Evaluation and Management of the Elderly Patient at Risk for Postoperative Delirium

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KEYWORDS

• Confusion • Surgery • Perioperative care • Geriatrics

Delirium is a common complication afflicting postsurgical geriatric patients. It is a medical emergency characterized by the acute onset of changes in cognition or attention that fluctuate throughout the course of a day. Up to 40% of hospitalized elderly patients experience delirium;[1] postoperatively, the incidence varies according to the type of surgery. The consequences of delirium can be devastating and impact mortality and morbidity in the medical, functional, psychological, and social domains.[2–15] Additionally, the economic burden of delirium is enormous. The treatment of delirium cost Medicare $6.9 billion in 2004 alone.[16] Those who experience delirium during hospitalization are more likely to use twice as many health care dollars in the following year, increasing the estimated total annual cost of delirium to $38 to $152 billion.[17] Thus, prevention, timely recognition, and targeted treatment may reduce the incidence of delirium and decrease the cost of postsurgical care. The purpose of this review is to summarize the findings in the literature concerning risk factors, preventive measures, diagnostic and screening instruments, and management strategies for postoperative delirium and to offer recommendations to the clinician caring for elderly surgical patients.

PATHOGENESIS

The underlying mechanisms contributing to delirium are poorly understood. Many theories emphasize aberrant neurotransmission. One of the most widely accepted

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mechanisms is cholinergic deficiency; increased serum anticholinergic activity is associated with delirium.[18] Other hypotheses invoke abnormalities in melatonin and serotonin,[19,20] with abnormal tryptophan metabolism unifying these ideas because tryptophan is a precursor for both.[21] Noradrenergic hyperactivity has also been implicated.[22]

Neuronal damage is an alternative explanation, secondary either to oxidative stress [23] or inflammation. Proinflammatory cytokines increase in postoperative delirium,[24] especially interleukin-6 and interleukin-8.[25] In addition, elevations in C-reactive protein occur in delirious patients.[9] A link between inflammation and neurotransmission has been proposed, with inflammation-induced perivascular edema leading to hypoxia and subsequent reduced synthesis of acetylcholine.[26]

It is generally thought that delirium represents global brain dysfunction. Electroencephalographic findings reveal a decrease in the fast alpha frequencies and an increase in the slower theta rhythm.[27] In hypoactive delirium, hypoperfusion occurs globally in the frontal, temporal, and occipital lobes, and focally in the caudate head, thalamus, and lenticular nuclei. Delirium improves once blood flow returns to normal, suggesting that cerebral hypoperfusion may play a role.[28]

RISK FACTORS

Inouye[29–31] categorized risk factors for postoperative delirium into predisposing factors inherent to the patient that increase baseline vulnerability and precipitating factors, which are the conditions during the perioperative period that trigger the development of delirium (**Table 1**). The interaction of these factors remains complex.[29–31]

PREDISPOSING RISK FACTORS

Various cohort and randomized studies consistently demonstrate the relationship of older age to increasing incidence of delirium.[3,7,9,14,32–43] Homeostenosis, the reduction in physiologic reserve with age, offers one possible explanation.[44] There is no consensus regarding the effect of gender, with some studies reporting a higher risk for women,[36,43,45] others for men,[3,4,46,47] but the majority revealing no gender predilection.[7,14,32,38–40,48,49] Vision or hearing impairment is consistently associated with greater risk.[9,12,38,41]

Impaired cognitive function contributes to delirium risk. Dementia and low scores on the Folstein Mini-Mental State Examination (MMSE) confer higher risk for postoperative delirium.[4,8,9,11,12,35,37–39,41,42,50–53] Abnormal performance on the clock-drawing test also increases risk,[47] which lends support to the hypothesis that impairments in executive function, rather than memory deficits, are more important indicators.[54] Slower reaction times on neuropsychiatric tests are also associated with delirium, suggesting that preexisting deficits in attention contribute to risk.[55] In one study, subjective memory complaints in patients older than 60 years undergoing cardiac surgery conferred a threefold higher risk for developing delirium postoperatively.[52]

Lower education level increases delirium risk,[38,43,48,56] and when present, delirium is of longer duration.[50] The cognitive reserve theory is often cited to explain this finding.[56] In fact, one study estimates that those who complete seventh grade are at a 60% higher risk for delirium when compared with those who complete high school.[56]

