Update in Perioperative Medicine

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Perioperative medical consultation, including risk stratification and risk reduction strategies, is an important function of internists and hospitalists. This article is a summary of the Update in Perioperative Medicine presentation from the 33rd Annual Meeting of the Society of General Internal Medicine. We performed a Medline search of the relevant literature from February 1, 2009 through February 1, 2010 using the medical subject heading (MeSH) terms preoperative care, intraoperative care, perioperative care, postoperative care, preoperative period, intraoperative period, intraoperative complications, postoperative complications, venous thromboembolism, and noncardiac surgery. We added the text words: intraoperative OR perioperative OR postoperative AND/OR complication OR event and excluded studies of transplantation surgery, cardiac surgery, and pediatric surgery. We selected for review 11 articles most likely to shape the practice of perioperative medicine.

CARDIOVASCULAR RISK STRATIFICATION

Systematic review: prediction of perioperative cardiac complications and mortality by the Revised Cardiac Risk Index. Ford MK, Beattie WS, Wijeyesundera DN. *Ann Intern Med*. 2010;152:26–35. Originally published in 1999, the Revised Cardiac Risk Index (RCRI) has served as the foundation of the current American College of Cardiology/American Heart Association (ACC/AHA) guidelines for perioperative cardiovascular care^{1,2}. The RCRI was created in a single-center, prospective cohort study conducted from 1989–1994 and utilized 2,893 patients for derivation and 1,422 for validation. In its original validation, this multivariable index was found to be superior to previous risk stratification methods at predicting perioperative cardiac complications with an area under the receiver-operating characteristic curve (AUC) of

0.806¹. However, subanalysis revealed lesser performance in vascular surgery patients (AUC 0.774), and its derivation in a single-center study raised concerns for generalization to other populations. Thus, Ford et al. sought to review subsequent studies of the capacity of the RCRI to predict perioperative cardiac complications and overall mortality.

Using the ISI Web of Science, EMBASE and MEDLINE databases, the authors performed literature searches through December 2008 using terms related to the RCRI. They included any cohort study that used an AUC or sufficient data to calculate an AUC to report the association of the RCRI with major perioperative cardiac complications or all-cause mortality. Twenty-four eligible studies were identified and included a total of nearly 800,000 patients. Twelve of the studies were prospective, and 10 focused on vascular surgery.

The authors found the RCRI had moderate performance at discriminating between low- and high-risk patients for perioperative cardiac complications after mixed non-cardiac surgery [pooled AUC 0.75 (CI, 0.72–0.79)]. Its performance with vascular surgery patients was significantly lower [pooled AUC 0.64 (CI, 0.61–0.68)], and in the six heterogeneous studies investigating its diagnostic accuracy for predicting all-cause mortality, the median AUC was even lower (0.62). Limitations of this systematic review were variability in the definitions of cardiac events and clinical and statistical heterogeneity in the eligible studies.

Implications for Clinical Practice. The RCRI remains a valid tool for predicting perioperative cardiac complications in non-cardiac surgery. It has lower performance in vascular surgery patients, but this may be related to the lower number of patients and greater heterogeneity in studies of the RCRI in this population. Until large prospective studies provide further information, clinicians should continue to use the RCRI for perioperative cardiovascular risk prediction in all situations, including before vascular surgery.

Is a pre-operative brain natriuretic peptide or N-terminal pro-B-type natriuretic peptide measurement an independent predictor of adverse cardiovascular outcomes within 30 days of noncardiac surgery? A systematic review and meta-analysis of observational studies. Karthikeyan G, Moncur RA, Levine O, et al. *J Am Coll Cardiol*. 2009;54(17):1599–606.

