

# CLEVELAND CLINIC JOURNAL OF MEDICINE

## PROCEEDINGS OF THE 3RD ANNUAL PERIOPERATIVE MEDICINE SUMMIT

Cleveland Clinic

in conjunction with the Society for Perioperative Assessment and Quality Improvement

SEPTEMBER 10–12, 2007, CLEVELAND, OHIO

PROGRAM • IMPACT CONSULTS • ABSTRACTS

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Limited Print Edition of Electronic Supplement 1, Volume 74

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SUPPLEMENT

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## Foreword:

### New topics, returning features, tools for enduring challenges

**T**he 3rd Perioperative Medicine Summit is upon us. We are again privileged to be collaborating with the Society for Perioperative Assessment and Quality Improvement (SPAQI), led by Angela Bader from the Harvard Medical School, and its esteemed and world-renowned board members.

#### Expanded meeting, additional topics

This year we accepted a total of 32 abstracts for the Summit, and we are excited about showcasing these submissions and all of our world-class faculty who will be presenting at the two-and-a-half-day meeting.

Several new topics are covered this year, including perioperative management of anemia, billing and coding issues, disparities in perioperative care, challenging cases, medicolegal issues, and advanced issues in quality improvement. We are also delighted to include this year a perspective on perioperative care in Britain.

#### More IMPACT Consults

For the second year, this Summit-based supplement includes a special feature—IMPACT Consults. This peer-reviewed collection of 10 brief articles answers clinically relevant perioperative questions in a highly focused, evidence-based manner. These articles, which are also being presented as posters at the Summit, are the result of an extraordinary effort by our

Cleveland Clinic colleagues in the Department of Hospital Medicine. We commend the articles' authors, as well as the IMPACT Consult editors—Drs. Harte, Kroen, and Gugliotti—for helping to orchestrate the overall effort.

#### Multidisciplinary knowledge-sharing

Today, both patients and third-party payors expect innovative and technologically advanced surgical care that results in superior outcomes. High-quality perioperative care demands a multidisciplinary approach. All members of the perioperative team—including nurses, surgeons, anesthesiologists, allied health professionals, hospitalists, subspecialists, and primary care physicians—need to be knowledgeable about medical and surgical issues that arise in the perioperative period. This multidisciplinary team also must work together effectively if the best outcomes are to be achieved.

We believe the Perioperative Medicine Summit can provide this multidisciplinary team with the latest evidence-based information so that we are all practicing at the cutting edge. If you agree, please tell at least five colleagues about the Summit. Also direct them to the online version of this supplement at [www.ccjm.org/toc/2007periop.htm](http://www.ccjm.org/toc/2007periop.htm). We aim to continue to grow the conference each year and take the field of perioperative medicine to new heights.



**Amir K. Jaffer, MD**  
Supplement Co-Editor and Summit Co-Director



**Franklin A. Michota, Jr., MD**  
Supplement Co-Editor and Summit Co-Director

# PROCEEDINGS OF THE 3RD ANNUAL PERIOPERATIVE MEDICINE SUMMIT

## PROGRAM • IMPACT CONSULTS • ABSTRACTS

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David L. Hepner, MD    Gerald A. Maccioli, MD  
Roop K. Kaw, MD (Co-Chair)

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Brian Harte, MD

# Summit Program

## MONDAY, SEPTEMBER 10, 2007

### Morning Session

- 7:00 AM **Registration/Continental Breakfast/Exhibits**  
*Bank of America Conference Center Foyer—3rd Floor*
- 7:30 AM **Welcome**—Amir K. Jaffer, MD, Franklin A. Michota, Jr., MD, Angela M. Bader, MD, MPH, Raymond Borkowski, MD
- 7:45 AM **Improving Quality and Safety in Perioperative Medicine**—Dale Bratzler, DO, MPH
- 8:15 AM **Q&A Period**
- 8:30 AM **Cardiac Risk Assessment and Risk Stratification for Noncardiac Surgery: Update from the 2007 ACC/AHA Guidelines**—Lee A. Fleisher, MD, FACC
- 9:15 AM **Q&A Period**
- 9:30 AM **Refreshment Break/Exhibits**  
*View Cleveland Clinic IMPACT Consult Posters*
- 10:00 AM **Perioperative Risk Reduction Therapy for Noncardiac Surgery: What Do the Latest Studies Show?**—Don Poldermans, MD, PhD, FESC
- 10:45 AM **Q&A Period**
- 11:00 AM **Preoperative Evaluation and Cost-Effective Lab Testing**—David L. Hepner, MD
- 11:30 AM **Q&A Period**
- 11:45 AM **Lunch & Presentations**  
**Real Age and How it Impacts Perioperative Care**—Michael F. Roizen, MD  
**Perioperative Care: A British Perspective**—Jane Jackson, SRN, MPhil, MCGI
- 12:45 PM **Q&A Period**

### Afternoon Session

- 1:00 PM **Perioperative Anemia**—Jeffrey Carson, MD, Ajay Kumar, MD
- 1:45 PM **Q&A Period**
- 2:00 PM **Perioperative Management of Warfarin and Antiplatelet Therapy**—Amir K. Jaffer, MD
- 2:45 PM **Q&A Period**
- 3:00 PM **Refreshment Break/Exhibits**  
*View Cleveland Clinic IMPACT Consult Posters*
- 3:30 PM **Prevention of Venous Thromboembolism After Surgery**—Franklin A. Michota, Jr., MD
- 4:15 PM **Q&A Period**
- 4:30 PM **Breakout Session I**
- A. Billing for Perioperative Consultation**—Gail Pfeiffer, RHIA, CCS-P
- B. Postoperative Fever**—James Pile, MD, FACP
- C. Perioperative Management of Devices**—Mina Chung, MD
- D. Cases in Critical Care**—Andrew Friedrich, MD
- E. Problem-Based Pain Management**—Darin Correll, MD
- F. Hands-On Quality Improvement 1**—Andrew D. Auerbach, MD, MPH, Eric D. Hixson, MBA, PhD Cand, Susan R. Kirsh, MD

5:30 PM **Adjourn**

5:30 PM **Reception and Poster Session**

## TUESDAY, SEPTEMBER 11, 2007

### Morning Session

- 7:00 AM **Continental Breakfast/Exhibits**  
*Bank of America Conference Center Foyer—3rd Floor*
- 7:30 AM **Welcome**—Amir K. Jaffer, MD, Franklin A. Michota, Jr., MD, Angela M. Bader, MD, MPH, Raymond Borkowski, MD
- 7:45 AM **Perioperative Management of Diabetes: Translating Evidence into Practice**—Byron Hoogwerf, MD
- 8:15 AM **Q&A Period**
- 8:30 AM **Pulmonary Risk Stratification and Risk Reduction for Noncardiac Surgery**—Gerald Smetana, MD
- 9:00 AM **Q&A Period**
- 9:15 AM **Disparities in Perioperative Care**—Selwyn Rogers, MD, MPH
- 9:45 AM **Q&A Period**
- 10:00 AM **Refreshment Break/Exhibits**  
*View Cleveland Clinic IMPACT Consult Posters*
- 10:30 AM **Challenging Perioperative Cases**—Steven Cohn, MD, FACP
- 11:30 AM **Q&A Period**
- 11:45 AM **Lunch: Bring Your Questions and Meet the Experts**
- 1. Anticoagulation**—Amir K. Jaffer, MD, Franklin A. Michota, Jr., MD
- 2. Quality Improvement**—Brian Parker, MD, Andrew D. Auerbach, MD, MPH
- 3. Anesthesiologists**—John E. Tetazlaff, MD, Angela M. Bader, MD, MPH
- 4. Hospitalists**—Christopher Whinney, MD, Collin Kroen, MD, Ajay Kumar, MD
- 5. Cardiac Risk Assessment**—Steven L. Cohn, MD, FACP, Brian Harte, MD

### Afternoon Session

- 1:00 PM **Best Research Abstracts**  
*Moderator: Angela M. Bader, MD, MPH (Co-chair, Research Abstract Committee)*
- 1:00 Preoperative Electrocardiograms: Patient Factors Predictive of Abnormalities**—Darin Correll, David Hepner, Lawrence Tsen, Candace Chang, Angela Bader
- 1:15 Impact of Combination Medical Therapy on Mortality in Vascular Surgery Patients**—Thomas Barrett, Motomi Mori, Caroline Koudelka
- 1:30 Do Large Electronic Medical Record Databases Permit Collection of Reliable and Valid Data for Quality Improvement Purposes?**—Ashish Aneja, Eric Hixson, Brian Harte, Vesselin Dimov, Amir Jaffer
- 1:45 PM **Perioperative Care of the Elderly**—Robert M. Palmer, MD

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## SUMMIT PROGRAM

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- 2:15 PM **Q&A Period**
- 2:30 PM **Perioperative Management of Heart Failure and Aortic Stenosis**—*Bobbie Jean Sweitzer, MD*
- 3:00 PM **Q&A Period**
- 3:15 PM **Refreshment Break/Exhibits**  
*View Cleveland Clinic IMPACT Consult Posters*
- 3:30 PM **Organizing a Perioperative Program: A Panel Discussion**—*Angela M. Bader, MD, MPH, Amir K. Jaffer, MD, Raymond Borkowski, MD, Bobbie Jean Sweitzer, MD*
- 4:15 PM **Breakout Session II**
- G. Billing for Perioperative Consultation**—*Gail Pfeiffer, RHIA, CCS-P*
  - H. Postoperative Fever**—*James C. Pile, MD, FACP*
  - I. Perioperative Management of Devices**—*Mina Chung, MD*
  - J. Cases in Critical Care**—*Andrew Friedrich, MD*
  - K. Problem-Based Pain Management**—*Darin J. Correll, MD*
  - L. Hands-On Quality Improvement 2**—*Andrew D. Auerbach, MD, MPH, Eric D. Hixson, MBA, PhD Cand, Susan R. Kirsh, MD*
- 5:00 PM **Adjourn**

## WEDNESDAY, SEPTEMBER 12, 2007

### Morning Session

- 6:45 AM **Continental Breakfast/Exhibits**  
*Bank of America Conference Center Foyer—3rd Floor*
- 7:15 AM **Welcome**—*Amir K. Jaffer, MD, Franklin A. Michota, Jr., MD, Angela M. Bader, MD, MPH, Raymond Borkowski, MD*
- 7:30 AM **Perioperative Management of Patients with Liver Disease**—*Brian Parker, MD*
- 8:00 AM **Q&A Period**
- 8:15 AM **Preventing and Treating Surgical Wound Infections**—*Steven M. Gordon, MD*
- 8:45 AM **Q&A Period**
- 9:00 AM **Rheumatologic Issues in the Surgical Patient**—*Brian F. Mandell, MD, PhD, FACP*
- 9:30 AM **Q&A Period**
- 9:45 AM **Refreshment Break/Exhibits**  
*View Cleveland Clinic IMPACT Consult Posters*
- 10:15 AM **Medicolegal Issues in Perioperative Medicine: Lessons from Real Cases**—*Victoria Vance, Esq, Franklin A. Michota, Jr., MD*
- 10:45 AM **Q&A Period**
- 11:00 AM **Medication Management**—*Christopher Whinney, MD*
- 11:30 AM **Q&A Period**
- 11:45 AM **Concluding Remarks**
- 12:00 PM **Adjourn**

**For information and resources from previous  
Perioperative Medicine Summits, visit:**

**<http://periopmedicine.org>**

Publications and proceedings from prior Summits

Webcasts from the 2nd Perioperative Medicine Summit

Clinical cases in perioperative medicine

Photos from prior Summits

New articles in perioperative medicine

Profile of the Internal Medicine Preoperative Assessment, Treatment  
and Consultation (IMPACT) Center at Cleveland Clinic



## Q: Are routine preoperative chest radiographs necessary in asymptomatic patients undergoing noncardiothoracic surgery?