Poor functional status is associated with delirium.[8,36,37,42] Requiring assistance with one or more activities of daily living (ADLs) confers a 54% increased risk.[33] Patients admitted from nursing homes, implying self-care deficits, are more likely to develop postoperative delirium than their community-dwelling counterparts.[12,38] Dependence in instrumental ADLs also augments risk.[43]

Table 1
Risk factors for the development of postoperative delirium

Predisposing	Precipitating
Widely accepted factors	
1. Age[3,7,9,14,32–43] 2. Cognitive impairment[4,8,9,11,12,35,37–39,41,42,50–53] 3. Lower education level[38,43,48,56] 4. Sensory impairment[9,12,38,41] 5. Decreased functional status[8,33,36,37,42,43] 6. Comorbid medical illness[3,7,9,10,32,36,40,49,52,57] 7. Malnutrition[31,39,58] 8. Depression[8,9,38,41,43,59]	1. Orthopedic > vascular > cardiac[10,32,39,52,57,64,65] 2. Urgent or emergent procedure[7,10,70] 3. Delayed surgery after hip fracture[11] 4. Preoperative hemodynamic instability[7,10] 5. Hypoxemia[59,62] 6. Electrolyte disturbance[9,37,38,40,42,49] 7. Transfusion requirement[7,9,10,72] 8. Sleep deprivation[40] 9. Urinary catheter[31] 10. Immobility[75] 11. Poorly controlled pain[35,36,43] 12. Polypharmacy[31] Benzodiazepines[18,33,42,50,78] Anticholinergics[59,79–81] 13. Meperidine[36,78,82]
Controversial factors	
1. History of delirium[42] 2. Gender Female[36,43,45] Male[3,4,46,47] No association[7,14,32,38–40,48,49] 3. Alcohol use or abuse[34,35,37] 4. Tobacco use[3,9,50] 5. Apolipoprotein E ϵ4 carrier status[63]	1. Longer operations[7,10,39,40]
Factors with no effect	
1. Preoperative anxiety[61,62]	1. General versus regional anesthesia[43,48,59,72] 2. Route of postoperative analgesia[34,35,67,72,76] 3. Type of opioid (except meperidine)[78,82,84–86]

Other comorbid medical diseases increase the likelihood of developing postoperative delirium. Diabetes, stroke, peripheral vascular disease, atrial fibrillation, heart failure, anemia, and prior or perioperative myocardial infarction increase the probability of postoperative delirium according to some studies, but these are not consistently associated.[3,7,9,10,32,36,40,49,52,57] Poor nutritional status increases the risk for delirium fourfold.[31,39,58] A higher number of comorbidities[57] and higher severity of illness based on Acute Physiology and Chronic Health Evaluation, version 2 (APACHE II) score[41] also predict greater risk.

Prior psychiatric disease may augment delirium risk. A history of delirium is reported to increase risk,[42] although other studies refute this association.[9] Preexisting depression and higher number of depressive symptoms on the Geriatric Depression Scale are associated with postoperative delirium[8,9,41,43,59] and longer duration of episodes,[50,60] with 1 study reporting a threefold increase in risk.[38] No relationship between preoperative anxiety and postoperative delirium has been shown.[61,62]

Social and lifestyle factors may also exert an effect on the development of postoperative delirium. Some studies,[34,35,37] but not all,[9,14,38,43,49,62] have reported that alcohol use or abuse increases risk for delirium. Past or present tobacco use increases risk,[3,9] with the number of pack-years smoked being the most important factor.[50] Again, this association is not consistently demonstrated.[7,49,57] Marital status may also play a role; those who are single, widowed, separated, or divorced are at a higher risk.[50]

There is limited evidence to suggest that genetics may play a role in the development of postoperative delirium. In 1 study, apolipoprotein E ϵ4 carrier status conferred an almost fourfold higher risk after adjusting for covariates, such as age, education, and functional status.[63] However, another study found no effect.[45] It remains to be determined if this association occurs independent of dementia.

