Preventing Postoperative Complications in the Elderly

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The population is aging because better medical care and living conditions have allowed people to reach an older age in better health than previously possible.1 As the elderly have continued to increase in number, so has the number of surgical procedures performed on this segment of the population. Orthopedic surgery provides an example of this phenomenon. From 1990 to 2004, the number of total hip arthroplasties performed increased by 158%.2 Adjusted rates of cervical spine fusions in the elderly increased by 206% from 1992 to 2005.3 In the Medicare population, from 1979 to 1992, rates of surgery for spinal stenosis increased 8-fold.4 Other surgical specialties, such as urology, have seen similar changes as demonstrated by a greater than 40% increase in surgical procedures for urinary incontinence in elderly women, from 1991 to 2001.5 Therefore, the practicing anesthesiologist can expect to manage ever-greater numbers of geriatric patients in the future.

Outcome studies demonstrate that morbidity and mortality are increased following surgery in the elderly as compared with the younger population.6 Among the many factors contributing to increased surgical morbidity and mortality,7 perioperative complications are directly related to poor outcome in the elderly.8 In a study examining the effect of age on perioperative complications, Polancyzk and colleagues9 showed

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that fatal and major complications increase with age. In addition, perioperative complications in the elderly are associated with greater mortality. Hamel and colleagues showed that patients aged 80 years and older with complications after a major surgery have a 25% greater 30-day mortality than patients without complications. Thus, quality initiatives with great potential for improving surgical outcomes in elderly patients should target the prevention of perioperative complications.

This review outlines evidence-based quality initiatives focused on decreasing postoperative complications in the elderly surgical patient. Of the many types of postoperative complications that may occur in the elderly, neurologic, pulmonary and cardiac morbidity is most common with a reported incidence of 15%, 7%, and 12%, respectively. Because these types of complications form the largest part of postoperative morbidity, this discussion focuses on evidence-based guidelines to prevent neurologic, pulmonary, and cardiovascular complications in the elderly.

NEUROLOGIC COMPLICATIONS

Neurologic complications are the most common type of complication in the geriatric surgical population. Postoperative delirium is the most frequent type of neurologic complication, with an incidence ranging from 15% to 53%, depending on the type of procedure. Other important postoperative neurologic complications in the elderly include stroke and peripheral nerve injury. Because of its overwhelming importance, this discussion focuses on quality initiatives for prevention of delirium.

Delirium Quality Control Initiatives Based on Randomized Controlled Trials

At present, the Cochrane Database has identified only 2 interventions that have definitively demonstrated through randomized clinical trials to prevent delirium in hospitalized patients. One intervention is the use of structured clinical protocols to assist in preventing episodes of delirium. Specialist delirium units that concentrate on the assessment of delirium risk factors and targeted risk factor modification represent a best practice model and should be a mainstay of clinical care. Table 1 outlines the risk factors specifically targeted with standardized protocols for management, including cognitive impairment, sleep deprivation, immobility, visual and hearing impairment, and dehydration. An alternative to the delirium unit is a combined geriatric-orthopedic approach using proactive geriatric consultation focused on modification of the above-mentioned risk factors. This type of surgical care model was found to decrease delirium incidence in patients with hip fracture by more than one-third.

A second intervention that decreases the severity of postoperative delirium is the prophylactic administration of haloperidol. This strategy has concentrated on patients undergoing orthopedic procedures. Low-dose haloperidol (1.5 mg/d) given prophylactically to elderly patients who underwent hip surgery does not reduce the incidence of postoperative delirium but decreases the severity and duration of the delirium episodes. Use of low-dose prophylactic haloperidol should be considered in vulnerable populations undergoing high-risk procedures.

Delirium Quality Control Initiatives Based on Analysis of Prospective and Retrospective Data Sets

The remainder of the quality initiatives to be discussed focuses on delirium prevention via control and/or elimination of modifiable risk factors. These risk factors for postoperative delirium have been determined via analysis of prospective and retrospective data sets. Except when specifically mentioned in this article, there are no definitive
randomized trials that test the effects of risk factor modification on postoperative delirium.

**Comorbidities**

The 2 most important risk factors associated with postoperative delirium are advanced age and dementia.\(^{19}\) It is important to systematically evaluate older surgical patients for the possibility of dementia. This assessment identifies patients at high risk for postoperative delirium. Identifying vulnerable individuals allows for the possibility of instituting structured delirium protocols or prophylactic drug administration.