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**A:** Routine preoperative chest radiographs (chest x-rays [CXR]) are not indicated for asymptomatic patients younger than age 50 years who do not have risk factors for postoperative pulmonary complications (PPCs). Patients with significant risk factors for PPCs may warrant a preoperative CXR irrespective of age. For asymptomatic patients older than 50 years with no risk factors, there is insufficient evidence for or against ordering routine CXRs.

### Pulmonary complications:

#### Just as common as cardiac complications

The American College of Physicians' (ACP) 2006 guidelines on preoperative pulmonary risk stratification for noncardiothoracic surgery notably state that PPCs are just as prevalent as cardiac complications.<sup>1,2</sup> The risk for PPCs increases with age and with patient- and procedure-related risk factors.<sup>1,2</sup> Risk factors for PPCs that may warrant a preoperative CXR include the following:<sup>1-3</sup>

- American Society of Anesthesiologists physical status classification of II or greater
- Functional dependency
- Known cardiopulmonary disease
- Upper abdominal or thoracic procedures, or surgery for an abdominal aortic aneurysm.

#### Few studies evaluate postoperative pulmonary complications

The practice of routinely obtaining preoperative CXRs originated during World War II to detect tuberculosis infection, now a rarity in developed nations.<sup>4</sup> Today clinicians often order CXRs as part of a routine preoperative evaluation in order to screen for abnormalities that may affect surgical risk or outcomes.

Few studies that have assessed abnormal versus normal preoperative CXRs have used PPCs as the primary end point. A systematic review conducted to

support the 2006 ACP guidelines found that only four such studies (two univariate analyses and two multivariate analyses) evaluated this outcome. Only two of these studies showed that an abnormal CXR was a statistically significant predictor of PPCs.<sup>1</sup>

The first of these studies, by Lawrence et al,<sup>5</sup> found that both abnormal lung examination and an abnormal CXR were statistically significant predictors of PPCs, but these authors did not indicate if patients with abnormal CXRs also had abnormal physical exam findings. Also, the cohort population consisted predominantly of male veterans with a high prevalence of smoking and chronic obstructive pulmonary disease.<sup>5</sup> The second study, by Bluman et al,<sup>6</sup> which was designed to evaluate the effects of smoking on PPCs, showed that an abnormal CXR was a predictor of PPCs.

#### Abnormal CXRs have little effect on management

Most studies looking at the utility of preoperative CXRs have evaluated changes in surgery date or anesthesia management as the primary end point. In one meta-analysis of 21 studies assessing the value of preoperative CXRs, only 10% of routine preoperative CXRs were abnormal, and in only 1.3% (95% confidence interval [CI], 0 to 2.8%) were these abnormalities unanticipated after a thorough history and physical exam.<sup>7</sup> Furthermore, the CXR findings changed management in only 0.1% of the patients (95% CI, 0 to 0.6%).

In a Canadian study of 1,000 patients who had a preoperative CXR, 74 had abnormalities on CXR, and 68 of these patients (92%) had a history or symptoms of cardiorespiratory disease.<sup>8</sup> Surgery was delayed in 1.3% of the patients with radiographic abnormalities. However, without symptoms or pertinent medical history, abnormal CXRs did not predict a worse clinical outcome.

In a United Kingdom study by the Royal College of Radiologists involving 10,619 patients undergoing nonacute, noncardiopulmonary surgery, preoper-

All authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

ative CXR results were found to have no influence on the decision to use inhalation anesthesia or to operate.<sup>9</sup> There was no evidence that the preoperative CXR could be used as a baseline to be compared against a postoperative CXR should pulmonary complications arise.

A recent systematic review of 14 eligible studies that looked at PPCs in patients undergoing noncardiothoracic surgery showed that 65% of abnormalities found on preoperative CXR were chronic, such as cardiomegaly (15% to 65%) and chronic obstructive pulmonary disease (10% to 30%).<sup>10</sup> The diagnostic yield of a preoperative CXR increased with patient age, and nine studies showed that the yield in patients younger than 50 years was low (3% to 16%) and that most of these findings were chronic abnormalities. Surgery cancellation rates of 1% to 4% were reported in four of the reviewed studies, while changes in anesthetic management ranging from 0.5% to 5.8% were reported in five studies. In two studies, rates of PPCs were similar regardless of whether patients' preoperative CXRs were abnormal or normal. Symptomatic congestive heart failure and pneumonia were the only conditions that appeared to affect postoperative outcomes in this meta-analysis,<sup>10</sup> and these can be predicted preoperatively by a thorough history and physical exam.

### Conclusions

Generally, there is limited evidence to guide the decision to order a preoperative CXR in an asymptomatic patient, and the decision should be based on the

patient's risk for PPCs. CXRs in patients younger than age 50 appear to have the lowest yield in the absence of risk, and a thorough history and physical examination is important for assessing risk for the individual patient.

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## Q: Do preoperative nutritional interventions improve outcomes in malnourished patients undergoing elective surgery?

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**A:** While preoperative malnutrition is associated with poorer outcomes, supplementation has been shown to be valuable only in severely malnourished patients.

### Importance of preoperative nutritional status

Poor preoperative nutritional status is associated with delayed wound healing, increased susceptibility to infection, pulmonary complications, prolonged hospitalization, and mortality.<sup>1</sup> However, the ability to assess the utility of an intervention depends first on defining the population at risk. Unfortunately, there is no "gold

Both authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

standard” for defining malnutrition or objectively measuring nutritional status. Moreover, it is difficult to separate the effect that malnutrition has on outcomes from the role played by the underlying disease process.

The history and physical examination provide initial evidence to support further investigation and risk stratification, but this strategy has never been validated as a means of objective risk assessment. Laboratory studies generally add little further value, although a large retrospective analysis found that preoperative serum albumin was a strong predictor of 30-day postoperative complications.<sup>2</sup> Various nutrition “risk indices” have been published, but there are no conclusive prospective or comparative studies of them. The one that is perhaps the simplest, the Nutrition Risk Index (NRI), combines serum albumin and an assessment of weight loss into a single measure (Figure).<sup>3</sup>

**Limited evidence on nutritional interventions**

Evidence to support routine use of preoperative nutritional interventions in malnourished patients is limited.

**Total parenteral nutrition.** There are no large randomized trials of preoperative total parenteral nutrition (TPN) that have enrolled homogeneous populations and used a supplement that meets current nutritional recommendations.

The most significant single study was the Veterans Affairs Total Parenteral Nutrition Cooperative Study,<sup>4</sup> which found no overall benefit to 7 to 15 days of preoperative TPN among 395 patients undergoing elective laparotomy or thoracotomy. All patients were “malnourished,” as defined by an NRI score of 100 or less (see Figure for score categories), and 65% of patients had cancer. However, the degree of malnourishment varied significantly across the study population, and the patients were overfed relative to current standards. Overall postoperative mortality was high (12%) but did not differ between the TPN group and the control group, which did not receive TPN. The rate of infectious complications was higher in the TPN cohort than in the control group (14.1% vs 6.4%), but the overall complication rate was similar between groups. Among the subgroup of patients with the poorest nutritional status (NRI score < 83.5), the overall rate of major noninfectious complications (eg, impaired wound healing) was significantly lower in the TPN group than in the control group (5.3% vs 42.9%).

A 2001 meta-analysis of 27 randomized controlled trials of perioperative TPN included 10 studies wherein the intervention was started in the preoperative setting.<sup>5</sup> In the pooled analysis, TPN had no effect on mortality, although it may have been associ-

Nutrition Risk Index (NRI) score =  
 $[1.519 \times \text{serum albumin level (g/L)}] + [0.417 \times (\text{current weight/usual weight}^*)] \times 100$

Guide to NRI scores

- > 100: No malnourishment present
- 97.5–100: Mild malnourishment
- 83.5–97.4: Moderate malnourishment
- < 83.5: Severe malnourishment

\*“Usual weight” defined as “stable weight ≥ 6 months prior to surgery.”

**FIGURE.** Method for calculating Nutrition Risk Index (NRI) score and key to score values.

ated with decreased complication rates compared with no TPN or standard care (risk ratio = 0.70; 95% confidence interval, 0.52 to 0.95). Most of the patients in these studies underwent gastrointestinal surgery, but definitions of malnourishment varied broadly, as did the composition of the TPN. In fact, the authors found that the studies were so heterogeneous that the finding of decreased complications could have been due to chance. A similar pooled analysis of 13 trials studying preoperative TPN likewise suggested that TPN decreased the risk of postoperative complications by approximately 10%, but no mortality benefit was demonstrated.<sup>6</sup>

**Enteral feeding.** There are few studies of enteral feeding as a preoperative intervention. One randomized study of 110 malnourished patients (defined by any of numerous clinical and laboratory parameters) demonstrated decreased infection and mortality rates in patients given enteral supplementation via nasogastric tube for 10 days before surgery.<sup>7</sup> Postoperatively, the patients who received supplementation had lower rates of wound infection and death, but details of the types of patients and their surgeries were not well described.

A 1992 trial randomized 151 malnourished patients (defined by a multivariable index) to receive at least 10 days of preoperative TPN, enteral nutrition, or no intervention.<sup>8</sup> All patients underwent resection of newly detected gastrointestinal cancers. Both intervention groups demonstrated a statistically significant reduction in the incidence of intra-abdominal abscess and septic complications as compared with the control group, but there was no difference between the two intervention groups. Outside of this trial, adequate comparisons between TPN and enteral intervention are lacking.

**Possible role for additional supplementation**

In the future there may be a role for additional supplementation of malnourished patients with specific nutrients. A 2002 Italian study enrolled 196 mal-

nourished patients (ie, weight loss  $\geq 10\%$ ) with cancer.<sup>9</sup> Compared with controls, the group that received both pre- and postoperative supplementation, which included omega-3 fatty acids and arginine, had a shorter hospital stay and fewer overall complications.