In nonoperative settings, high levels of brain natriuretic peptide (BNP) predict adverse outcomes among patients with heart failure, coronary artery disease and pulmonary embolism (PE). In this meta-analysis, investigators combined

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results from several small studies to determine whether preoperative BNP or N-terminal pro-BNP (NT-proBNP) levels predict cardiac complications among patients undergoing non-cardiac surgery. They conducted five search strategies to identify potentially eligible studies. In nine studies that met eligibility criteria, a total of 3,281 patients were included. Among these, 314 experienced one or more perioperative cardiovascular complications. The average proportion of patients with elevated BNP was 24.8% [95% confidence interval (CI): 20.1–30.4%; $I(2) = 89\%$]. All studies showed a statistically significant association between an elevated preoperative BNP level and various cardiovascular outcomes [e.g., a composite of cardiac death and nonfatal myocardial infarction (MI); atrial fibrillation]. Data pooled from seven studies demonstrated an odds ratio (OR) of 19.3 [95% CI: 8.5 to 43.7; $I(2) = 58\%$]. The preoperative BNP measurement was an independent predictor of perioperative cardiovascular events with an OR of 44.2 [95% CI: 7.6 to 257.0, $I(2) = 51.6\%$], and elevated levels remained an independent predictor even after adjustment for clinical history of heart failure as well as other traditional risk factors. These results suggest that an elevated preoperative BNP or NT-proBNP measurement is a strong independent predictor of cardiovascular events in the first 30 days after non-cardiac surgery.

Implications for Clinical Practice. This analysis suggests that elevated BNP levels are associated with increased risk for cardiac complications within 30 days after non-cardiac surgery. However, more research is required to evaluate whether therapies and treatments that are based on preoperative BNP assessment would lower risk and improve outcomes. Finally, since the reviewed studies used different BNP cutoffs, this analysis does not establish a specific BNP threshold.

CARDIOVASCULAR RISK MODIFICATION

Many regulatory agencies and guidelines recommend perioperative beta-blockers despite conflicting results regarding their benefit (and possible adverse effects). Although various retrospective studies with statins suggest a benefit in the perioperative setting, there has been only one small, prospective, randomized controlled trial in surgical patients, and that study only showed a benefit for a composite outcome at 6 months after surgery.

Questions to be answered include: (1) Are beta-blockers and/or statins safe and effective in reducing the risk of perioperative cardiovascular complications after noncardiac surgery? (2) Which patients would benefit from using these agents for perioperative risk reduction? (3) Which specific preparations and dosages are most effective?

Fluvastatin and perioperative events in patients undergoing vascular surgery. Schouten O, Boersma E, Hoeks SE, et al, for the Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography Study Group DECREASE III). *N Engl J Med*. 2009;2361:980–9.

Four hundred ninety-seven patients over 40 years old who were scheduled for vascular surgery and had a score >51 on a

prespecified risk index were randomized to extended-release fluvastatin 80 mg (started a median of 37 days before surgery) or placebo. Exclusion criteria included patients already on a statin, contraindications to statins, emergency surgery, unstable coronary artery disease (CAD) or extensive stress-induced myocardial ischemia suggestive of left main disease. Patients already on a beta-blocker continued it, and those not on one were started on bisoprolol 2.5 mg with the dose titrated per the DECREASE protocol. The primary outcome was myocardial ischemia, and the secondary outcomes were a composite of MI or cardiovascular death, and the effects on various biomarkers (lipids, CRP, IL-6). Safety measures included effects on alanine aminotransferase (ALT) and creatine kinase (CK) as well as development of myopathy or rhabdomyolysis.

Compared to the control group, fluvastatin was associated with a statistically significant reduction in myocardial ischemia (10.8% vs 19.0%; odds ratio 0.55; 95% CI 0.34–0.88) and the combination of postoperative MI and cardiac death (4.8% vs 10.1%; OR 0.47; CI 0.24–0.94; $p=0.03$), although the study was underpowered for this latter outcome. Serum lipids, CRP and IL-6 were also significantly reduced in the fluvastatin group. There was no evidence of adverse effects on ALT or CK.

Implications for Clinical Practice. This is the first study to demonstrate the association of fluvastatin with improved cardiac outcomes at 30 days after surgery. Although the manufacturers of these drugs as well as the 2002 clinical advisory of the ACC/AHA/NHLBI³ recommend withholding statins before major surgery, the 2007 ACC guidelines² recommend continuing them perioperatively, and it may be beneficial to start statins prophylactically before surgery in patients with indications for them. The potential benefits of statins should outweigh the concern over potential adverse effects. Future perioperative studies should focus on the potency of the statins with respect to their anti-inflammatory and pleiotropic effects on outcome and address dosing, onset of action, half-life and duration of action.