Despite the fact that dementia is closely associated with the onset of postoperative delirium, there is no evidence that many of the drugs used in managing dementia have efficacy in preventing delirium. Donezepil, when given prophylactically, does not decrease delirium incidence in elderly patients undergoing total joint replacement.\(^ {20,21}\) Similar studies with rivastigmine have also reported negative results.\(^ {22}\)

Abnormal preoperative laboratory values (especially level of electrolytes and glucose)\(^ {23}\) and hemoglobin levels less than 10 g/dL\(^ {24}\) have been associated with postoperative delirium. Requirements for postoperative blood transfusion have also been associated with delirium.\(^ {24,25}\) Correction of abnormal preoperative laboratory values is an important intervention in decreasing postoperative delirium. However, whether blood transfusion to increase hemoglobin levels has a significant effect on delirium severity has not been established. Recent evidence from randomized controlled trials suggests that transfusion alone is unlikely to affect the course of delirium in elderly patients with low postoperative hemoglobin levels.\(^ {26}\)

**Pain management**

Control of postoperative pain is important in preventing delirium. Higher pain scores at rest during the first 3 postoperative days are associated with postoperative delirium in patients undergoing noncardiac surgery.\(^ {27}\) Increased levels of both preoperative and

<table>
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<th>Risk Factor</th>
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| Cognitive impairment | Orientation protocol: board with names of care team members and day's schedule; communication to reorient to surroundings  
Therapeutic activities protocol: cognitively stimulating activities thrice daily (eg, discussion of current events or word games) |
| Sleep deprivation    | Nonpharmacologic sleep protocol: at bedtime, warm milk or herbal tea, relaxation tapes or music, and back massage  
Sleep-enhancement protocol: unit wise noise reduction strategies, and adjust schedules to allow sleep (eg, medications and procedures) |
| Immobility           | Early mobilization protocol: ambulation or active range of motion exercises thrice daily, minimal use of immobilizing equipment |
| Visual impairment    | Vision protocol: visual aids (glasses or magnifying lens) and adaptive equipment (eg, large print books) with daily reinforcement of their use |
| Hearing impairment   | Hearing protocol: portable amplifying devices, earwax removal, and special communication techniques with daily reinforcement of these adaptations |
| Dehydration          | Dehydration protocol: early recognition of dehydration and volume repletion (encourage oral intake of fluids) |

postoperative pain are risk factors for development of postoperative delirium.\textsuperscript{28} In the hip fracture population, Morrison and colleagues\textsuperscript{29} found that cognitively intact individuals with poorly controlled pain were 9 times more likely to become delirious.

When selecting narcotics for pain management, there is no difference in cognitive outcome when comparing fentanyl, morphine, and hydromorphone.\textsuperscript{30} Meperidine is the only narcotic that has been definitively associated with delirium.\textsuperscript{31,32} However, one prospective case series demonstrated an association between oral opioid administration and decreased risk of developing delirium as compared with an intravenous patient controlled analgesia.\textsuperscript{28} To summarize narcotic pain management in populations at risk for delirium, the strongest evidence is in support of avoiding meperidine, and evidence is weaker that mode of administration is an important factor.

Opioids themselves may induce delirium, and elderly patients have increased cerebral sensitivity to opioids.\textsuperscript{34} To circumvent these effects, nonopioid analgesics are increasingly used as a part of a multimodal pain management regimen. Several randomized studies have demonstrated that nonopioid-based analgesics decrease postoperative pain and the need for opioids.\textsuperscript{35,36} In addition, meta-analysis has demonstrated that nonsteroidal antiinflammatory drugs are associated with a 30\% to 50\% decrease in opioid consumption and decreased morphine-associated side effects.\textsuperscript{37} Given this result, a multimodal approach to pain management using nonsteroidal antiinflammatory agents or other nonopioids allows lower doses of drugs to be used, thus helping to reduce potential side effects.\textsuperscript{38}

**Sedatives**

Sedative medications are iatrogenic risk factors for delirium in patients in the intensive care unit (ICU).\textsuperscript{39} The use of opioids is strongly related to the development of ICU delirium.\textsuperscript{40} Similarly, benzodiazepines such as lorazepam are an independent risk factor for the transitioning of patients in the ICU into delirium.\textsuperscript{41} Among drugs commonly used in anesthetic practice, benzodiazepines\textsuperscript{31} have been implicated in the development of delirium. Dexmedetomidine may be the drug of choice for long-term sedation in the ICU because several studies have demonstrated that its use leads to a decreased incidence of ICU delirium.\textsuperscript{42,43} To date, there are no studies that demonstrate that dexmedetomidine has similar effects on delirium in the operation room setting.

