted for include age, anesthetic type (N2O vs. oxygen), dependence on performing ≥1 IADL, Postop analgesia (PCA vs. oral opioids), benzodiazepine use on POD 1 or POD 2 | Age:OR: 1.07(95% CI: 1.02-1.26)Dependence on performing ≥1 IADL:OR: 1.54(95% CI: 1.01-2.35)Postop analgesia (PCA vs. oral opioids:OR: 3.75(95% CI: 1.27-11.01)Benzodiazepine use on POD 1 or POD 2:OR: 2.29(95% CI: 1.21-4.36) | Postop analgesia, benzodiazepine use | Moderate |
| Pandharipande et al. 200640USA | Prospective cohort study198 patients | All adult mechanically-ventilated patients admitted to ICU; patients with preop neurological diseases that would confound delirium diagnosis were excluded. | Academic medical center | CAM-ICU and Richmond Agitation Sedation Scale (RASS) | Multivariable analysis of sedative and analgesic medications as risk factors for delirium in a Markov model; factors adjusted for include age, gender, visual and hearing deficits, dementia, depression, severity of illness, sepsis, neurologic disease, hematocrit, daily serum glucose level, lorazepam, midazolam, fentanyl, morphine, and propofol | **Risk factors for delirium:**Lorazepam:OR: 1.2(95% CI: 1.1-1.4)P = 0.003No other sedative or analgesic showed a statistically significant risk for delirium. | Use of lorazepam (alternative medications can be substituted) | Moderate |
| Ranhoff et al. 200641Italy | Prospective cohort study401 patients | Patients ≥60 years of age admitted to a sub-intensive care unit for elderly patients (SICU) | General hospital | CAM | Bivariate analysis then multiple logistic regression of variables with p<0.05 in bivariate analysis; factors adjusted for include heavy alcohol use, fitted bladder catheter, number of drugs, visual problems, Acute Physiology Score (APS), Age, S‑albumin, dementia | Heavy alcohol use:OR: 6.1(95% CI: 1.8-19.6)Fitted bladder catheter:OR: 2.7(95% CI: 1.4-4.9)Max no. of drugs (7+):OR: 1.9(95% CI: 1.1-3.2)Disabled:OR: 2.5(95% CI: 1.3-4.7)Probably demented:OR: 11.5(95% CI: 6.1-20.1) | Use of bladder catheters and no. of drugs | Moderate |
| Sheng et al. 200642Australia | Prospective cohort study156 patients | Stroke patients aged ≥65 years recruited over 1 year | Academic teaching hospital (450 beds) | DSM-IV criteria | Binary logistic regression then multiple logistic regression analyses using significant variables; factors adjusted for include age, dementia prestroke, hemorrhagic stroke, metabolic factor, able to lift both arms, Glasgow coma scale score <15, neglect, dysphasia, vision field loss, urinary tract infection, urinary incontinence, fecal incontinence, systolic blood pressure, diastolic blood pressure, and one or more metabolic factors | Age:OR: 1.1(95% CI: 1.0-1.2)Dementia prestroke:OR: 5.7(95% CI: 1.3-24.9)Hemorrhagic stroke:OR: 3.7(95% CI: 1.2-11.6)Metabolic factor:OR: 6.1(95% CI: 1.9-20.2)Able to lift both arms:OR: 0.3(95% CI: 0.1-0.9)Glasgow coma scale score:OR: 10(95% CI: 3.7-26.7) | None | Moderate |
| Korevaar et al. 200543The Netherlands | Prospective cohort study126 patients | All patients >65 years and acutely admitted | Academic medical center | CAM | Univariate and multivariate logistic regression analysis; factors adjusted for include cognitive impairment, Katz ADL, Urea, and leucocytes | **Risk factors for delirium:**Cognitive impairment: adjusted hazard ratio: 9.48(95% CI: 2.27-39.54)Katz ADL 5-6:8.14(95% CI: 1.08-61.31)Katz ADL ≥7:14.13(95% CI: 2.26-88.24)Urea:1.10(95% CI: 1.02-1.18)Leucocytes(109/L):0.87(95% CI: 0.79-0.97) | Cognitive impairment | Moderate |
| Shulman et al. 200544Canada | Retrospective cohort study10,230 patients | All patients >65 years who were newly dispensed 1 of 3 drugs: lithium, valproate, or benztropine | 4 administra­tive databases covering all hospitals in Ontario | Not reported | Cox proportional hazards regression, adjusted for lithium, valproate, benztropine, age, sex, comorbidity, visual impairment, and hearing impairment | Benztropine (vs. lithium): hazard ratio: 1.88(95% CI: 1.35-2.62) | Benztropine use | High |