### Conclusions

Surgery should not be delayed for either enteral or parenteral nutrition supplementation, except in the most severely malnourished patients, who may experience a modest decrease in the risk for noninfectious complications such as impaired wound healing. Enteral feeding is preferred when feasible, but no adequate trials have directly compared preoperative TPN with enteral feeding in such patients.

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## Q: Do all patients undergoing bariatric surgery need polysomnography to evaluate for obstructive sleep apnea?

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**A:** Yes. Clinical scoring schemes are not accurate enough to replace polysomnography in the evaluation for obstructive sleep apnea (OSA).

### Sleep apnea: A prevalent and serious risk factor in bariatric surgery patients

Obesity is associated with an increased risk of OSA. The prevalence of OSA in patients with a body mass index (BMI) greater than 30 is 20% to 40%.<sup>1</sup> Recent series of patients evaluated for bariatric surgery have shown that the prevalence in these patients can range between 70% and 91%.<sup>2–4</sup>

OSA can have a significant effect on both the

perioperative and postoperative care of the surgical patient. A 2001 study found that up to one third of patients with OSA undergoing hip replacement or knee replacement surgery developed substantial respiratory or cardiac complications (including arrhythmias, myocardial ischemia, unplanned intensive care unit transfers, and/or reintubation), mostly within the first 72 hours after surgery.<sup>5</sup> A more recent review of more than 3,000 patients undergoing bariatric procedures from a single institution found that sleep apnea was a positive predictive factor for anastomotic leaks.<sup>6</sup> In another series of 311 patients undergoing bariatric surgery, the presence of OSA more than doubled the odds of having a hospital stay longer than 3 days (odds ratio [OR] = 2.25).<sup>7</sup>

All authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

### Clinical scoring systems for apnea severity in obese patients

Despite the ease with which it can be assessed, daytime sleepiness is not a good predictor of OSA in the morbidly obese population. Several studies have attempted to determine whether clinical parameters such as the Epworth Sleepiness Scale (ESS) or BMI can predict OSA or its severity. In a study of 66 patients undergoing bariatric surgery, patients with an ESS score greater than 6 were selected to undergo polysomnography for evaluation for OSA.<sup>8</sup> No correlation was noted between the BMI, history of snoring, an elevated ESS score, and the severity of OSA as determined by the respiratory disturbance index.<sup>8</sup>

A larger study of 99 severely symptomatic obese patients undergoing bariatric surgery identified several independent clinical predictors of significant OSA, defined as a score of 15 or greater on the apnea-hypopnea index (AHI).<sup>9</sup> Conveniently expressed as the acronym BASH'IM, these predictors include the following (presented with OR and 95% confidence interval [CI] for an AHI score  $\geq$  15):

- **BMI  $\geq$  45** (OR = 4.3; 95% CI, 1.7 to 11.1)
- **Age  $\geq$  38 years** (OR = 3.4; 95% CI, 1.3 to 9.2)
- **Observed sleep apnea** (OR = 3.3; 95% CI, 1.4 to 8)
- **HbA<sub>1c</sub>  $\geq$  6%** (OR = 5.9; 95% CI, 2.2 to 15.8)
- **Fasting plasma insulin  $\geq$  28  $\mu$ mol/L** (OR = 10.2; 95% CI, 3.4 to 30)
- **Male sex** (OR = 5.2; 95% CI, 1.9 to 14.8).

Alternately, an additional factor—neck circumference of 43 cm or greater—can replace BMI and male sex and, together with the remaining four factors, provide similar predictive value (Cox and Snell  $r^2 = 0.46$ ).

Although the mean ESS score for this study population was higher than the community norm, none of these variables was associated with a higher ESS score. Furthermore, clinical symptoms such as habitual snoring were present in 94% of the study population, but the predictive value of such symptoms was poor, except for observed sleep apnea. A composite BASH'IM score of 3 or greater (in which 1 point is assigned for each factor present) was found to have a sensitivity of 80% and specificity of 91% for an AHI score of 15 or greater. The authors concluded that the BASH'IM score can be used to identify patients who are appropriate candidates for polysomnography. For instance, if polysomnography had not been performed on patients with a BASH'IM score of 0 to 1, 49% of negative polysomnographic findings in this study would have been avoided.<sup>9</sup>

### Evidence supporting routine polysomnography before bariatric surgery

Polysomnography remains the gold standard for the diagnosis of OSA. In a study of 100 consecutive patients evaluated prior to gastric bypass surgery, Rasheid et al diagnosed OSA by polysomnography in 58% of subjects and concluded that the severity of OSA cannot be reliably predicted by preoperative BMI or ESS score.<sup>10</sup> Similarly, O'Keeffe and Patterson demonstrated a 77% prevalence of OSA by polysomnography in a cohort of 170 consecutive patients presenting for bariatric surgery and found no correlation of OSA with BMI; the prevalence of OSA was higher in severely obese patients (BMI 35 to 39.9) than in morbidly obese patients (BMI 40 to 49.9).<sup>3</sup> In the most recent and largest study to date,<sup>4</sup> 19% of patients presenting for bariatric surgery had a clinical diagnosis of OSA. However, routine polysomnography prior to bariatric surgery demonstrated a 91% prevalence of OSA, as opposed to 58% when clinical parameters and ESS score alone were used to screen for OSA.<sup>4</sup> These and other authors strongly recommend polysomnography for all patients undergoing bariatric surgery.<sup>2-4,10</sup>

### Conclusions

Clinical evaluation continues to miss a significant proportion of OSA cases among morbidly obese patients presenting for bariatric surgery, and OSA portends a significant increase in postoperative complications. Until there is a reliable method to predict the presence of OSA, routine polysomnography is indicated for all patients undergoing bariatric surgery.

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## Q: Can brain natriuretic peptide identify noncardiac surgery patients at high risk for cardiac events?

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**A:** Emerging data indicate that preoperative testing for brain natriuretic peptide (BNP) and its related compound, NT-proBNP, is beneficial in identifying patients at high risk for major adverse cardiac events following noncardiac surgery. These major events include acute coronary syndromes, arrhythmias, heart failure, myocardial infarction, and stroke, which constitute a significant source of morbidity and mortality in the perioperative period.

### Prognostic and risk-stratifying value of BNP

The prohormone BNP is released from the myocardial cells in the left ventricle in response to volume expansion and is cleaved into BNP and its inactive N-amino terminal fragment (NT-proBNP). These markers are used to assess left ventricular dysfunction and to risk-stratify patients with acute coronary syndromes and heart failure.<sup>1</sup> Plasma BNP also provides prognostic information in patients with chronic heart failure and those with asymptomatic or minimally symptomatic left ventricular dysfunction.<sup>2</sup>

### Evidence on BNP and NT-proBNP in noncardiac surgery

A number of recent studies indicate that BNP and NT-proBNP have similar prognostic value in patients scheduled for noncardiac surgery.

Feringa and colleagues prospectively evaluated 335 patients undergoing abdominal aortic aneurysm repair (46%) or lower extremity bypass surgery (54%).<sup>3</sup> Preoperative plasma NT-proBNP was measured at a mean of 24 days before surgery. All patients

also underwent dobutamine stress echocardiograms. Multivariable analysis revealed that an NT-proBNP level of 319 ng/L or greater was the strongest predictor of all-cause mortality and major adverse cardiac events among all variables assessed, including age, cardiac risk score, echocardiographic results, and cardiac medications.

Similarly, Dernellis and Panaretou prospectively studied 1,590 patients undergoing noncardiac surgical procedures, of which 40% were orthopedic and 30% were abdominal.<sup>4</sup> Patients had their preoperative BNP level measured within 3 days before surgery and also were risk-stratified according to the Goldman multifactorial cardiac risk index. The authors found that patients who were at low preoperative clinical risk (as defined by the Goldman cardiac risk index) but still suffered perioperative cardiac events were successfully identified by a BNP level of 189 pg/mL or greater. They concluded that BNP is a stronger predictor of postoperative events than is the Goldman cardiac risk index. This study was limited, however, by the fact that the clinicians were not blinded to the BNP levels.

In a prospective study of 190 patients undergoing noncardiac surgery (158 major and 32 minor procedures), Yeh et al found that NT-proBNP was the only factor that was independently associated with postoperative cardiac complications ( $P < .001$ ) among several factors assessed (including age, clinical cardiac impairment, and American Society of Anesthesiologists fitness class).<sup>5</sup> An NT-proBNP level of 450 ng/L or greater had a sensitivity of 100% and a specificity of 82.9% in predicting postoperative cardiac complications in this study.

Gibson and colleagues conducted a prospective

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observational cohort study of 190 high-risk patients undergoing major noncardiac surgery.<sup>6</sup> They evaluated patients using plasma BNP levels measured a day before surgery and clinical risk assessment according to the Revised Cardiac Risk Index (RCRI). BNP was found to be a significant predictor of postoperative cardiac events ( $P < .001$ ) and superior to the RCRI. A plasma BNP level of 108.5 pg/mL or greater predicted cardiac events with sensitivity and specificity of 87%, a positive predictive value of 42%, and a negative predictive value of 98%.

In a study of 400 patients undergoing thoracic surgery for lung cancer, an elevated preoperative NT-proBNP level strongly and independently predicted postoperative atrial fibrillation, with a positive predictive value of 68% and a negative predictive value of 93% (67% sensitivity and 93% specificity).<sup>7</sup>

Interestingly, in a small prospective study of patients undergoing hip arthroplasty, preoperative BNP levels were significantly higher in patients who had a hypotensive response to surgery than in those who were normotensive after surgery.<sup>8</sup>

### Conclusions

Elevated levels of BNP and NT-proBNP appear to identify patients at risk for a variety of adverse postoperative cardiovascular events. Further investigations are needed to determine the role of these tests

in the risk stratification of patients undergoing non-cardiac surgery.

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## Q: What is the significance of an isolated elevated activated partial thromboplastin time in the preoperative setting?

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**A:** The significance of an isolated elevated activated partial thromboplastin time (aPTT) depends on the patient's clinical history, so a thorough history is essential when considering such a finding as a marker for perioperative hemorrhagic risk. The preoperative consultation should address and document any personal or family history of spontaneous bleeding, hemostatic difficulties with any prior surgeries (including

tooth extraction and childbirth), liver disease, malnutrition or malabsorption, and anticoagulant use or possible exposure, as well as physical exam findings suggestive of a bleeding disorder. In the absence of such a history or such findings, an elevated aPTT does not increase the perioperative risk of hemorrhage.