Bisoprolol and fluvastatin for the reduction of perioperative cardiac mortality and myocardial infarction in intermediate-risk patients undergoing noncardiovascular surgery (DECREASE IV). Dunkelgrun M, Boersma E, Schouten O, et al, for The Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography Study Group. *Ann Surg*. 2009;249:921–6.

A total of 1,066 patients age ≥ 40 undergoing elective non-cardiac surgery with an estimated risk of perioperative cardiovascular events of 1–6% were randomized to fluvastatin (80 mg extended release), bisoprolol (2.5 mg, titrated to heart rate of 50–70), both or neither, with the drugs started a median of 34 days preoperatively. Patients already taking either drug or undergoing emergency surgery were excluded. The primary endpoint was a combination of non-fatal MI or cardiac death within 30 days after surgery. Secondary efficacy end points included all-cause mortality, cardiac arrhythmias, acute heart failure and coronary revascularization. Safety end points included stroke, clinically significant bradycardia and hypotension, clinically significant liver dysfunction (ALT >3 times upper limit of normal), CK level >10 times upper limit of normal, myopathy and rhabdomyolysis.

Patients randomized to bisoprolol versus no bisoprolol had a statistically significant reduction in perioperative cardiac

death and non-fatal MI [2.1% vs 6.0%; HR 0.34 (95% CI 0.17–0.67), $p=0.002$], whereas those randomized to fluvastatin versus no fluvastatin only had a trend toward reduction that was not statistically significant [3.2% vs 4.9%; HR 0.65 (0.35–1.10), $p=0.17$]. There were no significant differences between treatment and control groups with respect to postoperative stroke or liver dysfunction, and there were no cases of myopathy or rhabdomyolysis. Study limitations were its open label design and its termination before reaching the target sample size.

Implications for Clinical Practice. In contrast to POISE⁴, this study showed that using the DECREASE protocol of starting a low-dose beta-blocker 30 days before surgery and titrating to heart rate control, bisoprolol significantly reduced perioperative cardiac death and non-fatal MI without increasing morbidity or non-cardiac mortality. This longer duration beta-blocker may reduce inflammatory mediators and stabilize coronary plaque while also minimizing the risk of significant bradycardia, hypotension and stroke. Whereas fluvastatin's benefit in higher risk vascular surgery patients (DECREASE IV) was statistically significant, in this study of intermediate risk patients, fluvastatin only showed a trend for improved outcome. Either a larger sample size is needed in order to show a significant benefit in this lower risk group or statins may only benefit higher risk patients.

The 2009 ACCF/AHA focused update on perioperative beta blockade. American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines; American Society of Echocardiography; American Society of Nuclear Cardiology; Heart Rhythm Society; Society of Cardiovascular Anesthesiologists; Society for Cardiovascular Angiography and Interventions; Society for Vascular Medicine; Society for Vascular

Surgery, Fleischmann KE, Beckman JA, Buller CE. J Am Coll Cardiol. 2009 Nov 24;54(22):2102–28.

New data presented or published after the 2007 ACC/AHA guidelines² prompted the guideline writing committee and task force to prepare a focused update on prophylactic perioperative beta-blockade. These updated recommendations (Table 1) incorporated data on efficacy, titration, and withdrawal of beta-blockers. The major changes were to downgrade one of the previous Class I recommendations to use beta-blockers for patients undergoing vascular surgery who had ischemia on stress testing to Class II and to stress the potential harm of starting high-dose beta-blockers shortly before surgery without titrating the dose to control heart rate.

This update reinforced the importance of continuing beta-blockers in patients already taking them, made several Class IIa recommendations for patients with inducible ischemia, CAD or multiple risk factors undergoing vascular or intermediate-risk surgery, and emphasized initiating therapy well in advance of surgery with careful dose titration to control heart rate without causing significant bradycardia or hypotension.