PRECIPITATING RISK FACTORS

The type of surgery affects the delirium rates. The incidence is highest after orthopedic procedures, with a range of 16% to 62% after femoral neck fracture repairs.[64] Estimates for delirium after vascular surgery are 29.1% to 42.3%.[39,65] The incidence of postoperative delirium after cardiac surgery is 8.4% to 41.7%.[10,32,52,57] Specifically, risk with valve surgery is greater than with coronary artery bypass grafting surgery,[10] almost fourfold higher according to one study.[52] After general surgery, delirium occurs 7% of the time,[66] but estimates increase to 26% after major abdominal surgery for cancer (mainly colectomy).[67] Data on the incidence of delirium after laparoscopic surgery are scarce. In contrast to the more invasive surgeries mentioned earlier, delirium after cataract surgery occurs less than 5% of the time.[68,69]

Emergency surgery, as opposed to elective surgery, may also increase delirium risk. A meta-analysis of 26 studies found a 16.2% increase in absolute risk for delirium in hip fracture patients compared with patients undergoing elective orthopedic procedures,[70] with 1 study implicating greater pain in the fracture group as a possible explanation.[14] Longer waiting times for operations after hip fracture may also increase risk.[11] Urgent or emergent cardiac operations, compared with elective surgery, are associated with higher incidence of delirium postoperatively,[7,10] but no difference was seen when urgent and elective thoracic surgeries were compared.[40] Agnoletti and colleagues[71] are currently conducting a study to investigate further the effect of elective versus emergency surgery on postoperative delirium.

There is no consensus on the effect of intraoperative factors on delirium risk. Some studies report no association between total surgery duration and delirium,[9,32,46,50,62] whereas others demonstrate higher risk after longer operations.[7,10,39,40] There is no difference in delirium rates for those receiving general versus regional anesthesia.[43,48,59,72] Comparisons among various anesthetic agents also reveal similar incidence.[33,73] Intraoperative hypotension may be a risk factor for delirium,[13] but again, this is not consistently identified.[9,72] Hemodynamic instability or requiring an intra-aortic balloon pump increases the risk for delirium after cardiac surgery by as much as 24%.[7,10]

Immediate postoperative events, such as hypoxemia,[59,62] dehydration,[74] and disturbances of sodium, potassium, and glucose increase the risk for developing delirium.[9,37,38,40,42,49] Postoperative RBC transfusion requirement, especially for a hematocrit value of less than 30%, may augment risk,[7,9,10,72] although some studies do not show any relationship.[40] Sleep deprivation increases the likelihood,[40] as does the presence of a urinary catheter.[31] Each day of delayed ambulation after hip surgery confers a 72% increased risk for delirium.[75] There are no data on the effect of postoperative hypotension and delirium risk.

Poorly controlled postoperative pain is a risk factor for delirium.[35,43] Patients with severe pain are 9 times as likely to develop delirium.[36] Interestingly, higher pain scores at rest are predictive compared with those for pain with movement or maximal pain.[35,36] Comparisons among epidural, intravenous, intrathecal, and oral postoperative analgesia show no difference in delirium rates.[34,35,67,72,76] However, oral agents may reduce likelihood,[43,77] with 1 study estimating a fourfold reduction with oral opioids versus intravenous patient-controlled analgesia opioids.[33]

Polypharmacy is a risk factor for delirium, as are certain classes of medications. Drug toxicity accounts for up to 40% of delirium in medical and surgical patients.[1] Starting more than 3 new medications increases risk by almost threefold.[31] Preoperative, perioperative, and postoperative use of benzodiazepines augments risk by almost threefold.[18,33,42,50,78] Anticholinergic medications are hazardous,[59,79,80] especially diphenhydramine.[81] Some data suggest that preoperative antidepressant use and antipsychotics also increase risk.[18,42,50] Preoperative chronic use of opioids is associated with delirium,[42] although in this case, delirium may be a surrogate for pain severity.

Among opioids, only meperidine increases risk for delirium,[36,78,82] probably because its metabolite normeperidine has anticholinergic and stimulant activity in the central nervous system. However, none of these cohort studies comments on the efficacy of analgesia, which may play an important role.[83] Morphine, fentanyl, hydromorphone, tramadol, oxycodone, and codeine are all associated with similar rates of delirium.[78,82,84–86]

PREVENTION

Delirium is an adverse outcome and often an indicator of the quality of health care.[87] Moreover, as much as 50% of the delirium in medical and surgical patients can be prevented.[87] Modification of known risk factors remains the cornerstone of all strategies.