**Medication management**

Preoperative drug-related risk factors for delirium include treatment with multiple psychoactive and multiple drugs and alcohol abuse.\textsuperscript{13} Drug-related risk factors that may precipitate postoperative delirium include the use of sedatives, narcotics, and/or anticholinergics; polypharmacy; and alcohol or drug withdrawal.\textsuperscript{13} The major psychoactive drugs associated with delirium are sedatives and narcotics, which have been discussed previously. The general consensus is that medications with anticholinergic effects should be avoided\textsuperscript{44} because such drugs are associated with increased central effects.\textsuperscript{45} Simplification of the medication regimen is important to decrease the possibility of drug interactions involving the central nervous system. A patient’s medication profile should be carefully assessed for any drugs that have been associated with delirium in the elderly. Several reviews contain extensive lists of drugs known to provoke delirium.\textsuperscript{46,47} The Beers criterion for potentially inappropriate medications in the elderly is also a helpful guide in determining which medications to avoid or eliminate.\textsuperscript{48} However, it is important to emphasize that there is
conflicting evidence concerning the potential of many drugs and/or drug classes to provoke delirium (eg, anticholinergics\textsuperscript{32}). Therefore, the recommended quality initiatives concerning medication management do not focus on specific drugs. Rather, it is recommended that the patient’s medication regimen be simplified as much as possible and regularly assessed for drugs with the potential of precipitating delirium.

Alcohol abuse is a risk factor for postoperative delirium and postoperative cognitive decline.\textsuperscript{23,49} Alcohol abuse in the elderly is often underdiagnosed. The prevalence of problem drinking among the elderly is unclear.\textsuperscript{50} It is important to try and obtain an accurate history concerning alcohol use from the elderly surgical patient. This information can be used for planning postoperative care such as management of alcohol withdrawal symptoms and helps in determining if the patient will be at high risk for postoperative delirium.

**Anesthesia management**

Most studies examining elective surgery suggest no difference in postoperative delirium when regional and general anesthesia are compared.\textsuperscript{51} Many comparisons have been made among different general anesthetic regimens in terms of delirium prevention. The only positive outcome has been in patients who underwent cardiac surgery in whom administration of 0.5 mg/kg ketamine on induction was associated with decreased incidence of postoperative delirium in comparison to a fentanyl or etomidate anesthetic.\textsuperscript{52} However, the results require verification because the study was underpowered (n = 29/group).

Controlling the level of sedation during regional anesthesia prevents delirium in high-risk populations. A recent randomized double-blinded trial examined the question of whether light versus deep sedation can decrease the incidence of postoperative delirium.\textsuperscript{53} In elderly patients undergoing hip fracture repair with spinal anesthesia, patients were randomized to receive either light or deep sedation with propofol and followed up postoperatively for delirium. The study demonstrated that in this high-risk population, light sedation decreased the incidence of postoperative delirium by 50% compared with deep sedation. The effect was associated with a mean reduction of almost 1 day of delirium for the light sedation group. This study points excessive sedation during the perioperative period as a risk factor for delirium in highly vulnerable populations.

There is no clear consensus as to whether intraoperative hemodynamic management prevents postoperative delirium. Large retrospective analyses of geriatric populations have found no association between intraoperative hypotension or hemodynamic complications and increased delirium incidence.\textsuperscript{24} In randomized trials, hypotensive epidural anesthesia in elderly patients is not associated with an increased incidence of postoperative delirium.\textsuperscript{54} In contrast, hypotension may play a role in the development of delirium in select subpopulations. Yocum and colleagues\textsuperscript{55} demonstrated a relationship between intraoperative hypotension and postoperative cognitive decline in patients with preoperative hypertension. Until further studies are available, no recommendations for hemodynamic management can be made, concerning the prevention of postoperative delirium.