### An abnormal aPTT alone lacks predictive value

Historically, the aPTT was used to monitor known factor deficiencies within the intrinsic pathway—namely, hemophilia.<sup>1</sup> Now, however, this test is

Both authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

commonly used to assess bleeding risk in patients undergoing surgery. In the preoperative setting, a prolonged aPTT is encountered in up to 17.6% of blood samples sent.<sup>2</sup> An abnormal aPTT can be due to poor phlebotomy technique, erythrocytosis, or the in vitro phenomenon of the antiphospholipid antibody, and therefore is often of no hemostatic consequence.

Krishna and Lee<sup>3</sup> performed a meta-analysis of eight retrospective and four prospective studies of patients undergoing tonsillectomy to examine whether those with a prolonged aPTT had a higher rate of post-tonsillectomy bleeding relative to those with a normal aPTT. Tonsillectomy is an excellent surgical model to follow, as it poses a high hemostatic challenge, given the rich fibrinolytic environment of the oral pharynx. The positive predictive value of an abnormal aPTT for postoperative hemorrhage among the prospective trials in this analysis ranged from 0.00 to 0.14. Pooled analysis of the 3,384 patients in the prospective trials revealed an aggregate positive predictive value of 0.10.

Chee and Greaves<sup>2</sup> obtained similar findings in a systematic review of the literature addressing preoperative and preinvasive coagulation profiles for a variety of surgical procedures. They found no statistical difference in adverse event rates between patients with and without an elevated aPTT.

**The clinical history: Evidence for its predictive value**

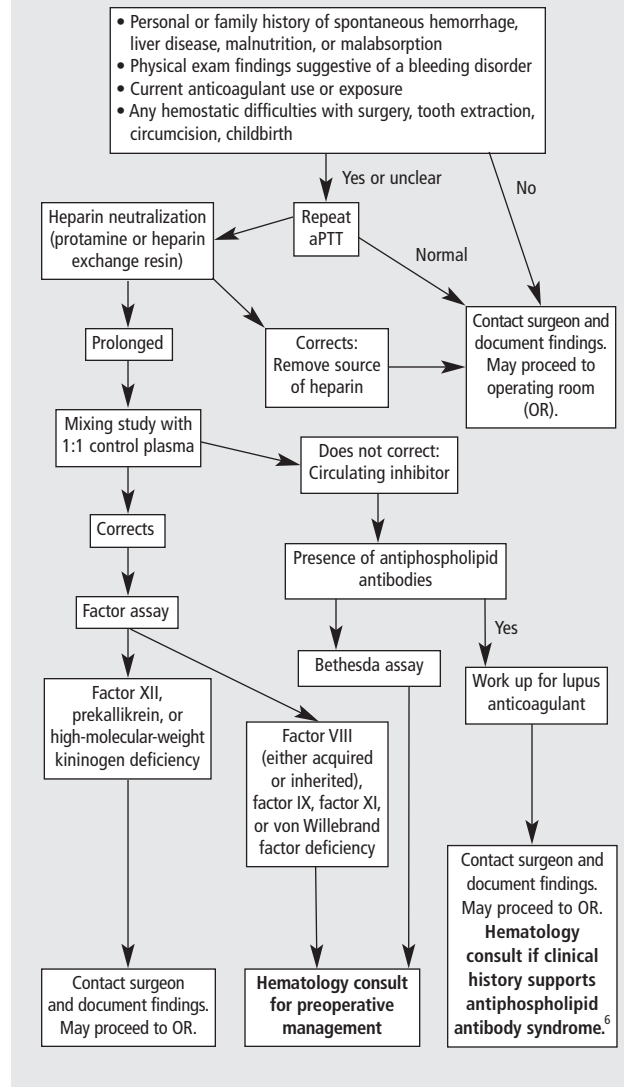
To determine whether the clinical history would improve the predictive power of the aPTT, Suchman and Mushlin<sup>4</sup> conducted a retrospective study of 12,338 admissions for invasive procedures. Patients were assigned to one of four risk groups based on clinical history:

- Those with known coagulopathies
- Those with potential factor deficiency (liver disease, malnutrition, malabsorption)
- Those with trauma or active hemorrhage
- Those with low hemorrhagic risk (all others).

In low-risk patients, who constituted 92% of the overall sample, an abnormal aPTT had no ability to predict the risk of hemorrhage. When the abnormal aPTT value was used in conjunction with clinical risk group assignment, the predictive power of the aPTT was improved, although not significantly.

The usefulness of a thorough history was further supported in a prospective study of 100 consecutive patients referred for preoperative consultation regarding an isolated abnormal aPTT.<sup>5</sup> All patients underwent a thorough history and physical exam,

**Preoperative approach to an elevated aPTT**



**FIGURE**

after which they were stratified into groups based on clinical risk of bleeding: 14% of patients were determined to have had an artifactually prolonged aPTT; 36% of patients had a prolongation that posed no increased hemorrhagic risk; and the remaining 50% of patients had deficits that did pose potential hemostatic consequences. This last group was divided into clinical risk categories, and those in the highest-risk subgroup—patients with moderate or severe factor VIII, IX, or XI deficiencies, disseminated intravascular coagulation, or severe liver disease—all had a positive clinical history.



**Conclusions**

No randomized controlled trials have focused on preoperative aPTT and surgical outcomes. Evidence from the medical and surgical literature suggests that an elevated aPTT, used independently, has no ability to determine which patients will bleed perioperatively.

In the preoperative setting, patients may proceed to surgery without delay if they have no personal or family history of hemorrhage or liver disease, no history of malnutrition or malabsorption, no physical exam findings suggestive of coagulopathy, and no history of hemorrhage with previous surgery. It is essential that this management decision be documented and that there be consensus with the perioperative team. In patients with a clinical history suggestive of hemorrhagic risk or an uncertain clinical history, an elevated aPTT should be fully investigated prior to surgery.

The algorithm presented in the **Figure** (see previous page) can be used to manage patients with an elevated preoperative aPTT.

**Acknowledgment**

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**Q: Does unrecognized diabetes in the preoperative period worsen postoperative outcomes?**

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**A:** Yes. Studies in both cardiac and noncardiac surgical patients demonstrate a correlation between glucose levels and length of hospital stay, in-hospital mortality, wound healing and infection rates, length of stay in the intensive care unit (ICU), and health care utilization. Randomized controlled trials in cardiac surgery patients and in surgical ICU settings demonstrate improved outcomes with aggressive glycemic control.

**Surgery and hyperglycemia**

Approximately 15% to 20% of patients who undergo surgery in the United States have diabetes, and this proportion is likely higher among those undergoing cardiothoracic procedures.<sup>1</sup> Many more patients proceed to surgery with undiagnosed diabetes, which is usually untreated.

Much of our current practice is based on the limited number of available studies and our knowledge of complications that result from hyperglycemia. Euglycemia is maintained by a strict balance between insulin and counterregulatory hormones such as cortisol, catecholamines, glucagon, and growth hormone. The stress of surgery and anesthesia disrupts this balance and increases levels of these counterregulatory hormones. Hepatic glucose production and peripheral insulin resistance increase, while glucose uptake and utilization in peripheral tissues and insulin secretion decrease. The decreased levels of insulin and elevated levels of catecholamines and glucagon stimulate protein catabolism and lipolysis, providing the precursors needed for gluconeogenesis, ultimately leading to hyperglycemia.

**Hyperglycemia and poor surgical outcomes**

Hyperglycemia has been associated with a host of complications, including dehydration, electrolyte abnormalities, impaired wound healing, diabetic ketoacido-

Both authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

sis, and nonketotic hyperosmolar coma. Elevated glucose levels correlate with increased morbidity and mortality in both cardiac and noncardiac surgical patients, and a number of studies have shown that aggressive glycemic control improves clinical outcomes.

**Cardiac surgery.** Several studies have evaluated postoperative complications among diabetic patients undergoing coronary artery bypass graft (CABG) surgery. Golden et al noted progressively higher rates of infectious complications (including sternal and leg wound infections, pneumonia, and urinary tract infections) among patients with higher blood glucose levels in the 36 hours following surgery.<sup>2</sup> Researchers at Providence St. Vincent Medical Center in Portland, Oregon, have published several studies evaluating glycemic control and outcomes in patients undergoing CABG surgery.<sup>3-5</sup> In 1991 they implemented an aggressive insulin infusion protocol aimed at maintaining blood glucose levels below 200 mg/dL, with resultant decreases in the risk of deep sternal wound infections, length of hospital stay, and overall in-hospital mortality.<sup>3-5</sup>

**Surgical ICU.** Intensive treatment of hyperglycemia has also been evaluated in the surgical ICU setting in a randomized controlled trial from Belgium.<sup>6</sup> This study showed that aggressive insulin therapy aimed at maintaining blood glucose levels of 110 mg/dL or less was associated with reductions in both ICU and in-hospital mortality, ICU length of stay, bacteremia, duration of antibiotic use, acute renal failure, and the need for mechanical ventilation.

**Noncardiac surgery.** A recent retrospective case-control study from the Netherlands compared 904 patients who died within 30 days of hospitalization for noncardiac, nonvascular surgery with 1,247 matched controls.<sup>7</sup> Patients with preoperative glucose levels of 200 mg/dL or greater had twice the overall mortality rate and a fourfold higher rate of cardiovascular mortality compared with controls. "Prediabetes" glucose levels (110 to 200 mg/dL) were found to have a similar but less pronounced association with increased mortality. The authors suggested that impaired glucose tolerance may be a risk factor for perioperative cardiac events, as the pathophysiologic changes in the vasculature may be under way before the onset of outright diabetes.

Studies of intensive glucose control have not yet been performed in patients undergoing noncardiac, nonvascular surgery, so it is not known whether aggressive control in this patient population will lead to benefits similar to those in the cardiac surgery and surgical ICU settings.

### Unrecognized diabetes:

#### A common cause of complications

In a retrospective analysis of 2,030 patients admitted to a single community hospital, Umpierrez et al found that 37% of patients admitted for surgery had hyperglycemia that was previously unrecognized.<sup>8</sup> Among all patients with newly discovered hyperglycemia, in-hospital mortality was 16%, compared with 1.7% among patients with normoglycemia. Patients with newly discovered hyperglycemia also had worse functional outcomes and longer hospital stays, and were more frequently admitted to the ICU and more likely to need skilled care or nursing home care at discharge.

#### Conclusions

Patients with hyperglycemia undergo surgery frequently and are at increased risk of perioperative complications, regardless of whether they carry a prior diagnosis of diabetes. Current evidence suggests that optimal treatment of hyperglycemia, with a target blood glucose level of 110 mg/dL or less, reduces the risk of perioperative complications and death.<sup>9</sup> Further studies are needed to ascertain the ideal blood glucose level for minimizing complications and to better define patient populations that will benefit from aggressive glycemic control measures.

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## Q: Should an asymptomatic patient with an abnormal urinalysis (bacteriuria or pyuria) be treated with antibiotics prior to major joint replacement surgery?