The data are scarce regarding interventions related to the surgery itself. Beating-heart cardiac surgery (off-pump) may lower the incidence of delirium when compared with conventional cardiopulmonary bypass, but the off-pump group in this nonrandomized study had more favorable baseline characteristics, which may have decreased their likelihood for developing delirium.[10]

Given that there are usually several risk factors present, it logically follows that most interventions are multimodal. Rarely is one intervention implemented alone. Inouye and colleagues[88] intervened on 6 risk factors in geriatric medical patients (cognitive impairment, sleep deprivation, immobility, dehydration, visual impairment, and hearing impairment) and showed an absolute risk reduction in delirium of 6.1% compared with usual care. Frequent orientation, sleep hygiene, early mobilization, visual aids and large print books, hearing aids, and early recognition of dehydration were components of the intervention group. Another randomized study compared postoperative usual care with care given in a specialized geriatric ward after hip fracture surgery. The interventions were numerous, but included an almost 1:1 nurse/aide-to-patient ratio, staff education, interdisciplinary teams, individual care planning, active prevention of complications, including urinary tract infections, constipation, falls, anemia, supplemental oxygen, active nutrition, and early mobilization. The intervention group experienced an absolute risk reduction of 20.4%; the duration of delirium was almost half that of controls, and they remained in the hospital for a fewer number of days.[6] Combining pre- and postoperative geriatric assessments, early surgery, supplemental oxygen, close monitoring of blood pressure to reduce hypotension, and treatment of postoperative complications for hip fracture patients reduced the incidence, severity, and duration of delirium episodes, but this study was not randomized.[89]

Geriatric consultation alone reduces the incidence of delirium. A randomized trial of hip fracture patients comparing proactive geriatric consultation with usual care resulted in a number needed to treat of 5.6 patients to prevent 1 case of delirium, and the reduction was more robust in preventing severe delirium.[90] On average, 9.5 recommendations were made for each patient, relating to oxygen delivery, environmental modifications, fluid/electrolyte management, pain, medications, bowel/bladder function, nutrition, mobilization, prevention, detection and treatment of complications, and treatment of agitation. Other studies corroborate the benefits of a perioperative comprehensive geriatric assessment.[91]

Environmental modifications may influence delirium rates. Interventions as simple as music therapy during the postoperative period reduce the rates of delirium.[92] One study reported higher incidence of delirium in the winter,[93] suggesting that access to sunlight may be important. Improving ward conditions with spacious rooms, community dining, and unrestricted visiting hours, and encouraging family members to visit and bring familiar items from home are beneficial.[94]

Improving staff awareness, education, and continuity is valuable. Although no reduction in the incidence of delirium was seen, educating the nursing staff, systematically screening all patients, and using a pain-management protocol decreased the duration of delirium episodes in 1 nonrandomized trial.[95] Improving continuity of care has been implemented as part of multifactorial strategies,[94] but the data on the benefit of this intervention are limited.

Several methods to restore normal sleep–wake cycles have been studied. Bright light therapy had no effect on the incidence of delirium in 1 small, randomized study.[96] In another prospective, randomized trial, administration of flunitrazepam, pethidine (meperidine), and diazepam postoperatively resulted in an absolute risk reduction of 30% for developing delirium.[97] However, these medications can precipitate delirium and generally are not recommended for use in the elderly.[33,36,42,50,78,82,98] Lastly, case reports suggest that melatonin might be helpful in the prevention and treatment of delirium.[99]

Various medications have been prescribed in an attempt to reduce the incidence of delirium. A randomized trial of patients who underwent elective cardiac surgery demonstrated an absolute risk reduction of 20.6% when the patients were given 1 mg of risperidone once on awakening.[100] Haloperidol, 1.5 mg daily, did not reduce the incidence of delirium, but the severity and duration of symptoms were decreased.[101] As an adjunctive pain medication and opioid-sparing agent, gabapentin, 900 mg daily, significantly reduced the incidence of postoperative delirium, but this study enrolled only 21 patients with a mean age of about 60 years.[102] Two small studies randomized participants to donepezil 5 mg daily or placebo before elective orthopedic surgery and found no difference in the rates of postoperative delirium.[103,104]

In addition to the immediate benefits, preventive strategies reduce subsequent health care costs. Leslie and colleagues[105] followed patients, who had participated in a randomized study aimed at the prevention of delirium, for 1 year. Although both intervention and control arms had similar rates of long-term institutionalization, those in the intervention group used 15.7% fewer health care dollars (almost $10,000 less annually), primarily because of shorter duration of nursing home stays (mean stay: 241 days for intervention group vs. 280 days for usual care).