| Yildizeli et al. 200545Turkey | Retrospective cohort study432 patients | Patients aged ≥18 years admitted for major elective or urgent thoracic surgery | Academic hospital | DSM-IV criteria | Univariate analyses, then multivariate stepwise logistic regression; factors adjusted for include age, gender, chronic disease, alcohol abuse, psychiatric problems, diabetes, cerebrovascular disease, chemotherapy usage, operation due to malignancy, urgent operation, respiratory insufficiency, markedly abnormal serum chemistry values, operation time, length of hospital stays, length of intensive care unit stays, sleep deprivation, hypertension, infection, blood transfusion, use of various drugs, immobilization | Markedly abnormal serum chemistry values:OR: 3.01p = 0.038Sleep deprivation:OR: 5.64p = 0.05Age:OR: 1.04p = 0.03Operation time:OR: 1.29p = 0.04 | Sleep deprivation, abnormal serum chemistry | High |
| Bucerius et al. 200446Germany | Retrospective cohort study16,184 patients | All patients receiving cardiac surgery | Academic hospital | Physician diagnosis based on American Psychiatric Association (APA) guidelines | Univariate analyses, then significant variables added to multivariate regression model (backward stepwise procedure); factors adjusted for include age, beating-heart surgery, atrial fibrillation, cerebrovascular disease, diabetes, peripheral vascular disease, LVEF, preop cardiogenic shock, urgent operation, operating time, intraop hemofiltration, and RBC transfusion | **Risk factors for delirium:**Cerebrovascular disease: OR: 2.15(95% CI: 1.69-2.72)Atrial fibrillation:OR: 1.36(95% CI: 1.14-1.62)Diabetes:OR: 1.31(95% CI: 1.16-1.49)Peripheral vascular disease:OR: 1.34(95% CI: 1.17-1.53)LVEF ≤30%:1.30(95% CI: 1.09-1.49)Preop cardiogenic shock: OR: 1.23(95% CI: 1.05-1.45)Urgent operation:OR: 1.17(95% CI: 1.02-1.34)Operating time ≥3 hr:OR: 1.26(95% CI: 1.01-1.45)Intraop hemofiltration:OR: 1.26(95% CI: 1.06-1.49)RBC transfusion ≥2000 ml:OR: 3.15(95% CI: 2.71-3.65)**Lower risk of delirium:**Beating-heart surgery:OR: 0.47(95% CI: 0.32-0.69)Younger age:Age <50 years:OR: 0.22(95% CI: 0.15-0.31)Age ≥50 and <60 years: OR: 0.34(95% CI: 0.27-0.43)Age ≥60 and <70 years: OR: 0.6(95% CI: 0.52-0.68) | Type of surgery (if patient is candidate for beating-heart surgery); AF can be treated prior to surgery | High |
| Caeiro et al. 200447Portugal | Prospective cohort study218 patients | Consecutive acute stroke patients admitted to stroke unit | Academic hospital with 12-bed stroke unit | Delirium Rating Scale (DRS) score ≥10 and fulfilled DSM‑IV-TR criteria | Univariate and multivariate analysis with stepwise logistic regression | Non-neuroleptics anticholinergics (ACH) during hospitalization, medical complications, ACH taken before stroke, and intracerebral hemorrhage (ICH) all remained in the final regression model. | Use of ACH medications | High |
| Santos et al. 200448Brazil | Prospective cohort study220 patients | Patients aged ≥60 years admitted for nonemergency CABG; patients with severe cognitive deficits were excluded. | Academic tertiary referral hospital | DSM-IV criteria | 3 multivariate analyses:(1) preop variables; (2) preop and intraop variables; (3) preop, intraop, and postop variables); factors adjusted for include age, blood urea, cardiothoracic index, hypertension, smoking, blood replacement, AF, pneumonia, blood balance 2nd postop day | Age:OR: 1.1(95% CI: 1.01-1.19)Blood urea:OR: 1.03(95% CI: 1.01-1.05)Cardiothoracic index:OR: 3.38(95% CI: 1.39-8.25)Hypertension:OR: 3.55(95% CI: 1.25-10.14)Smoking:OR: 4.19(95% CI: 1.35-13.05)AF:OR: 2.62(95% CI: 1.05-6.58)U:OR: 6.36(95% CI: 1.24-32.71) | Blood urea, hypertension and AF are potentially modifiable prior to nonemergency surgery | Moderate |