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**A:** There are no clear guidelines for the treatment of asymptomatic patients with abnormal urinalysis results prior to major joint replacement surgery. However, the current literature supports treating with a course of antibiotics and proceeding with joint replacement surgery for those asymptomatic patients with evidence of bacteriuria on preoperative evaluation.

### Defining terms

Diagnosis of asymptomatic bacteriuria requires isolation of a specified quantitative count of bacteria (usually  $\geq 10^5$  colony-forming units [CFU]/mL), collected in a manner to minimize contamination, from a person without symptoms or signs referable to urinary infection. In a urinary dipstick specimen, the leukocyte esterase is a more sensitive indicator of bacteriuria than are nitrites. Pyuria is defined as the presence of increased numbers of polymorphonuclear leukocytes in the urine (usually  $\geq 6$  to 10 white blood cells per high-power field).<sup>1</sup>

### Preoperative urinalysis: Common, but cost-effective?

Orthopedic prosthetic surgery is becoming increasingly important as the US population ages and requires more procedures. Deep joint infection continues to be one of the most dreaded complications of total joint arthroplasty, and urinary tract infections (UTIs) are generally believed to be a source for hematogenous seeding of the prosthetic joint. Because of this, routine urinalysis continues to be common practice.

A 1989 cost-effectiveness study of elective clean-wound, nonprosthetic knee procedures estimated that approximately \$7 million is spent annually on preoperative urinalysis and its consequent treatment in the United States.<sup>2</sup> This study estimated that about five wound infections may be prevented annually with routine urinalysis prior to these knee procedures in the United States, at a cost of \$1.5 million per wound infection prevented, and that the cost of treating additional cases of wound infection is approximately 500-fold less

than the cost of screening with routine urinalysis.<sup>2</sup> The cost-effectiveness of preoperative urinalysis in prosthetic joint surgery has not been studied extensively.

### A limited literature on connections between deep joint infection and preoperative UTI

In a review of the literature on the risk of deep joint infection in patients with abnormal perioperative urinalyses, David and Vrahas noted that several case reports in the 1970s linked postoperative UTIs to prosthetic joint infection but that the literature supporting a correlation between preoperative UTIs and deep joint infection following total joint arthroplasty is inadequate.<sup>3</sup> A 1974 retrospective study of 274 total hip replacements found that 5 patients with deep joint infection had perioperative UTI.<sup>4</sup> However, only in 3 patients were the same organisms isolated from the urinary tract and the hip. Of these 3 patients, who had risk factors for joint infection (diabetes or rheumatoid arthritis), only 1 had a documented preoperative urinalysis.<sup>4</sup>

Few studies have evaluated the risk of deep joint infection associated with the presence of asymptomatic UTI in the preoperative setting.

A 1987 retrospective analysis of 277 patients undergoing 364 total joint replacements showed that 35 patients had evidence of preoperative or perioperative UTI with colony counts greater than  $10^5$  CFU/mL on preoperative “clean catch” urine specimens.<sup>5</sup> Only 3 patients (1.1%) developed joint infections—at 9, 19, and 45 months, respectively—and none was secondary to perioperative UTI.

A 1984 retrospective analysis of 299 patients admitted for hip or knee arthroplasty found that 57 patients (55 asymptomatic and 2 symptomatic) had bacteriuria on admission.<sup>6</sup> Twenty of the 57 patients went to surgery before the routine culture results were available but received appropriate antibiotics postoperatively for treatment of UTI. Eighteen of the 57 patients had preoperative UTI and underwent surgery during a treatment course of antibiotics. The remaining 19 patients

All authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

had completed their antibiotic course prior to surgery and received no intraoperative or postoperative antibiotics for UTI. Deep joint infection was not seen in any patients at 3-month follow-up, prompting the authors to conclude that asymptomatic bacteriuria is common and should not be a cause for postponement of surgery. These findings suggest that a treatment course of antibiotics can be implemented at any time perioperatively once urinalysis results are known to be abnormal.

In a prospective multicenter study of 362 knee and 2,651 hip operations published in 1992, deep joint infections were diagnosed at 1-year follow-up in 9 of 362 patients (2.5%) after knee arthroplasty and in 17 of 2,651 patients (0.64%) after hip arthroplasty.<sup>7</sup> All patients had received a short course of perioperative cefuroxime. Univariate analysis showed no association between deep joint infection and preoperative UTI ( $> 10^5$  CFU/mL), although multivariate analysis showed that postoperative UTI increased the incidence of hip joint infections.

#### A few risk factors merit more caution

More caution is indicated in patients who are determined to be at a higher risk for deep joint infections. In a study of 12,118 primary knee arthroplasties, risk factors for an increased incidence of joint infection included a large prosthesis, postoperative wound-healing complications, rheumatoid arthritis, a prior deep infection, and skin infections.<sup>8</sup> In other studies, patients with diabetes, prior hip surgeries, or posttraumatic degenerative joint disease have had a higher incidence of deep joint infection.<sup>9,10</sup>

#### Conclusions

There are no treatment guidelines for the management of asymptomatic bacteriuria or pyuria prior to major

joint replacement surgery. A strategy of treating asymptomatic patients who have urine counts greater than  $10^5$  CFU/mL with an effective perioperative course of antibiotics and proceeding with surgery seems reasonable, based on the limited literature.<sup>3-5</sup> Treatment of patients with asymptomatic preoperative pyuria is less clear. Clinicians may consider more aggressive management of asymptomatic bacteriuria and pyuria if other risk factors for postoperative deep joint infection are present.

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## Q: Does a carotid bruit predict cerebrovascular complications following noncardiac surgery in asymptomatic patients?

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**A:** A carotid bruit is a poor marker for significant carotid stenosis and does not predict perioperative stroke. Further evaluation and consideration for surgical treatment are warranted only in patients with

recent neurovascular events such as stroke or transient ischemic attack.

#### Perioperative stroke and relationship to carotid stenosis

Despite advances in surgical technique and improvements in medical care, the incidence of perioperative stroke has not decreased in recent years, likely reflect-

Dr. Mayock reported that he has no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

ing the aging of the population and the increased number of patients with comorbid medical conditions.<sup>1</sup> Likewise, its consequences remain substantial: in one large retrospective study, perioperative stroke after general surgery carried a poor prognosis: 8% of patients experienced full recovery, 43% were left with some disability but were still independent, 31% were left with full disability, and 18% died.<sup>2</sup>

Carotid atherosclerosis is believed to be responsible for 30% of perioperative strokes,<sup>3</sup> with the large majority of these events occurring at the time of surgery or within the first 48 hours after surgery.<sup>4</sup> Retrospective studies of all perioperative strokes suggest that 45% occur on the first day and 55% occur between postoperative days 2 and 30.<sup>1</sup>

### Carotid bruit: Not a reliable marker for stenosis

The presence of a carotid bruit is not a reliable marker for carotid artery stenosis, and cannot be relied upon to determine the need for further investigation or treatment.

Carotid bruits are heard in 4% of the general population older than 40 years of age and in up to 14% of patients older than 55 years undergoing noncardiac surgery.<sup>5</sup> The prevalence of asymptomatic carotid stenosis greater than 50% was found to be 6.4% in a population-based study of 500 volunteers aged 50 to 79 years.<sup>6</sup>

In a recent prospective study of 153 patients undergoing coronary artery bypass graft surgery,<sup>7</sup> the positive predictive value of carotid bruit as a marker for significant ( $\geq 50\%$ ) carotid stenosis was 25% and the negative predictive value was 95.5%. In addition, more than 3% of patients with critical stenosis did not present with a bruit. Older studies in unselected medical patients have found bruits to have still lower positive and negative predictive values for critical stenosis.<sup>7</sup>

### Carotid bruit and perioperative stroke: No association

The risk of perioperative stroke in general surgery patients is very low. A prospective study of 2,463 general surgery patients with a mean age of 65 years revealed an incidence of perioperative stroke of only 0.2%.<sup>8</sup>

The predictive value of carotid bruit for stroke in otherwise unselected patients was assessed in a prospective study of 735 patients undergoing general and vascular surgery.<sup>5</sup> The investigators found that although 14% of patients had carotid bruits, the stroke rate (0.7%) was similar between those who had bruits and those who did not. These authors pooled this study's findings with data from five other studies (2,205 patients in total) and again found no difference in stroke rates between patients with and with-

out bruits, which further argues that the presence of a bruit does not predict perioperative stroke.<sup>5</sup>

### No clear role for preoperative carotid endarterectomy

Furthermore, surgical correction of severe carotid stenosis in patients without prior neurologic symptoms (stroke or transient ischemic attack) is not indicated prior to noncardiac surgery. A recent prospective randomized trial enrolled 79 neurologically asymptomatic patients with carotid stenosis of 70% or greater who were undergoing major vascular surgery.<sup>9</sup> Patients were randomized to carotid endarterectomy performed either 1 week prior to surgery or 1 to 6 months after surgery. At 1-month follow-up, there were no neurologic events in either group and no mortality difference between groups. Two patients in the second group suffered small strokes, at days 65 and 78, both of which occurred prior to carotid endarterectomy. No other randomized prospective studies have been conducted.

### Conclusions

Carotid bruit is a poor marker for significant carotid stenosis. Patients without prior neurologic symptoms (transient ischemic attack/cerebrovascular accident) who are undergoing noncardiac surgery are at minimal risk for perioperative stroke, and no additional studies or surgical interventions are required.

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## Q: What risks does a history of pulmonary hypertension present for patients undergoing noncardiac surgery?

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**A:** The potential perioperative complications of pulmonary hypertension include a substantially higher rate of death, right ventricular failure, persistent postoperative hypoxia, and cardiac arrhythmias.

### Scarcity of data in the noncardiac surgery setting

Patients with pulmonary hypertension are often counseled against undergoing elective surgery because early and sudden postoperative death has been reported in these patients.<sup>1,2</sup> In a retrospective study of 2,066 patients undergoing cardiopulmonary bypass surgery, a preoperative mean pulmonary artery pressure greater than 30 mm Hg was the only baseline variable that was independently predictive of perioperative mortality (odds ratio = 2.1).<sup>3</sup> However, few data are available on patients undergoing noncardiac surgery, although increased mortality has been reported in patients with pulmonary hypertension undergoing orthotopic liver transplantation.<sup>4</sup>

### Perioperative complications in patients with pulmonary hypertension

The most significant study to assess outcomes of patients with pulmonary hypertension undergoing noncardiac surgery included 145 such patients and was published by Ramakrishna et al in 2005.<sup>5</sup> The incidence of early mortality ( $\leq 30$  days after surgery) in these patients was 7% (10 patients), and among those who survived surgery, the incidence of morbidity was 42%. The most frequent contributors to early death were respiratory failure (60%) and right ventricular failure (50%). The most common morbid events were respiratory failure (including pneumonia, hypoxia requiring oxygen, or prolonged intubation), which occurred in 28% of the group, cardiac arrhythmias (12%), and congestive heart failure (11%).