Summary of quality initiatives for delirium prevention in the elderly surgical patient.

1. Structured clinical protocols focused on risk factor modification for delirium management should be used via either specialized delirium units or geriatrician-led patient management. Many of these protocols are contained in the recent National Institute for Health and Clinical Excellence recommendations.\textsuperscript{56}

2. Prophylactic use of low-dose haloperidol for delirium in high-risk elderly orthopedic surgical populations should be considered.
3. Older surgical patients should be evaluated for dementia, and a history of alcohol abuse at the time of admission helps identify patients at high risk for postoperative delirium.

4. Correction of abnormal preoperative laboratory values (especially levels of electrolytes and glucose) is important.

5. When using narcotics for pain management, use of meperidine should be avoided.

6. A multimodal approach to pain management helps reduce the potential side effects of narcotics.

7. The patient’s medication profile should regularly be assessed for simplification, avoiding polypharmacy and drugs reported to precipitate delirium.

8. Dexmedetomidine may be the drug of choice for long-term sedation in the ICU.

9. During regional anesthesia in high-risk populations, the level of sedation should be monitored and deep sedation avoided.

**Cardiopulmonary Considerations**

In addition to neurocognitive complications in the elderly, cardiovascular and pulmonary issues present the largest risk to older patients in the postoperative period. The increased morbidity caused by these complications represents a combination of increased incidence of cardiac and pulmonary disease as well as an intrinsic vulnerability due to predictable age-related changes. Turrentine and colleagues examined the American College of Surgeons National Surgical Quality Improvement Program data from their institution from 2002 to 2005 and found that patients older than 80 years had higher morbidity and mortality (51% and 7%, respectively) than all patients (28.0% and 2.3%, respectively) following surgical procedures. Multiple studies have confirmed an excess in mortality and morbidity in older patients, especially following emergency procedures. There are limited data on successful postsurgical quality improvement initiatives specific to the elderly population. There are, however, several strategies to reduce cardiopulmonary complications that are highly applicable to the geriatric population.

**PULMONARY COMPLICATIONS**

As with other postoperative complications, pulmonary complications following surgery lead to increased morbidity, length of stay, and perioperative mortality in elderly patients. Manku and colleagues also found that older patients with in-hospital postoperative pulmonary and renal complications had increased mortality after hospital discharge, especially in the first 3 months. Although comorbidities predispose patients to postoperative complications, a recent systematic review of the available evidence reported that age remains a significant risk factor for pulmonary complications even after adjusting for the presence of comorbidities. When compared with patients younger than 60 years, the risk of a postoperative pulmonary complication is twice as high in patients aged 60 to 69 years and thrice in patients aged 70 to 79 years. Although it is known that older age is associated with an increase in pulmonary complications, there are few trials specifically addressing the reduction of complications in older patients per se, so most recommendations are extrapolated from general adult data.

**Pulmonary Quality Initiatives Based on Randomized Controlled Trials and Clinical Guidelines**

A rigorous review of available data identified patient-related and procedure-related risk factors for pulmonary complications following noncardiac surgery. Patient-related risk factors with good evidence include advanced age, American Society of
Anesthesiologists score greater than 2, congestive heart failure, functional dependency, and chronic obstructive pulmonary disease. The most important procedure-related risk factor with good evidence is the surgical site; unadjusted complication rates were 20% for upper abdominal surgery versus 8% for lower or 14% for any abdominal surgery, and abdominal, aortic, and thoracic surgeries carry the highest risk of a perioperative pulmonary complication. Additional procedure-related risks include emergency surgery, duration of procedure exceeding 3 hours, general anesthesia, and multiple transfusions.

The American College of Physicians has compiled several guidelines that provide recommendations on perioperative pulmonary care. The recommendations are applicable to older patients.

Pulmonary Risk Factors

Long-acting neuromuscular blockade
One of the few areas in the literature supported by good evidence addresses the administration of long-acting muscle relaxation agents. In a randomized controlled trial, Berg and colleagues compared long-acting with intermediate-acting muscle relaxants in 691 patients undergoing noncardiac surgery. They found that 26% of patients receiving pancuronium versus 5% receiving atracurium or vecuronium had residual block. In patients with residual blockade, those who had received pancuronium had a 17% rate of pulmonary complications compared with a 5% rate in patients who had received either atracurium or vecuronium. Although this trial was not designed to address age-related risk factors, the conclusions are highly relevant to the elderly patient for several reasons.