| Bohner et al. 200349Germany | Prospective cohort study153 patients | Patients undergoing elective arterial surgery with an expected time of ≥90 minutes | Academic hospital | DSM-IV criteria plus DRS score ≥12 points | Univariate then stepwise multivariate analysis, which adjusted for age, depression, major amputation, supraortic occlusive disease, body length, cognitive impairment (MMSE), colloid infusion, minimal potassium level, hypercholesterinemia | **Risk factors for delirium:**No history of supraortic occlusive disease:OR: 6.73P = 0.001History of major amputation:OR: 24.4P = 0.001No history of hypercholesterinemia:OR: 5.51P = 0.001Age >64 years:OR: 3.03P = 0.018Body length <170 cm:OR: 3.95P = 0.004MMSE <25 points:OR: 28.0P = 0.001Intraop colloid infusion >800 ml:OR: 2.62P = 0.035Intraop minimal potassium <3.4 mmol/L:OR: 3.18P = 0.021 | Intraop colloid infusion, intraop minimal potassium; cognitive impairment can be treated prior to surgery | High |
| Centorrino et al. 200350USA | Retrospective cohort study139 patients | Consecutive adult hospitalized patients given clozapine | Academic hospital | Investigator consensus based on signs and symptoms in medical chart, and rated by consensus on a 3-point severity scale (mild, moderate, severe) | Bivariate analysis followed by multivariate logistic regression of factors with associations with delirium (p≤0.10); factors adjusted for include anticholinergic meds, clinical responder, age, hospitalized ≥20 days, antipsychotic meds, CNS agent, anticonvulsants, any mood stabilizer, clozapine dose >250 mg/day, tricyclic antidepressants, benzodiazepines, serotonin reuptake inhibitors, women, lithium, any antidepressant | Any centrally active anticholinergic:X2 = 9.69p = 0.002Age ≥39 years:X2 = 5.69p = 0.017 | Anticholinergic exposure | High |
| Morrison et al. 200351USA | Prospective cohort study541 patients | Patients admitted for hip fracture without evidence of delirium | 4 metropolitan hospitals | CAM | Univariate analyses then multivariate logistic regression; factors adjusted for included age, gender, residence, cognitive impairment, FIM score, RAND score, abnormal BP, abnormal heart rhythm, chest pain, heart failure, medical complication, morphine, meperidine | **Risk factors for delirium:**Cognitive impairment:OR: 3.6(95% CI: 1.8-7.2)Abnormal BP:OR: 2.3(95% CI: 1.2-4.7)Heart failure:OR: 2.9(95% CI: 1.6-5.3)Parenteral morphine sulfate equivalents/d <10 mg:OR: 5.4(95% CI: 2.4-12.3)Received meperidine:OR: 2.4(95% CI: 1.3-4.5) | Morphine dose, meperidine use; cognitive impairment can be treated prior to surgery | Moderate |
| Zakriya et al. 200252USA | Prospective cohort study168 patients | Patients admitted for hip fracture service (age 50‑98); patients with pre-existing delirium or dementia were excluded. | Academic hospital | CAM | Univariate analyses then multiple logistic regression of variables with P≤0.1 from univariate; factors adjusted for include normal white blood cell count, abnormal serum sodium, ASA class, history of congestive heart failure, history of AF, history of peripheral vascular disease | Normal white blood cell count:OR: 2.2(95% CI: 1.2-4.1)Abnormal serum sodium: OR: 2.4(95% CI: 1.1-5.3)ASA class >II:OR: 11.3(95% CI: 2.6-49.2) | Abnormal serum sodium and white blood cell count | High |
| Agostini et al. 200153USA | Prospective cohort study426 patients | Patients aged ≥70 years with no baseline delirium admitted to general medical service (non-ICU); profound dementia precluding verbal communication was an exclusion criterion. | Academic hospital (900 beds) | CAM | Logistic regression model adjusted for baseline delirium risk, gender, and age | Diphenhydramine:OR: 2.3(95% CI: 1.4-3.6) | Diphenhydramine | Moderate |