Implications for Clinical Practice. These recommendations challenge existing protocols in many hospitals that mandate the use of perioperative beta-blockers. The guidelines highlight the risk of beginning high-dose beta-blockers immediately before surgery in beta-blocker naïve patients as demonstrated in POISE⁴. The authors stress the importance of starting prophylactic beta-blockers at a low dose, well in advance of surgery, and titrating them to achieve heart rate control (DECREASE) in order to receive the potential benefit while minimizing potential risk. These new recommendations are more in line with the somewhat more liberal European Society of Cardiology guidelines⁵ (see Table 1 for comparison) issued

Table 1. Recommendations for Perioperative Beta-blockers

Class	Perioperative beta-blockade: indications and level of evidence	
	2009 American Heart Association/American College of Cardiology (AHA/ACC)	European Society of Cardiology (ESC)
Class I	1. <i>Should be continued</i> if patient is already receiving BB (C)	2. <i>Recommended</i> in patients with known IHD or ischemia on preop stress testing (B) 3. <i>Recommended</i> in patients scheduled for high-risk surgery (B) 4. <i>Continuation recommended</i> in patients previously treated with BB for IHD, arrhythmias or HTN (C)
Class IIa	BB titrated to HR and BP are: 1. <i>Probably recommended</i> for patients undergoing vascular surgery with known CAD or ischemia on preop stress testing (B) 2. <i>Reasonable</i> for patients undergoing vascular surgery with >1 clinical risk factor (C) 3. <i>Reasonable</i> for patients undergoing intermediate risk surgery with CAD or >1 clinical risk factor (C)	4. <i>Should be considered</i> for patients scheduled for intermediate-risk surgery (B); 5. <i>Consider continuation</i> in patients previously treated with BB for CHF with systolic dysfunction (C)
Class IIb	<i>Usefulness of BB is uncertain</i> for patients undergoing: 1. Intermediate risk or vascular surgery with 1 clinical risk factor in the absence of CAD (C) 2. Vascular surgery with no clinical risk factors (B)	3. BB <i>may be considered</i> in patients scheduled for low-risk surgery with risk factors (B)
Class III	1. <i>Should not be given</i> to patients with absolute contraindications to BB (C) 2. Routine administration of high-dose BB in the absence of dose titration is <i>not useful and may be harmful</i> to patients not currently taking BB who are undergoing noncardiac surgery (B)	3. Periop high-dose BB without titration is <i>not recommended</i> (A) 4. BBs are <i>not recommended</i> in patients scheduled for low risk surgery without risk factors (B)

Adapted from Fleischmann et al. Circulation. 2009;120:2123–51 and Poldermans et al. Eur Heart J. 2009; 30:2769–812 (permission pending)

several months earlier. They also highlighted the need to determine the cause of postoperative tachycardia and noted potential differences related to the specific beta-blockers, genomics and gender. Unfortunately, available evidence does not allow the committee to recommend a specific drug. Future studies should address the timing, dose and choice of particular beta blocker.

CARDIOVASCULAR COMPLICATIONS

Perioperative acute ischemic stroke in non-cardiac and non-vascular surgery. Bateman BT, Schumacher HC, Wang S, et al. *Anesthesiology*. 2009; 110:231–38.

Acute ischemic stroke (AIS) is a well-recognized complication of cardiovascular surgeries; however, there are few data available regarding the incidence, risk factors and effect on outcome of perioperative stroke associated with non-cardiac surgeries.

The authors performed a query of the Nationwide Inpatient Sample (NIS) from 2000–2004. The NIS is an administrative database that contains 20% of all discharges from non-federal hospitals each year. The sampling strategy used by the NIS uses five hospital characteristics to generate a sample that is maximally representative of all hospitalizations in the United States and included 7–8 million hospital discharges per year during this period.

Hemicolectomy, total hip replacement and lobectomy/segmental lung resection were chosen to represent major abdominal, orthopedic and non-cardiac thoracic procedures. The database was queried using specific ICD-9 codes for AIS and risk factors for AIS associated with the three aforementioned surgeries. Multivariate logistic regression was performed to identify independent predictors of perioperative AIS and to ascertain the effect of AIS on outcome.