CLINICAL PRESENTATION

Hallmarks of delirium include inattention, disorientation, and disorganized thinking. Patients may be aware of their delirium and report confusion. The onset is acute,

and impairments fluctuate within the course of a day. Altered behavior, memory problems, irritability, changes in sleep cycle, and hallucinations may also occur.

Three categories of delirium exist: hyperactive, hypoactive, and mixed.[106] Psychomotor agitation characterizes the hyperactive form, which can be accompanied by diaphoresis, tachycardia, xerostomia, mydriasis, tremor, and combativeness. These manifestations are more commonly identified early in the course, as they often disrupt and interfere with medical care. The hypoactive form, less easily recognized,[107] consists of low psychomotor activity and somnolence. Hallucinations, perceptual disturbances, and delusions occur with either subtype.[108] A systematic review of 10 studies revealed no consensus as to which type is more common in medical and surgical geriatric patients.[109] Some studies report that after hip surgery hypoactive delirium is more common,[110] whereas others report a higher proportion of the hyperactive form.[111] This discrepancy may be because of the lack of a standardized assessment tool to differentiate among the subtypes of delirium.[109]

DIAGNOSIS

The American Psychiatric Association describes the diagnostic criteria for delirium in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR).[112] The diagnostic criteria for delirium include the following: (1) disturbance of consciousness (ie, reduced clarity of awareness of the environment) with reduced ability to focus, sustain, or shift attention; (2) a change in cognition (such as memory deficit, disorientation, and language disturbance) or the development of a perceptual disturbance that is not better accounted for by a preexisting, established, or evolving dementia; (3) development of the disturbance over a short period of time (usually hours to days), with a tendency for it to fluctuate during the course of the day; and (4). There is also evidence from the history, physical examination, or laboratory findings that the disturbance is caused by the direct physiologic consequences of a general medical condition.

Delirium is a clinical diagnosis without a ''gold standard'' diagnostic test. Initial laboratory investigation should include a complete blood count, electrolytes, blood urea nitrogen, creatinine, glucose, calcium, magnesium, phosphorus, hepatic function panel, urinalysis, arterial blood gas, ECG, and chest radiograph.[113] Abnormalities on the ECG should prompt analysis of serial cardiac enzymes, even in the absence of cardiac symptoms, such as chest pain or shortness of breath. Findings on history and physical examination should guide further laboratory investigation, such as urine toxicology screen or serum levels of medications. An electroencephalogram may be useful if seizure disorder is suspected.[30] Neuroimaging is indicated when focal neurologic deficits are identified or there is a history of head trauma.[30] Given that postoperative stroke incidence increases with age[114,115] and acute stroke is often associated with delirium,[116] neuroimaging may be useful in evaluating for a new stroke or intracranial hemorrhage even in the absence of new neurologic deficits.

Various delirium-screening instruments exist for clinical and research use (**Table 2**). A comparison of 13 instruments recommends the NEECHAM confusion scale (NCS, named after its developers Neelon and Champagne) and delirium observation screening (DOS) scale for screening high-risk, hospitalized elderly patients.[117] The NCS is the only instrument to include physiologic parameters, such as vital sign stability and urinary incontinence, and the scale is 86% to 100% sensitive and 86% to 90% specific.[118,119] The DOS is easy to use and, therefore, is preferred over the NCS; the DOS is 89% sensitive and 88% specific.[119,120]

Table 2
Comparison of common screening and diagnostic instruments

Instrument	Variables Evaluated	Comments

NCS[118,119]	• Processing—attention, following commands, orientation
	• Behavior—appearance, motor, verbal
	• Physiology—vital signs, urinary continence
	  • Systolic BP <100 or >160
	  • Diastolic BP <50 or >90
	  • Heart rate <60 or >100 bpm
	  • Respiratory rate <14 or >22 per min
	  • Room air oxygen saturation <93%
		• Only instrument to include physiologic parameters
		• 86%–100% sensitive
		• 86%–90% specific