Advanced age is associated with a gradual decrease in chest wall compliance and decreased respiratory muscle strength, so any diminution in strength may lead to hypoventilation and postoperative pulmonary complications. In addition, older patients have blunted responses to hypoxia and hypercapnia, thus respiratory drive is also affected. To conclude, evidence supports that use of long-acting neuromuscular blockers, such as pancuronium, should be avoided in elderly patients.

Intraoperative anesthetic technique
The role of neuraxial anesthesia and analgesia in preventing complications is controversial. There are no good randomized trials specifically for elderly patients, although many older patients are included in most studies. The results of 2 meta-analyses reviewing outcome data in patients receiving general, epidural, or spinal anesthesia found some trends in improved outcomes in the epidural or spinal group. However, there are some major issues with the data. First, a large proportion of the surgeries were orthopedic surgeries, which by most criteria are relatively low-risk surgeries for pulmonary complications. Furthermore, the small subject numbers in several studies included and the lack of data regarding intraoperative and medication fluid use make it difficult to reach a conclusion about regional anesthesia. Postoperative analgesia seems to be superior to epidural analgesia for aortic and upper abdominal surgery but has not been shown to reduce the risk of pulmonary complications.

Lung expansion
Postoperative pain, drowsiness, immobilization, and bed rest are just few of the postoperative events that can lead to shallow breathing and the potential development of atelectasis and subsequent pulmonary complications. Lung expansion modalities include chest physiotherapy, deep breathing exercises, incentive spirometry, and continuous positive airway pressure. The goal of these procedures is to increase the postoperative functional residual capacity and expand partially or completely.
collapsed alveoli. A recent Cochrane meta-analysis included 1160 patients from trials comparing incentive spirometry to no respiratory treatments, physiotherapy, and deep breathing. Sufficient evidence to support the use of incentive spirometry postoperatively was not obtained. In contrast, the American College of Physicians clinical guidelines, developed following a systemic review of the literature, support the use of lung expansion modalities including both incentive spirometry and continuous positive airway pressure. The difference in evidence may reflect the methodologies of the review. The Cochrane review only included incentive spirometry, whereas the American College of Physicians guidelines included all modalities. The American College of Physicians reviews suggested that any of the above-mentioned interventions may be superior to no lung expansion, but it is not possible to recommend one particular modality.

**Surgery**

Surgical site is a significant risk factor for the development of postoperative pulmonary complications, and upper abdominal operation close to the diaphragm is a significant risk factor, with 13% to 33% complications compared with 1% to 16% in lower abdominal surgeries.

**Aspiration**

Aging is associated with a decrease in the usual protective reflexes in the oropharynx, predisposing to aspiration. Patients with swallowing disorders, Parkinson disease, and other neurologic syndromes are particularly at high risk. In cases in which the airway is unprotected and in the postoperative period, administration of sedatives should be carefully monitored and strict nil per os (NPO) guidelines adhered to even for minor noninvasive procedures.

**Recommendations**

1. There is good evidence to recommend avoiding long-acting muscle relaxants.
2. Postoperative pain control: it is not possible to recommend regional versus general anesthesia based on current evidence. However, evidence supports good pain control and epidural analgesia for aortic, vascular, and thoracic surgery.
3. There are conflicting recommendations on lung expansion in the postoperative period. However, given that elderly patients represent a high-risk group, there is probably benefit to providing incentive spirometry or other maneuvers to prevent prolonged atelectasis.
4. Aspiration risk is increased in the elderly and requires vigilant care.