In a retrospective series of 21 patients with pulmonary hypertension (mean pulmonary artery pressure,  $53.0 \pm 14.4$  mm Hg) undergoing 28 noncardiac procedures, Minai et al<sup>6</sup> reported 18% postoperative mortality and a 19% incidence of right ventricular failure.

### Predictors of increased risk after noncardiac surgery in patients with pulmonary hypertension

Unfortunately, the 2002 guideline update on perioperative cardiovascular evaluation for noncardiac surgery from the American College of Cardiology and American Heart Association<sup>7</sup> does not include criteria for risk-stratifying patients with pulmonary hypertension.

Ramakrishna et al<sup>5</sup> identified several predictors of short-term morbidity after noncardiac surgery:

- New York Heart Association functional class of II or greater
- Intermediate-risk or high-risk surgery
- History of pulmonary embolism
- Anesthesia lasting longer than 3 hours.

Univariate analysis suggested that the following were also associated with short-term mortality: right ventricular hypertrophy ( $P = .04$ ), a ratio of right ventricular systolic pressure to systolic blood pressure of 0.66 or greater ( $P = .01$ ), and a right ventricular index of myocardial performance greater than or equal to 0.75 ( $P = .03$ ).

When these authors stratified risk by type of surgery, they found that 17% of patients undergoing low-risk procedures experienced morbid events compared with 48% of patients undergoing orthopedic surgery and 62% of those undergoing thoracic surgery.<sup>5</sup>

Minai et al<sup>6</sup> reported higher mortality in the patients in their series who had pulmonary artery catheter (PAC) monitoring during surgery than in those without PAC monitoring, although the difference was not statistically significant ( $P = .17$ ). The authors hypothesized that patients with more severe pulmonary hypertension may have been more likely to have PAC monitoring.

### Conclusions

Based on limited available data, pulmonary hypertension confers substantial risks for death and cardiac morbidity in the perioperative period. Although data suggest that features from the clinical history and parameters from the electrocardiogram and two-dimensional echocardiography may help identify patients at highest risk of complications and death, there are currently no specific risk-assessment tools available for objectively categorizing this increased risk.

All authors reported that they have no commercial affiliations or financial interests that pose a potential conflict of interest with this article.

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# Q: Does a systolic murmur heard in the aortic area need to be further evaluated prior to elective surgery?

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**A:** The decision to further evaluate a systolic murmur heard in the aortic area by transthoracic echocardiography prior to surgery should depend on the available clinical information and the cardiovascular risk associated with the surgical procedure. An isolated systolic murmur in the aortic area can be due to either aortic stenosis or aortic sclerosis, or it can be functional.

**Aortic stenosis needs to be identified prior to elective noncardiac surgery**

Aortic stenosis (AS) occurs in about 2% of adults 65 years of age or older.<sup>1</sup> Severe AS poses a high risk for complications in patients undergoing noncardiac surgery, with an approximate mortality rate of 10%.<sup>2</sup> Patients with severe AS have symptoms of angina, heart failure, and effort syncope. Physical examination findings that are helpful in establishing the presence of significant AS include delayed carotid upstroke, mid-to-late peaking of murmur intensity, and decreased intensity of the second heart sound. Absence of radiation of the systolic murmur to the right carotid artery rules out significant AS.<sup>3</sup> The **Table** (see next page) presents the various likelihood ratios for these findings.<sup>3</sup>

It is important to identify patients with AS, since risk reduction strategies can be instituted perioperatively.

**What other conditions are responsible for similar systolic murmurs?**

**Aortic sclerosis** produces a systolic ejection murmur in the aortic area. It is more common than AS, occurring in 26% of adults older than age 65.<sup>1</sup> In contrast to AS, in aortic sclerosis there is no fixed aortic outflow tract obstruction, so the second heart sound and the carotid pulses are preserved. Patients with aortic sclerosis can undergo surgery safely without complications.

**Functional murmurs** caused by anemia, hyperthyroidism, or fever result from augmentation of blood flow through a structurally normal aortic valve.

**The decision to obtain a TTE should be individualized**

If AS is suspected in a *symptomatic* patient, a transthoracic echocardiogram (TTE) is warranted, regardless of the risk of the surgical procedure. At this point, the focus is primarily on treating the aortic valve disorder, and the surgery has to be delayed.

If AS is suspected in an *asymptomatic* patient undergoing a *low-risk* surgical procedure under local anesthesia, it is reasonable to proceed with surgery without a preoperative TTE. In a retrospective analysis of 48 patients with known severe AS who were

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**TABLE**  
Accuracy of the physical examination for detecting aortic stenosis

Finding	Reference standard (no. of patients)	Positive likelihood ratio* (95% CI)	Negative likelihood ratio† (95% CI)	Quality grade
Slow rate of rise of carotid pulse				
Study 1	Cardiac catheterization (781)	130 (33–560)	0.62 (0.51–0.75)	A
Study 2	Cardiac catheterization (231)	2.8 (2.1–3.7)	0.18 (0.11–0.30)	C‡
Study 3	Cardiac catheterization (106)	6.4 (0.8–45)	0.73 (0.59–0.90)	C
Timing of peak murmur intensity				
Late peaking	Cardiac catheterization (781)	101 (25–410)	0.31 (0.22–0.44)	A
Mid peaking	Cardiac catheterization (106)	8.0 (2.7–23.0)	0.13 (0.07–0.24)	C
Decreased intensity or absent second heart sound				
Study 1	Cardiac catheterization (781)	50 (24–100)	0.45 (0.34–0.58)	A
Study 2	Cardiac catheterization (231)	3.1 (2.1–4.3)	0.36 (0.26–0.49)	C‡
Apical carotid delay	Cardiac catheterization (44)	∞ (2.4–∞)	0.05 (0.01–0.31)	C
Brachioradial delay	Echocardiogram (58)	6.8 (3.2–14.0)	0.0 (0.0–0.3)	C
Fourth heart sound	Cardiac catheterization (781)	2.5 (2.1–3.0)	0.26 (0.14–0.49)	A
Presence of any murmur	Cardiac catheterization (781)	2.4 (2.2–2.7)	0.0 (0.0–0.13)	A
Reduced carotid volume				
Study 1	Cardiac catheterization (231)	2.3 (1.7–3.0)	0.31 (0.21–0.46)	C‡
Study 2	Cardiac catheterization (106)	2.2 (1.2–4.2)	0.39 (0.22–0.69)	C
Radiation to right carotid				
Study 1	Cardiac catheterization (781)	1.4 (1.3–1.5)	0.10 (0.13–0.40)	A
Study 2	Cardiac catheterization (231)	1.5 (1.3–1.7)	0.05 (0.01–0.20)	C‡
With Valsalva maneuver intensity is decreased	Cardiac catheterization (50)	1.2 (0.8–1.6)	0.0 (0.0–1.6)	C

\* The applicable likelihood ratio when the finding is present. CI indicates confidence interval.

† The applicable likelihood ratio when the finding is absent.

‡ Grade A study except cardiac catheterization interpreted with knowledge of clinical findings.

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inoperable candidates for aortic valve replacement, 25 underwent noncardiac surgery under local anesthesia with intravenous sedation, and none had complications.<sup>4</sup> In another study of 55 patients with severe AS, no complications occurred in patients undergoing local anesthesia.<sup>5</sup> In general, patients with AS undergoing surgery with local anesthesia and sedation have a benign perioperative outcome.<sup>6</sup>

If AS is suspected in an *asymptomatic* patient undergoing noncardiac surgery that involves general or regional anesthesia, a TTE is warranted. The TTE usually provides data about the severity of AS and the presence of left ventricular dysfunction and left ventricular hypertrophy. In a retrospective cohort of 92 patients, Kertai et al<sup>7</sup> found that perioperative death or nonfatal myocardial infarction occurred in 31% of patients with severe AS (aortic valve area < 0.7 cm<sup>2</sup> or a mean transvalvular gradient ≥ 50 mm Hg) and in 11% of patients with moderate AS (valve area of 0.7 to 1 cm<sup>2</sup> or a mean gradient of 25 to 49 mm Hg). The key point is to quan-

tify the severity of AS, since postoperative complications occur even in patients with moderate AS.

### Conclusions

Systolic murmurs that are heard in the aortic area are not specific for AS. Aortic sclerosis can mimic the murmur of AS, as can other functional murmurs. A thorough and careful history and physical examination are essential in the preoperative evaluation. In the absence of clinical signs and symptoms of AS, surgery can proceed without need for a TTE. For symptomatic patients, a TTE is warranted and surgery must be postponed. If clinical suspicion suggests AS in an asymptomatic patient, the course depends on the type of surgery and anesthesia: if the patient is scheduled for minor surgery under local anesthesia with intravenous sedation, the surgery can proceed without further evaluation; if the surgery requires general or spinal anesthesia, a TTE is warranted to confirm the diagnosis and assess the severity of disease.



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# Oral Abstract Presentations—Tuesday, September 11

## 1:00 Preoperative Electrocardiograms: Patient Factors Predictive of Abnormalities

Darin Correll, David Hepner, Lawrence Tsen, Candace Chang, Angela Bader  
Brigham and Women's Hospital and Harvard Medical School, Boston, MA

**Background:** Most institutions recommend preoperative electrocardiograms (ECGs) for patients over 50 years old. However, resting ECGs have been shown to be poor screening devices for coronary artery disease. Medicare has recently stopped reimbursing for preoperative routine ECGs based on age alone. This study was designed to determine whether preoperative guidelines could be refined to eliminate unnecessary ECGs. Our hypothesis was that significant abnormalities are unlikely in the absence of coronary risk factors.

**Methods:** We reviewed ECGs for patients presenting for preoperative evaluation during a 2-month period. ECG abnormalities considered to be significant were major Q waves, major ST segment depression, major T wave changes, ST segment elevation, Mobitz type II or higher blockade, left bundle branch block, and atrial fibrillation. Patient risk factors included myocardial infarction, anginal symptoms, congestive heart failure, severe valvular disease, diabetes, renal insufficiency, low functional capacity, stroke, hypertension, smoking, high cholesterol, coronary artery disease, and peripheral vascular disease.

**Results:** A total of 1,337 ECGs were reviewed, with 94 patients (7%) having at least one significant abnormality. These patients were compared with a control group of 232 patients with

a normal ECG or with insignificant abnormalities. A minor T wave change, seen in 198 (14.8%) of all the ECGs, was the most common abnormality. Major T wave changes, present in 63 patients (4.7%), constituted the most common significant abnormality. Patients at higher risk for having an abnormal ECG were those older than 65 years of age and those who had a history of heart failure, high cholesterol, angina, myocardial infarction, or severe valvular disease (Table). Six patients (0.5%) had an abnormal ECG without having any risk factor.