Delirium Observation Screening Scale (DOS)[119,120]	• Intermittent somnolence • Easily distracted • Attention • Gives incomplete answers • Gives inappropriate answers • Reaction time • Oriented to place • Oriented to time • Short-term memory • Restlessness • Agitation • Labile affect • Perceptual disturbances	• Initial scale included 25 items, which was modified to 13 items • Takes <5 min to complete • 89% sensitive • 88% specific
Confusion Assessment Method (CAM)[121]	• Inattention • Acute onset and fluctuating course and • Altered level of consciousness or • Disorganized thinking	• Most commonly used • Takes <5 min to complete • 94%–100% sensitive • 90%–95% specific
Delirium Rating Scale-Revised-98 (DRS-R-98)[123]	• Sleep–wake cycle disturbance • Perceptual disturbances and hallucinations • Delusions • Lability of affect • Language • Thought-process abnormalities • Motor agitation • Motor retardation • Orientation • Attention • Short-term memory • Long-term memory • Visuospatial ability • Temporal onset of symptoms • Fluctuations in symptom severity • Physical disorder	• Also assesses severity of symptoms • 91%–100% sensitive • 85%–100% specific

Abbreviations: BP, blood pressure; bpm, beats per minute.

The Confusion Assessment Method (CAM), considered the best diagnostic tool,[117] looks for the following features (1) inattention, (2) acute onset and fluctuating course, (3) altered level of consciousness, and (4) disorganized thinking. When patients show features 1 and 2 and either feature 3 or 4, the CAM is 94% to 100% sensitive and 90% to 95% specific for diagnosing delirium.[121] All the aforementioned instruments require a verbal patient; hence, the CAM-ICU was developed for ventilated patients; it has 93% to 100% sensitivity and 98% to 100% specificity compared with expert diagnosis of delirium.[122]

The Delirium Rating Scale-revised-98 (DRS-R-98) is yet another tool that is 91% to 100% sensitive and 85% to 100% specific in diagnosing delirium and distinguishing it from dementia, depression, and schizophrenia.[123] Observations of sleep–wake cycle, perceptual disturbances and hallucinations, delusions, lability of affect, language, thought processes, motor agitation or retardation, orientation, attention, short- and long-term memory, visuospatial ability, temporal onset of symptoms, fluctuations in symptom severity, and underlying physiologic, medical, or pharmacologic disorders are included. Although more time-consuming than the CAM, the added benefit of the DRS-R-98 is that it evaluates delirium severity and is helpful in the context of prior psychiatric disorders.[123]

Despite sensitive and specific screening tests, delirium remains underrecognized[107] with up to two thirds of cases being missed by physicians.[30] One study revealed that requests for psychiatric consultation for depression were actually delirium or dementia in up to 52% of referrals.[124] Inouye and colleagues[107] demonstrated that nurses were more likely to miss the diagnosis of delirium if patients exhibited the hypoactive form, had dementia, had vision impairment, or were 80 years or older. Many of these variables are characteristics that place patients at a higher risk for developing delirium. Inouye and colleagues[107] estimated that patients with 3 or 4 risk factors for delirium have a 20-fold risk for delirium underrecognition by nurses. Staff training may be another factor; 1 study suggests that the sensitivity of the CAM depends on the training background of the operator.[125]

MANAGEMENT

Identification and treatment of the underlying causes of delirium are essential. This remains a difficult task, given that there may be many contributing factors, and the elderly often present with nonspecific findings. In one study of delirium after hip fracture surgery, only 7% were assigned a definite cause and 61% were presumed to be related to a comorbid condition. In addition, 74 identifiable causes were attributable to the 33 comorbid cases, suggesting that, frequently, there is more than one causative factor.[126] A careful review of the patient's medication list is of paramount importance.[30] Apart from treating the underlying condition, management strategies are categorized into supportive measures and symptom control.

Supportive measures are geared toward maintaining patient safety and include many of the preventive strategies. A multidisciplinary approach emphasizing frequent reorientation, appropriate stimulation, environmental safety, and patient comfort is crucial. Geriatric consultation may help modify known risk factors. Physical restraints should be avoided because they may worsen confusion; use of restraints placed patients at a fourfold higher risk for developing delirium in 1 study.[31] A one-on-one companion is often helpful in reorienting the patient and ensuring safety.