Between 2000 and 2004, 131,067 patients underwent hemicolectomy, of which 939 cases of AIS were identified (0.7% incidence; 95% CI, 0.7%–0.8%). AIS was identified in 420 of 201,235 patients who underwent total hip replacement (0.2% incidence; 95% CI, 0.2%–0.2%) and in 242 of 39,339 patients who underwent lobectomy or segmental lung resection (0.6% incidence; 95% CI, 0.6%–0.7%). These rates were also stratified by age group, which is outlined in Figure 1.

In the final regression model, independent risk factors for AIS included hemicolectomy or lung resection (compared to total hip replacement), advanced age, female gender, atrial fibrillation, renal disease, history of prior stroke and cardiac valvular disease. Perioperative AIS was also consistently associated with worse outcomes, most notably in-hospital mortality.

Implications for Clinical Practice. Although its incidence in the common procedures of hemicolectomy, lung resection and hip replacement is <1%, perioperative AIS is an important source of perioperative morbidity and mortality, particularly in the elderly and those with comorbid disease.

Figure 1. The rate of perioperative acute ischemic stroke by surgery and patient age group. The rate of perioperative acute ischemic stroke is shown with 95% confidence intervals for each patient group. Figures for the 85-year-old and older age group cannot be shown for the lobectomy/segmental resection group as it contains fewer than 10 patients.

VENOUS THROMBOEMBOLISM (VTE) PROPHYLAXIS

Rivaroxaban versus enoxaparin for thromboprophylaxis after total knee arthroplasty (RECORD4): a randomised trial. Turpie AG, Lassen MR, Davidson BL, et al. *Lancet*. 2009;373 (9676):1673–80.

The American College of Chest Physicians (ACCP) guidelines recommend prophylaxis for venous thromboembolism (VTE) for at least 10 days after total knee arthroplasty⁶. Rivaroxaban is a new oral agent that directly inhibits factor Xa and offers an alternative to parenteral VTE pharmacologic prophylaxis.

RECORD 4 (Regulation of Coagulation in Orthopedic Surgery to Prevent Deep Vein Thrombosis and Pulmonary Embolism) is a multicenter, randomized, double-blind trial sponsored by the manufacturer of this new drug. The study was designed to assess the efficacy and safety of oral rivaroxaban compared to subcutaneous enoxaparin for the prevention of VTE after elective total knee arthroplasty (TKA). RECORD 4 differs from the previously reported RECORD trials^{7–9}, in that it compares rivaroxaban with the enoxaparin regimen approved in North America for the prevention of VTE after TKA. In this phase III study, 3,148 patients undergoing TKA received either oral rivaroxaban 10 mg once daily, beginning 6–8 h after surgery, or subcutaneous enoxaparin 30 mg every 12 h, starting 12–24 h after surgery. Patients had bilateral venography between days 11 and 15. The primary efficacy outcome was the composite of any deep vein thrombosis (DVT), non-fatal pulmonary embolism (PE) or death from any cause up to day 17 after surgery. Efficacy was assessed as non-inferiority of rivaroxaban compared with enoxaparin. The primary efficacy outcome occurred in 67 (6.9%) of 965 patients given rivaroxaban and in 97 (10.1%) of 959 given enoxaparin (absolute risk reduction 3.19%, 95% CI 0.71–5.67; $p=0.0118$). The rates of symptomatic VTE were 0.7% with rivaroxaban vs. 1.2% in the enoxaparin arm; the study was not powered to detect differences in symptomatic events. The primary safety outcome was major bleeding. Ten (0.7%) of 1,526 patients given rivaroxaban and four (0.3%) of 1,508 given enoxaparin had major bleeding ($p=0.1096$). Limitations of this study include that a number of venograms were diagnostically inadequate, and this number was higher than expected. The investigators also excluded surgical site bleeding from the major bleeding definition used in this study, and this may have underestimated the overall rate of major bleeding in this study.

Implications for Clinical Practice. Oral rivaroxaban 10 mg once daily for 10–14 days was significantly superior to subcutaneous enoxaparin 30 mg given every 12 h for the prevention of VTE after TKA. The drug is only approved in Canada and the European Union, but once approved in the US, will provide an oral alternative to established parenteral medications for VTE prophylaxis.