**Conclusion:** Although our model is capable of identifying patients who are at risk of having significant preoperative ECG abnormalities, it cannot capture all patients who have abnormal ECGs. It will need to be determined if it is economically feasible to limit ECGs to this high-risk population with the potential to cancel very few cases on the day of surgery if a patient is noted to have an abnormality on the two-lead ECG monitor.

**TABLE**  
LOGISTIC REGRESSION ANALYSIS FINDINGS

Risk factor	P value	Odds ratio	95% CI
Age > 65 years	< .0001	4.3	2.32–7.96
Heart failure	< .0001	12.1	3.46–45.58
High cholesterol	.0175	2.2	1.15–4.36
Angina	.0149	5.8	1.41–23.86
Myocardial infarction	.0001	6.5	2.50–17.05
Severe valve disease	.0012	8.0	2.28–28.0

## 1:15 Impact of Combination Medical Therapy on Mortality in Vascular Surgery Patients

Thomas Barrett<sup>1,2</sup>, Motomi Mori<sup>2</sup>, Caroline Koudelka<sup>2</sup>  
<sup>1</sup>Portland Veterans Affairs Medical Center and <sup>2</sup>Oregon Health & Science University, Portland, OR

**Background:** The use of combination evidence-based medical therapies consisting of aspirin, beta-blockers, statins, and ACE inhibitors in acute coronary syndrome has been shown to decrease mortality compared with the use of no evidence-based therapies. The single or combination use of beta-blockers or statins has been associated with decreased mortality after noncardiac surgery. The single use of aspirin has been associated with decreased mortality after cardiac surgery. There have been no published data on improved perioperative outcomes with ACE inhibitors.

**Methods:** We sought to ascertain if the combination use of four study drugs—aspirin, beta-blockers, statins, and ACE inhibitors—compared with no study drug use was associated with decreased mortality 6 months after vascular surgery. We performed a retrospective cohort study of 3,020 patients presenting for vascular surgery at five regional Veterans Affairs medical cen-

ters between January 1998 and March 2005. Patients were categorized as using the study drugs if they filled a prescription for the study drug within 30 days before surgery. Cochran-Mantel-Haenszel analysis was used to assess associations with 6-month mortality adjusted for the Revised Cardiac Risk Index score.

### Results:

- Compared with taking no study drug, use of all four study drugs had an RR of 0.45 (95% CI, 0.25 to 0.82;  $P = .0078$ ).
- Compared with taking no drug, use of three study drugs had an RR of 0.54 (95% CI, 0.35 to 0.84;  $P = .0052$ ).
- Compared with taking no drug, use of two study drugs had an RR of 0.73 (95% CI, 0.51 to 1.05;  $P = .0934$ ).
- Compared with taking no drug, use of one study drug had an RR of 0.88 (95% CI, 0.63 to 1.22;  $P = .4357$ ).

The most common single agent was aspirin; the most common two-drug combination was aspirin and an ACE inhibitor; and the most common three-drug combination was aspirin, a beta-blocker, and a statin.

**Conclusion:** Combination use of three or more study drugs was consistently associated with decreased mortality after vascular surgery. Further study of combination perioperative use of aspirin, beta-blockers, statins, and ACE inhibitors is warranted.

### 1:30 Do Large Electronic Medical Record Databases Permit Collection of Reliable and Valid Data for Quality Improvement Purposes?

Ashish Aneja, Eric Hixson, Brian Harte, Vesselin Dimov, Amir Jaffer  
Cleveland Clinic, Cleveland, OH

**Background:** A quality improvement program was initiated at Cleveland Clinic to evaluate current practices and trends in pre-operative cardiac risk assessment and prescription of perioperative beta-blockers for patients undergoing elective, noncardiac surgery with a planned hospitalization of 1 day or longer.

**Methods:** Data for this study originated exclusively from institutional databases, primarily the electronic medical record (EMR). Determinants of eligibility were defined using a standardized assessment and treatment protocol developed by a core working group of physicians, surgeons, and nurses. A validation sample (n = 190) of patients seen in the year 2005 was randomly generated from the analysis set of 11,985 consecutive patients. A single physician re-abstracted all relevant data for determining beta-blocker eligibility from the validation sample. A kappa statistic was used to assess the rate of agreement between the original assessment and validation assessment for determining beta-blocker eligibility derived from the random sample.

**Results:** The initial rate of agreement was moderate (kappa = 0.62). The rates of agreement for each eligibility component are reported in the **Table**. Closer examination revealed that characterization of hypertension had the lowest level of agreement. Originally, hypertension was defined by documented diagnoses in the EMR while the validation study utilized actual measured

blood pressures. When the hypertension diagnosis was replaced with actual blood pressures (defined as blood pressure > 160/90 mm Hg by the group), the rate of agreement was substantially improved (kappa = 0.81).

**Conclusion:** The content and quality of information contained in the EMR remains dependent in large part on the documentation practices of health care providers. EMR-derived data can be used to produce valid correlates for quality improvement if they can be confidently validated with a random sample, as documented here. Clinically derived variables should be selected before diagnosis codes to define clinical conditions when it is feasible and when they are available to investigators.

**TABLE**  
RATES OF AGREEMENT BETWEEN ASSESSMENTS

Eligibility component	Agreement	Expected agreement	Kappa	P
Coronary artery disease	95.8%	72.7%	0.846	< .001
Stroke/TIA	94.2%	87.7%	0.530	< .001
Diabetes	97.9%	75.6%	0.914	< .001
Renal disease	99.0%	94.9%	0.795	< .001
Heart failure	96.8%	90.0%	0.685	< .001
Peripheral vascular disease	98.4%	93.4%	0.761	< .001
Hypertension and age > 65	80.0%	72.9%	0.262	< .001
Overall initial agreement	86.3%	63.7%	0.623	< .001
Overall agreement with revised hypertension criteria	93.7%	67.4%	0.807	< .001

# Poster Abstracts

## Innovations in Perioperative Medicine

(Note: Abstracts 4, 6, and 10 were chosen as the best in this section by the Innovation Abstracts Committee.)

### 1 PONV: 'An Ounce of Prevention is Worth a Pound of Cure'

Catherine Capitula, Shari Duguay  
Seton Health/St. Mary's Hospital, Troy, NY

**Background:** Nursing identified postoperative nausea and vomiting (PONV) in surgical patients to be a huge source of patient dissatisfaction. Previous patient experiences predestine negative outcomes. PONV is hard to rescue with medications and has a negative impact on patient safety.

**Purpose:** Using evidence-based practice, we aimed to develop a screening tool to screen all surgical patients for their risk of PONV, notify all members of the perioperative team of each patient's risk score, develop a multidisciplinary team approach for the prevention of PONV, and use multimodal antiemetic prophylaxis to decrease PONV and increase patient

satisfaction and safety.

**Description:** We developed a PONV risk assessment tool and education tools, implemented protocols involving patient education and nursing documentation, and provided in-service programs for all involved in the care of surgical patients (anesthesiologists, pharmacists, surgeons, nursing staff).

**Results and Conclusions:** A 6-month chart audit of all high-risk surgical outpatients showed that an average of 11% of our high-risk surgical outpatients actually experienced PONV, well below the potential risk of up to 70%, decreasing the risk of postoperative complications. We have received many letters from patients praising this process for their positive experiences. Surgeons are collaborating with nurses regarding risk and prevention from their offices preoperatively. Nurses are taking an active role as patient advocates in the prevention of PONV and increasing patient satisfaction and safety.

### 2 Optimization of Perioperative Processes Through Innovation and Technology for the Orthopaedic Operating Room of the Future

J.H. James Choi, Jennifer Blueter, Barbara Fahey, James Leonard, Ted Omilanowski, Vincent Riley, Mark Schauer, Timothy Sullivan, Viktor Krebs, Jonathan Schaffer  
Advanced Operative Technology Group, Cleveland, OH

**Background:** Three key challenges are influencing orthopaedics: an increasingly older population that is living longer, improved technology, and value optimization per procedure. Domestic annual demand for knee replacements will increase 12% to 15% for the next 20 years. Similar increases in all orthopaedic subspecialties will also stress capacity and requisite perioperative processes. The Orthopaedic Operating Room of the Future (OORF) program focuses the capability to respond to these demands.

**Purpose:** Operating room success is dependent on preoperative, intraoperative, and postoperative processes that comprise orthopaedic care. The OORF program initiated a Lean Six Sigma-based reengineering collaboratory to increase efficiency and efficacy. The process mapping for total joint arthroplasty was initiated with the goal of improving performance and predictability, minimizing variances, decreasing "waste," and increasing value while minimizing costs. Capabilities across the continuum of orthopaedic care were investigated, starting with the initial orthopaedic clinical visit, through preoperative evaluations, standardizing operating environments, and ultimately leading to the development of three state-of-the-art, standardized orthopaedic operating rooms.

**Description:** An open-participation, cross-divisional collaboratory was established to integrate complementary efforts of all groups involved in the care of orthopaedic patients and included over 175 doctors, administrators, nurses, therapists, and support staff. Process engineering tools were used to identify critical path processes and their stakeholders to optimize process efficiency, efficacy, productivity, and satisfaction. Key issues included setting appropriate expectations, education and training, identification of processes while maintaining a patient-first and quality focus, and evaluating pre-, post-, and intraoperative technology.

**Results and Conclusions:** The OORF program identified the critical aspects of pre- and postoperative processes to achieving success with day-of-surgery processes by enhanced communication and seamless integration of perioperative information and functions. Standardization facilitated maintenance and case turnover. Updated anesthesia ceiling-mounted booms, equipment ceiling-mounted booms, and environmental controls, and better access to health information technology applications, including electronic medical records, picture archiving, and communication system and communications capabilities, added value to operative and perioperative staff. Lessons learned include setting realistic and specific problem scopes, providing continual progress updates, establishing competency, structure, and capability within the organization, and avoiding premature, overreaching solution definitions. The OORF program has been a helpful tool in the continuous pursuit of the perfect operation in the perfect environment.

### 3 A Systematic Approach to Interpreting Electrocardiograms by Using Two Mnemonics

Vesselin Dimov<sup>1</sup>, Kalina Uzunova-Dimova<sup>2</sup>, Ajay Kumar<sup>1</sup>, Ashish Aneja<sup>1</sup>  
<sup>1</sup>Cleveland Clinic, Cleveland, OH; <sup>2</sup>Private practice

**Background:** Electrocardiogram (ECG) interpretation is an integral part of the perioperative assessment. Trainees in anesthesiology and perioperative medicine often find this interpretation among the more challenging aspects in the evaluation of patients scheduled to undergo surgery.

**Purpose:** Our aim was to create a simple tool that can help in accurate and time-efficient interpretation of ECGs.

**Description:** A two-step memory tool (mnemonic) was developed at a large tertiary care center to help anesthesiology and medical residents in interpreting ECGs.