Symptom control for agitation and aggression may be necessary to ensure patient and staff safety, but such measures should not delay the diagnosis of an underlying cause. Antipsychotics are first-line, with haloperidol being the preferred agent

because of its minimal anticholinergic side effects and lack of active metabolites. Starting doses of as low as 0.25 to 0.50 mg every 4 hours as needed are recommended in the elderly.[113] Only a few trials have compared haloperidol with the newer, atypical antipsychotics, and a meta-analysis revealed no difference in efficacy and tolerability between low-dose haloperidol and olanzapine or risperidone.[127]

Benzodiazepines are not recommended to treat delirium unless the underlying cause is withdrawal from alcohol or benzodiazepines.[113] Lorazepam, with its short half-life and absence of active metabolites, is preferred in the elderly, with starting doses of as low as 0.5 mg. If both antipsychotics and benzodiazepines are used, the doses of each should be decreased because they work synergistically.

Given the side-effect profiles of antipsychotics and benzodiazepines, studies have been conducted on other medications to treat delirium. Intravenous administration of the serotonin receptor antagonist ondansetron to postoperative delirious patients resulted in improvements in consciousness, awareness, and agitation.[128] However, this was a nonrandomized, nonblinded study, the delirium diagnostic tool was not validated, and long-lasting improvements in mental status were not evaluated. Case reports suggest that cholinergics, such as physostigmine, may be useful in delirium known to be caused specifically by anticholinergic medications.[129]

Lastly, patient and family education on delirium should take place.[113] The experience takes a psychological toll on patients and families, especially when psychotic symptoms occur. Emphasizing the temporary nature of the condition, its reversibility, and its relationship to the underlying cause are critically important. Limited data exist on the effectiveness of these efforts, but surveys of family members of patients with terminal delirium in palliative care units suggest they are helpful.[130]

OUTCOMES

Mortality is higher for those who experience postoperative delirium,[2,3] in the immediate postoperative setting[7] and up to 1 year after surgery.[4] Morbidity in the medical, functional, psychological, and social domains is also affected.

Patients with postoperative delirium are at increased risk for experiencing other medical postoperative complications.[2,5] Studies show higher rates of falls, pressure ulcers, urinary infections, wound infections, aspiration, pneumonia, need for urinary catheters, malnutrition, perioperative myocardial infarction, and atrial fibrillation.[6–8] Delirious patients often require longer intubations and re-intubations,[7,10] use more hospital resources, spend longer time in the intensive care unit,[5,9,10] and remain in the hospital longer than their nondelirious counterparts.[3,5,10,13,42,59]

Postoperative delirium increases the risk for subsequent functional loss and institutionalization. Fewer delirious patients are able to continue living at home[11] or with family members[5] after hospital discharge, and many require nursing home placement,[2] confirming the association between delirium and loss of independence. Six months after hip fracture surgery, those with delirium are more likely to have reduced walking ability[2,8] and be wheelchair-bound or bedridden.[11] Delirious patients experience subsequent decline in ADLs,[2] which persists even a year after surgery.[4]

Postoperative delirium is a risk factor for subsequent cognitive decline. Confusion can remain for up to 6 months after an episode of delirium.[2] Delirious patients are more likely to experience a decline in subsequent MMSE scores[12] and have a higher likelihood of developing dementia.[13] It is possible that some patients have unrecognized preexisting cognitive impairment, which the delirium unmasks, but most studies report preoperative MMSE scores indicating normal cognitive function.

Quality-of-life measures are affected during and after an episode of delirium. Patients with delirium are more likely to report sleep dissatisfaction[14] and insomnia[8] in the immediate postoperative period.[14] They are at risk for more episodes of subsequent delirium and are more likely to be depressed.[8] Lower self-rated well-being[8] and declines in health-related quality of life[12] persist for up to 6 months after delirium. Lastly, a study of delirious cancer patients found that most patients recall their delirious episodes, and when they do, they suffer subsequent psychological distress as do their family members and caregivers.[15]

RECOMMENDATIONS AND CONCLUSIONS

Modeling of the preventive multidisciplinary strategies used in trials is ideal but not always feasible. Interventions that can be implemented by a surgical team preoperatively and postoperatively are listed in **Box 1**. In addition, specific diagnostic tools and treatment plans based on a review of the literature are presented in **Box 2**.