**CARDIAC COMPLICATIONS**

The presence of cardiac disease increases with advanced age, and the number of older patients undergoing noncardiac surgery is also steadily increasing making appropriate cardiac care of elderly patients extremely relevant. Multiple indices have been developed over years to identify high-risk individuals before surgery. One of the most widely used is the revised cardiac risk index. This index identifies 6 independent risk factors that have been correlated with increased cardiac risk: ischemic heart disease, congestive heart failure, cerebral vascular disease, high-risk surgery, preoperative insulin for diabetes, and a creatinine value more than 2 mg/dL. Unlike the risk of pulmonary complications, age has not consistently been found to be an independent predictor of perioperative cardiac risk. However, the intraoperative or perioperative mortality is higher in geriatric versus younger patients in the event of an acute myocardial infarction. The 2009 American College of Cardiology...
Foundation/American Heart Association revised guidelines\textsuperscript{62,70–72} provide an extensive analysis of the available literature and have been recently revised to address controversial issues surrounding the administration of β-blockers. Several areas are important when considering risk reduction in the elderly patient, including the use of β-blockers and statins, the importance of blood pressure control perioperatively, and the utility of preoperative electrocardiography (ECG). The role of these issues in reducing cardiac complications is discussed briefly.

**Cardiac Quality Initiatives Based on Randomized Controlled Trials and Clinical Guidelines**

### β-blockers

Early data on perioperative β-blocker use resulted in widespread perioperative administration of β-blockers to low-risk and moderate-risk as well as high-risk patients. Data from a more recent randomized controlled trial including more than 8000 patients indicated a reduction in myocardial infarction, coronary revascularization, and atrial fibrillation within 30 days of surgery in the metoprolol versus placebo group. However, a significant increase in death, stroke, and hypotension and bradycardia. These data and others have resulted in a reevaluation of the recommendations on β-blockers use. The most recent guidelines\textsuperscript{70,73} recommend (class 1 evidence) that use of β-blockers should be continued during the perioperative period in patients who are already receiving β-blockers preoperatively. Class 2a evidence suggests that β-blockers should be administered to patients with inducible ischemia on testing before high-risk vascular surgery. There is also some evidence to recommend β-blockers for high-risk patients, defined as more than one clinical risk factor, undergoing vascular or intermediate surgery, with careful titration of heart rate and blood pressure. In contrast to the earlier guidelines, β-blockers are not recommended in patients undergoing low-risk surgery. These recommendations are not specific to the elderly but clearly affect a large percentage of vascular patients.

### Statins

Statins have been shown to reduce lipid levels, decrease vascular inflammation, and stabilize atherosclerotic plaques. Several trials have demonstrated significant benefits in patients with coronary artery disease, including a reduction in the incidence of myocardial infarction, stroke, and death.\textsuperscript{62,71} Recommendations for perioperative statin use are based on observational data and there are limited randomized trials. Current guidelines recommend that patients undergoing vascular surgery be started on statin therapy in advance of surgery, preferably 30 days. Abrupt discontinuation of use of statins has been associated with increased risk of myocardial infarction and death, and thus, continuing statin therapy in the perioperative period is recommended. Statins are not available for intravenous administration. However, there are extended-release formulations (eg, fluvastatin) available that may be used to bridge the NPO status over surgery.

### Hypertension

Hypertension is extremely prevalent among the elderly and is associated with increased incidence of coronary artery disease and other comorbidities such as cerebrovascular and renal disease. The perioperative period represents a unique opportunity to evaluate hypertensive therapy, compliance, and efficacy. Every effort should be made to control hypertension preoperatively, and it is also important to avoid abrupt discontinuation of antihypertensive therapy. Despite widespread prevalence of hypertension in the geriatric population, there is no strong evidence that stage 1 or 2 hypertension is consistently associated with increased cardiac risk during surgery.
However, hypertension is associated with increased lability of blood pressure, and intraoperative hypotension has been associated with postoperative myocardial infarction and mortality.\textsuperscript{74,75} In a prospective observational study of more than 8000 patients undergoing general, urological, and vascular surgery, Kheterpal and colleagues\textsuperscript{74} identified 9 risk predictors for a cardiac adverse event. These predictors were age more than 65 years, body mass index (calculated as the weight in kilograms divided by height in meters squared) greater than 30, emergent surgery, prior cardiac intervention or surgery, active congestive heart failure, cerebrovascular disease, hypertension, operative duration exceeding 3.8 hours, and administration of packed red blood cells intraoperatively. It was also found that high-risk patients experiencing hypotension or tachycardia were more likely to experience a cardiac adverse event.