HYPERGLYCEMIA MANAGEMENT

Intensive versus conventional glucose control in critically ill patients. The NICE-SUGAR study investigators. *N Engl J Med.* 2009;360:1283–97.

While mean blood glucose values correlate with in-hospital mortality in intensive care unit (ICU) patients¹⁰, the impact of strategies to improve glycemic control in such patients remains controversial. In a trial of predominantly surgical patients, Van den Berghe and colleagues reported lower morbidity and mortality with a strategy of tight glycemic control to a target blood sugar of 80–110 mg/dl¹¹. However, in a subsequent study of medical ICU patients that used identical glucose targets, the same investigators reported decreased morbidity but not mortality among patients randomly assigned to tight glycemic control¹². Of concern was the finding of increased mortality among patients who stayed in the ICU for less than 3 days.

In the NICE-SUGAR trial, the authors randomly assigned 6,106 ICU patients (37% surgical and 63% medical) to a strategy of intensive (blood glucose goal 81–108 mg/dl) or conventional (blood glucose goal 144–180 mg/dl) glycemic control. The primary outcome was unadjusted death from any cause at 90 days. The mean blood glucose levels were 115 mg/dl (intensive group) and 144 mg/dl (conventional group). At 90 days after randomization, 27.5% of the intensive group and 24.9% of the conventional group had died. In a prespecified subgroup analysis, death was significantly more likely in postoperative patients (OR 1.31, 95% CI 1.07–1.61). Importantly, severe hypoglycemia was substantially more common in the intensive group (6.8% vs 0.5%, $p < 0.001$), and the proportion of deaths due to cardiovascular causes was higher (41.6% vs 35.8%, $p = 0.02$). A limitation of this study was the inability to blind clinicians to assignment arm.

Implications for Clinical Practice. Largely on the basis of this study, the American Association of Clinical Endocrinologists and the American Diabetes Association have recently modified their recommendations for inpatient glycemic control¹³. Their current recommendations for critically ill patients are to initiate insulin therapy for blood sugars >180 mg/dl and to aim for a target range of 140–180 mg/dl. We agree with these recommendations that will substantially change the care of critically ill ICU patients.

SURGICAL SITE INFECTION PROPHYLAXIS

Timing of antimicrobial prophylaxis and the risk of surgical site infections. Steinberg JP, Braun BI, Hellinger WC, et al. *Ann Surg.* 2009;250:10–16.

Current guidelines recommend the administration of prophylactic parenteral antibiotics within 1 h (or 2 h for fluoroquinolones and vancomycin) of cardiac surgery, hysterectomy and knee and hip arthroplasty¹⁴. Despite these guidelines, appropriate utilization of antimicrobial prophylaxis continues to be deficient, and the optimal timing of antibiotic administration remains unknown. The objective of this study was to determine the best timing of prophylactic antibiotics to reduce surgical site infections (SSIs).

The authors utilized data from the Trial to Reduce Antimicrobial Prophylaxis Errors, a 44-hospital study of antimicrobial prophylaxis and SSIs. A total of 4,472 cardiac, hysterectomy and knee/hip arthroplasty operations from 29 hospitals were included. The association between timing of antibiotic administration and SSIs was evaluated using conditional logistic regression.

More than 90% of operations used antibiotics consistent with Surgical Care Improvement Project (SCIP) guidelines, and 81% of patients received antimicrobial prophylaxis within 1 h before incision. Only 113 SSIs were identified, and risk factors for SSIs included surgery at a teaching hospital [relative risk (RR) 1.74, $p < 0.04$], prophylactic antibiotics given post-incision (RR 2.20, $p < 0.02$) and duration of surgery >4 h (RR 2.75, $p < 0.001$). No statistically significant difference in SSIs was identified between patients receiving antibiotics 0–30 and 31–60 min before incision. The authors also found a trend toward decreased risk if shorter acting antibiotics were redosed in surgery lasting >4 h. Only 12.6% of patients received no postoperative antibiotic prophylaxis, and more than 25% received this for up to 48 h after surgery. No statistically significant difference in SSIs was seen in patients receiving extended duration antibiotic prophylaxis. This study was limited by the low number of SSIs and non-standardized surveillance protocols for detecting post-hospitalization infections.