In the preoperative period, recognition of predisposing factors, although usually nonmodifiable, is essential to identify patients at risk for developing postoperative delirium. A Folstein MMSE or clock-drawing test should become part of the routine preoperative assessment to assess cognitive impairment. Additionally, vital signs, such as blood pressure and oxygen saturation before surgery should be stabilized, electrolyte imbalances (especially disorders of sodium and potassium) should be identified and treated, reasonable glycemic control should be enforced, and volume status should be monitored. Geriatric consultation should be requested for vulnerable elderly patients undergoing major surgery, especially orthopedic and cardiac procedures. Vulnerability includes poor self-rated health, functional disabilities (such as ADL impairment), limitations in physical functioning (such as difficulty carrying 10 lb or walking one-quarter of a mile), and age older than 75 years.[131] For these patients, preoperative geriatric consultation can assist in identifying the risk factors for postsurgical

Box 1
Summary of recommended perioperative actions for the surgical team

Preoperative actions

- Assess baseline risk with MMSE or clock drawing test
- Optimize vital signs (BP, oxygen saturation)
- Treat electrolyte imbalances
- Maintain glycemic control
- Monitor volume status
- Geriatric consultation for vulnerable elderly undergoing major surgery
- Consider psychiatric consultation for evaluation and treatment of depression

Postoperative actions

- Optimize awareness of and interaction with environment
- Ensure adequate pain control
- Avoid meperidine, benzodiazepines, and anticholinergics (diphenhydramine)
- Ensure early ambulation
- Remove urinary catheters as soon as possible

Box 2
Diagnostic and treatment recommendations for the surgical team

Diagnosis

- Maintain high index of suspicion
- Use the CAM for quick and accurate diagnosis
- Investigate for underlying causes

Treatment strategies

- Treat the underlying causes
- Emphasize patient safety
- Ensure adequate nutrition and hydration
- Avoid restraints; consider ordering one-on-one companion
- Use low-dose haloperidol for symptom control
- Educate patient and family

complications and suggest preventive strategies. In addition, recommendations based on the Assessing Care of Vulnerable Elders Project Quality Indicators[132] specific to medication management, pain control, bowel and bladder function, nutrition, and mobilization may benefit patients. Lastly, the team should consider psychiatric consultation for evaluation and treatment of depression, although this may be more helpful in the weeks before surgery rather than in the days preceding the operation.

In the postoperative period, the patient's awareness of and interaction with his or her environment should be optimized through the use of visual aids, hearing aids, familiar visitors, frequent reorientation, and access to sunlight. Ensuring adequate pain control is essential; the use of opioids may be necessary, but meperidine should be avoided. Other medications, such as benzodiazepines and anticholinergics, especially diphenhydramine, are equally dangerous for the elderly patient. Ambulation should occur as soon as possible, along with prompt removal of urinary catheters.

Timely diagnosis of delirium necessitates a high index of suspicion on the part of the surgical team. Any change in clinical or mental status should prompt a thorough investigation. Of the many diagnostic instruments available, the authors recommend the CAM. Searching for the underlying causes is a necessary component of the diagnostic endeavor.

Regarding management strategies, the priorities are ensuring appropriate nutrition and hydration and emphasizing patient safety while treating the underlying causes. Restraints should be avoided and a one-on-one companion should be considered instead. When medications are required for agitation or aggression, low doses of haloperidol (0.25–0.5 mg) should be given and titrated to symptom control. The patient and his or her family should be educated about the condition and its expected course.

In summary, postoperative delirium commonly afflicts the geriatric population, but is often unrecognized despite sensitive and specific screening and diagnostic instruments. Predisposing and precipitating factors interact to confer risk for developing postoperative delirium, and it is both helpful and feasible for the surgical team to implement preventive strategies aimed at modifying those risk factors. Management consists of treating the underlying causes, providing supportive measures, and using antipsychotics for agitation. The consequences of postoperative delirium can be devastating and impact mortality and morbidity in the medical, functional, psychological,

and socioeconomic domains. Improving recognition and treatment of this condition will benefit patients and mitigate a significant economic burden.

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