| Andersson et al. 200154Sweden | Prospective cohort study457 patients | Patients aged ≥65 years referred for orthopedic surgery (hip fracture or elective coxarthros or gonarthros surgery) | Hospital | Modified Organic Brain Syndrome (OBS) Score; also considered DSM-IV criteria | Multiple regression, stepwise model; factors adjusted for included gender, age, vision, hearing, reason for hospital admission, number of other diseases, postop complications, bladder catheter, preop medical treatment, anesthesia time and method, loss of blood during surgery, time from admission to surgery, surgery time, time of admission, marital status, cohabitation, type of housing | **Risk of developing delirium:**Four or more physical diseases:Exp (B): 15.94(95% CI: 4.60-55.31)Reason for admission: Exp (B): 4.74(95% CI: 1.76-12.80)Impaired vision:Exp (B): 4.52(95% CI: 2.27-8.98)Preop medical treatment: Exp (B): 2.66(95% CI: 1.26-5.62)Anesthesia time:Exp (B): 1.82(95% CI: 1.31-2.53)OBS-score on admission:Exp (B): 1.28(95% CI: 1.06-1.54)Age:Exp (B): 1.10(95% CI: 1.04-1.15) | Impaired vision, anesthesia time, possibly preop medical treatment; cognitive impairment can be treated prior to surgery | Moderate |
| Dubois et al. 200155Canada | Prospective cohort study418 patients | Consecutive patients aged ≥18 years admitted for >24 hrs to the ICU | Academic hospital with 16-bed medical and surgical ICU | Intensive care delirium screening checklist | Univariate analyses then multivariate analysis using the 5 best factors (morphine, use of epidural, smoking history, bilirubin level, hypertension)Univariate non-significant factors: COPD, alcohol abuse, sodium level, glucose level, lorazepam, rooms without windows, rooms with windows  | **Risk of developing delirium:**Hypertension:OR: 2.6(95% CI: 1.14-5.72)Bilirubin level (% days abnormal):OR: 1.2(95% CI: 1.03-1.40)Use of Epidural:OR: 3.5(95% CI: 1.20-10.39)Morphine (mean daily dose):0.01-7.1 mg:OR: 7.8 (1.76-34.4)7.2-18.6 mg:OR: 9.2 (2.17-39.0)18.7-331.6 mg:OR: 6.0 (1.41-25.4) | Hypertension, bilirubin level, use of epidural, morphine dose | High |
| McCusker et al. 200156Canada | Retrospective cohort study444 patients (326 with delirium, 118 without) | Patients ≥65 years admitted from ED to medical services; 59.5% had dementia. | Primary acute care general hospital | CAM | Multivariable analyses of variance; factors adjusted for include age, delirium index score, comorbidity, length of follow-up, dementia, study group, prevalent delirium, visual or hearing impairment, number of room changes, hospital unit, in isolation, stimulation level, not in the same room, in a single room, physical restraint, medical restraint, surroundings not well-lit, surroundings noisy/quiet, radio/TV on, clock/watch absent, calendar absent, no personal possessions, not wearing glasses, not using hearing aids, family absent | **Final model for prediction of delirium severity:**Delirium index score: Beta: 0.54 ±0.03, (P<0.01)Dementia:Beta: 1.09 ±0.28, (P<0.01)Number of room changes:Beta: 0.40 ±0.16,(P = 0.01)ICU vs. medical:Beta: 4.62 ±0.60, (P<0.01)Physical restraint:Beta: 1.21 ±0.17, (P<0.01)Medical restraint:Beta: 0.42 ±0.19,(P = 0.02)Not wearing glasses: Beta: 0.81 ±0.19(P<0.01) | Room changes, physical and medical restraint, glasses | Moderate |
| Christe et al. 200057Switzerland | Double-blind RCT65 patients | Consecutive geriatric inpatients requiring upper gastrointestinal endoscopy | Academic geriatric hospital (304 beds) | MMSE decrease of 3 points or more | Univariate analyses then multivariate stepwise forward and backward logistic regressions; factors adjusted for were not stated | Basal MMSE <21:OR: 6.4(95% CI: 1.1-37.3) | None | High |