**ECGs**

The value of a routine preoperative ECG in elderly patients undergoing noncardiac surgery has been debated. Earlier recommendations included age-based requirements for preoperative ECGs. Although abnormal ECGs are prevalent in the elderly population, abnormal preoperative ECGs have not been predictive of a postoperative event and are no longer recommended universally. Current guidelines (class 1 evidence) state that ECGs are indicated in patients with at least one risk factor, in patients undergoing vascular surgery, and in patients with coronary heart disease, cerebrovascular disease, or peripheral vascular disease, who are undergoing intermediate-risk or high-risk surgery. There is class 2 evidence to support performing preoperative ECG even in patients with no clinical risk factors but who are undergoing vascular surgery and in those with at least one risk factor and undergoing intermediate-risk surgery. In contrast to earlier recommendations, a preoperative ECG is not recommended in asymptomatic patients undergoing low-risk procedures.\textsuperscript{71}

**Thermoregulation**

Perioperative hypothermia has been shown to be a significant cause of postoperative adverse events including poor wound healing, susceptibility to infections, shivering, discomfort, increased cardiovascular stress, and subsequent complications. Numerous age-related physiologic changes predispose the older patient to the development of hypothermia. These changes include impaired central temperature regulation, altered shivering threshold, impaired vasoconstriction, and reduced metabolic activity. Perioperative temperature management is now a recognized Physician Quality Reporting Initiative measure for anesthesiologists.

**Summary**

1. Risk stratification: the revised cardiac risk index is a useful way to identify patients with increased cardiac risk during surgery as well as an indicator of long-term prognosis.
2. $\beta$-Blockers should be administered and their use continued perioperatively in high-risk individuals undergoing intermediate-risk or high-risk surgery, as outlined by the American College of Cardiology Foundation/American Heart Association guidelines. Indiscriminate and widespread use of $\beta$-blockers is not recommended.
3. Statin therapy in the perioperative period is indicated in patients with high-risk indices, who are undergoing intermediate-risk and high-risk surgeries. Perioperative statin use should not be abruptly discontinued in the perioperative period.
4. Preoperative ECGs are indicated in patients with cardiac risk factors and active disease, who are undergoing at least intermediate surgery. Age-based criteria for
patients undergoing low-risk surgery are not recommended to guide ordering of preoperative ECGs.

5. Hypertension should be controlled, but limited evidence is available to suggest postponing elective surgery. Observational data suggest that perioperative hypertension and intraoperative hypotension may be associated with increased risk of myocardial infarction and mortality following surgery. Further data analysis in this area is needed.

6. Temperature management is required for older patients, who may require more active warming compared with younger patients.

**Process Measures and Quality**

Despite the growing popularity of quality measurements in health care, there are few recognized quality measures directed at the elderly surgical population. This insufficiency is at odds with the actual surgical morbidity and mortality data that have repeatedly shown that older patients have increased morbidity and mortality following surgery. The standard quality assessment performance measures for surgery (myocardial infarction, surgical site infection, and deep venous thrombosis) are not specific to the elderly. Although older patients do have a higher incidence of cardiac complications, the same has not been shown for deep venous thrombosis and surgical site infection. The development of more relevant quality improvement methods and markers for elderly surgical patients is needed especially for postoperative pulmonary and urological complications. Process measures look at multiple aspects of care, such as interpersonal communication and diagnostic and treatment strategies. It seems possible that these more global markers may provide a relevant method of assessing the quality of care in elderly patients with complications. Using an exhaustive process involving expert review panels, structured interviews, and literature reviews, McGory and colleagues identified 96 perioperative quality candidate indicators of care in 8 domains for elderly surgical patients. These domains include comorbidity assessment, elderly issues, medication usage, patient-provider discussions, intraoperative care, postoperative management, discharge planning, and ambulatory surgery. Within each domain, several quality indicators were identified. In many instances, these indicators are quite specific to the elderly; for example, an assessment of an elderly patient’s decision-making capacity and specific discussions about expected functional outcome. This approach provides an opportunity to investigate more elderly specific issues. However, there are significant difficulties in implementing follow-up on such a vast number of both objective and subjective indicators. Despite these challenges, measuring quality of care is especially important, given the excess morbidity and mortality in this growing population.

**SUMMARY**

Elderly patients represent a significant portion of the patients that anesthesiologists currently take care and will take care in the future. Quality measures and evidence-based strategies to reduce potential complications are present in some areas. However, there are limited geriatric specific data to direct care of the elderly patients. The value of process-based measures is as yet unknown but seems to hold promise for the geriatric patient.

**REFERENCES**