Implications for Clinical Practice. Administration of SCIP-recommended antibiotics should be done within 1 h of incision to reduce the risk of SSIs. However, the exact timing of antibiotic delivery within the hour before surgery does not affect the incidence of SSIs. In surgeries lasting more than 4 h, antibiotics other than vancomycin and fluoroquinolones should be redosed intraoperatively.

Table 2. Postoperative Outcomes Incidence Based on Age

Surgical outcome	Overall	Age (years)			
		40–54	55–65	66–74	≥ 75
30-day mortality	2.8%	1.1%	1.8%	3.5%*	4.8%*
Major postoperative complication	26.7%	21.8%	24.9%	27.4%*	30.7%*
Prolonged length of stay (>75 th percentile, 12 days)	26.9%	19.8%	24.3%	27.3%*	33.7%*

* P value < 0.0001

Adapted with permission from Al-Refaie WB, Parsons HM, Henderson WG, et al. Major cancer surgery in the elderly: results from the American College of Surgeons National Surgical Quality Improvement Program. *Ann Surg.* 2010;251:311–18

Antibiotic prophylaxis should not be continued for >24 h (>48 h for cardiac surgery) postoperatively.

RISK STRATIFICATION IN THE ELDERLY

Major cancer surgery in the elderly: results from the American College of Surgeons National Surgical Quality Improvement Program. Al-Refaie WB, Parsons HM, Henderson WG, et al. *Ann Surg*. 2010;251:311–18.

As the population continues to age, the number of patients presenting with surgically resectable malignancies is expected to rise. Data on operative outcomes of elderly oncologic patients are conflicting. Single-center studies suggest surgical risk is similar to the general population, while large-scale observational studies describe higher risk in the elderly¹⁵. Accurate estimation of operative risk is important to prevent inappropriate avoidance or performance of surgery. Al-Refaie and coworkers conducted this study to provide further data to inform surgical decision-making in elderly cancer patients.

The authors utilized data collected in the American College of Surgeons National Surgical Quality Improvement Program, a prospectively gathered, multivariable database from 190 academic and private hospitals with 8,781 patients over age 40 undergoing thoracic, abdominal or pelvic surgery. They assessed several different outcomes, including major and minor complications, length of stay, need for repeat operation and 30-day mortality. Bivariable and multivariable logistic regression analyses were performed to determine the independent association of advanced age and poor operative outcomes.

Most studied outcomes occurred with greater frequency in patients aged 65 years and older (Table 2). After multivariable analysis, age 66–74 years had a 30-day mortality odds ratio of 2.75 compared to age 40–54 years. For age >75 years the 30-day mortality odds ratio was 4.11, higher than any other predictive factor studied. An important limitation of this study is a lack of data on hospital and surgical volume, which have previously been shown to predict operative outcomes.

Implications for Clinical Practice. Advanced age (>65 years) is a significant, independent predictor of poor outcomes following major oncologic surgery. However, the risk conferred by advanced age is comparable to other predictive factors and should not be used in a prohibitive manner. Instead, advanced age should be weighed along with other risk factors in informed surgical decision-making in elderly cancer patients.

Conflicts of Interest: Dr. Smetana is a consultant for Anvita Health. Dr. Cohn is on the speakers bureau for Sanofi-Aventis and Lilly/Daichi Sankyo and has stock ownership in Astra-Zeneca, Glaxo Smith Kline, Merck and Pfizer. Dr. Jaffer is a consultant for Sanofi-Aventis, Astra-Zeneca, Boehringer Ingelheim, Ortho-McNeil-Janssen Pharmaceuticals and Canyon Pharmaceuticals. Dr. Jaffer also serves as a board member for both the Anticoagulation Forum and the Society for Perioperative Assessment and Quality Improvement (SPAQI). Drs. Pfeifer and Mauck have no conflicts in the past 3 years to declare.

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