In step one, all elements of the ECG were assessed systematically with the mnemonic **A RARE PQRST**: Age, Rate, Axis, Rhythm, Evaluate, P wave, Q wave, R wave, ST segment, T wave.

In step two, the causes of abnormalities detected in step one were

evaluated by using the differential diagnosis mnemonic **DR EEE III**: Drugs, Rhythm/rate/conduction abnormalities, Enlargement of a chamber, Electrolyte disturbances, Endocrine causes, Ischemia, Infarct (old), Infection.

A suggested approach to using the tool was to write the mnemonic on a piece of paper (eg, "A RARE PQRST," "DR EEE III"), circle the abnormalities discovered in step one, and then attempt to explain these abnormalities by connecting them to the list of possible etiologies listed in the second step. We conducted a pilot study focused on the perceived usefulness of the mnemonic for ECG interpretation; the study involved four anesthesiology residents and four internal medicine residents (post-graduate year 1).

**Results and Conclusions:** After practicing ECG evaluation with the help of the two-step mnemonic, 87% of the residents rated the tool as useful. We concluded that our two-step mnemonic for interpreting ECGs may be a valuable tool in perioperative medicine education. A follow-up study on a larger scale may be needed to confirm our findings.

### 4 Improving and Standardizing Medicine Consultation

Benny Gavi, Lisa Shieh, Keith Posley, Shahram Sepehri, Phil Pang  
 Stanford University, Stanford, CA

**Background:** The Stanford Medicine Consult Service, staffed by hospitalist and nonhospitalist attending physicians, as well as by house staff, provided variable quality of care and education. Variability involved timeliness, frequency, and modes of communication, use of different practice guidelines, recommendation of different tests and therapies for similar conditions, and different styles of communication (eg, general vs specific recommendations). Furthermore, attending physicians provided variable supervision, feedback, and education to house staff.

**Purpose:** Our goal was to improve and standardize internal medicine consultation and house staff supervision and education.

**Description:** A working group of internal medicine physicians, hospitalists and nonhospitalists, experienced in the field of medicine consultation and quality improvement met weekly, together with house staff, and followed rapid-cycle improvement methodology. We reviewed current published trials and guidelines and we developed and standardized a "best practice" focusing on the processes, outcomes, and education of medicine consultation. Given the broad scope of medicine consultation, we focused on preoperative cardiac evaluation and risk reduction.

**Results and Conclusions:** Best practice was determined to include the following key competencies:

- (1) Timeliness to performing consultation (respond to nonurgent consults within 4 hours)
- (2) Relevant history (cardiac symptoms, pulmonary symptoms, prior revascularization, prior stress testing)
- (3) Assessment of functional status
- (4) Relevant physical exam (vital signs, JVP, pulmonary and cardiac auscultation, evaluation for edema)
- (5) Assessment of electrocardiogram
- (6) Uniform and consistent practice guidelines (ACC/AHA 2002 update and Revised Cardiac Risk Index [RCRI] score)
- (7) Patient and surgery risk stratification (low, intermediate, high)
- (8) Assessment for stress testing
- (9) Assessment for beta-blocker therapy
- (10) Effective documentation (specific, prioritized)
- (11) Effective communication (verbal for any recommendation requiring action within 24 hours).

A laminated pocket card provided guidance on the key competencies, including information about practice guidelines (ACC/AHA 2002, RCRI score), patient and surgery risk stratification, and functional status assessment. Medicine consults performed by house staff were audited by hospitalist attending physicians using a checklist of the key competencies. The completed audits were given to house staff and facilitated supervision and feedback. A knowledge assessment tool was administered to house staff on the medicine consult rotation at the beginning and end of the month in order to help define required knowledge, reinforce important points, and document knowledge gained. These tools will be shared at the conference.

### 5 Medical Students' Assessment of a Required Rotation in Perioperative Medicine and Pain

Amir Jaffer, Samuel Irefin, John Tetzlaff, J. Harry Isaacson  
 Cleveland Clinic, Cleveland, OH

**Background:** Students graduating from US medical schools get little required training in perioperative medicine. In the context of new curriculum development for the Cleveland Clinic Lerner College of Medicine, a multidisciplinary group of physicians helped

develop learning objectives, structure, and content for a 1-month required clerkship in perioperative medicine and pain (PMP).

**Purpose:** To describe the PMP clerkship curriculum and medical students' assessment of it.

**Description:** The overall goals of this 4-week rotation are to help medical students acquire, develop, and enhance cognitive and technical skills in the medical care of the surgical patient. The curriculum provides students with the knowledge, skills, and attitudes necessary to evaluate and medically manage patients periopera-

tively and to appreciate the evaluation of acute and chronic pain.

All students spend 1 week in the Internal Medicine Preoperative Assessment, Consultation, and Treatment (IMPACT) Center and the Preanesthesia Evaluation Clinic (PACE), where they perform preoperative and preanesthesia evaluations, respectively. One week is spent in the operating room and the PACU, where students learn the basics about airway management on a simulator and then manage patients intraoperatively with an anesthesiologist. The third week is spent on the internal medicine consult service, where students evaluate patients with postoperative medical complications. The final week is spent in the chronic pain clinic, where students learn about chronic and acute pain. Each week, students meet for 2 hours with staff to discuss cases on common perioperative topics. In addition, students meet weekly

for 1 hour with a staff preceptor to review and discuss a landmark article during journal club.

At the end of each block, the students were asked to respond to multiple questions about the rotation on a Likert scale of 1 (strongly disagree) to 4 (strongly agree). These data will be presented at the meeting.

**Results and Conclusions:** A total of 12 students have gone through this curriculum thus far. The rotation has received a mean score of 4.6 on a Likert scale where 1 equals poor and 5 equals excellent. We believe that by actively working with a multidisciplinary group of clinician educators in managing medical problems of surgical patients, students will be better prepared to handle the aging population they encounter during their future resident training.

## 6 Improving Safety for Adult Surgical Patients with Obstructive Sleep Apnea

Karen Watkins

Edward Hospital, Naperville, IL

**Background:** Obstructive sleep apnea (OSA) is a common and treatable medical condition that affects more than 12 million adults in the United States. This disorder results in partial or complete airway collapse causing apneic and hypoxic episodes and may result in death. Surgical patients are at special risk because of the impact of anesthetic and analgesic medications.

**Purpose:** This project is designed to identify patients at risk for OSA prior to surgery and to modify their care. A collaborative program among all members of the perianesthesia care team, this process enhances communication and facilitates safe hand-offs across sites of care and among various disciplines.

**Description:** Preadmission testing nurses screen for OSA using specific questions. On admission to the hospital for surgery, anes-

thesiologists refine the screening process using a questionnaire and risk analysis process, rating the patient for OSA risk. A care protocol, called an OSA order set, is established by the anesthesiologist and communicated to the surgical team. Postprocedurally, patients return to the post-anesthesia care unit (PACU) for individualized care. Report is conveyed to either the ambulatory care center or the postoperative unit nurse upon PACU discharge.

**Results and Conclusions:** Use of a standardized screening method and an OSA order set appropriately identifies a vulnerable population, individualizes care to prevent surgical complications, and ensures appropriate patient placement. All patients are actively involved in their plan of care and meeting their postdischarge needs. Outcomes data support continuous process improvement and evidence-based practice. The OSA surgical algorithm is a concrete and measurable method of care for an at-risk population. The perianesthesia nurse joins physicians, respiratory therapists, and other specialists in assessment, evaluation of interventions, and educational aspects of perioperative patient care.

## 7 A Multidisciplinary Approach to Improving the Safety of High-Risk Spine Surgery: The Complex Spine Protocol

Peter Kallas<sup>1</sup>, Anjali Desai<sup>1</sup>, Andrew Naidech<sup>1</sup>, Tyler Koski<sup>1</sup>, Steve Ondra<sup>1</sup>, Mary Lou Green<sup>2</sup>

<sup>1</sup>Northwestern University and <sup>2</sup>Northwestern Memorial Hospital, Chicago, IL

**Background:** Multilevel spine fusion surgeries (defined here as greater than six levels) present unique challenges to the surgeon, anesthesiologist, and hospitalist. The extent of the surgery, in combination with a large volume of blood loss, can lead to problems that include volume overload and a consumption/dilutional coagulopathy.

**Purpose:** A task force consisting of physicians from neurosurgery, orthopedics, anesthesiology/critical care medicine, perioperative medicine, and hematology was charged with creating a pathway for complex spine surgeries that would improve patient safety and outcomes at a large inner-city academic institution. Primary goals included (1) reducing the degree of coagulopathic bleeding, and (2) reducing the volume of fluids administered. Secondary goals included (1) decreasing ventilator days, (2) decreasing postoperative comorbidities and death, and (3) decreasing length of stay.

**Description:** The three segments of the pathway include preoperative, intraoperative, and postoperative protocols. Preoperatively,

patients are identified as being at high risk if their surgery is anticipated to involve greater than six levels or 6 hours of surgery time. Most patients are referred by the surgeon's office to be assessed and optimized in the preoperative clinic by hospitalists. Each patient is then presented at a multidisciplinary meeting that includes the surgeon, the perioperative medicine physician, and the select anesthesiologists involved in the complex spine protocol.

Intraoperatively, blood for lab studies (CBC, PT, PTT, fibrinogen, and ionized calcium) is drawn every 2 hours for the first 6 hours, and then every hour thereafter. Coagulopathy prevention, as advised by hematology, is focused on avoiding the use of fresh frozen plasma and the volume that is associated with its administration. Cryoprecipitate is administered when the level is less than 150. Platelets are administered below 100,000. If the patient is oozing despite adequate levels of fibrinogen and platelets, DDAVP is administered. If the patient continues to ooze and the international normalized ratio (INR) is greater than 2, factor VIIa is administered.

The coagulopathy protocol is maintained postoperatively. Vitamin K is administered to patients with elevated INRs (> 2) and no evidence of bleeding.

**Results and Conclusions:** The Complex Spine Protocol was introduced in stages—first intraoperatively, then pre- and postoperatively. It has been in full effect since January 2007.

**8 The Nurse Practitioner Role in Evidence-Based Medication Strategies**

**Patricia Kidik, RNCS; Kathleen Holbrook, RNCS**  
*Brigham and Women's Hospital, Boston, MA*

**Background:** Nurse practitioners at Brigham and Women's Hospital Weiner Center for Preoperative Evaluation use evidence-based medication strategies in their assessment of high-risk elective surgical patients.

**Purpose:** Our objective is to identify those patients who meet

the criteria for perioperative beta-blockade and for deep vein thrombosis prophylaxis.

**Description:** Our nurse practitioners were provided with education and training in using established guidelines to identify patients at risk. The nurse practitioner communicates with the appropriate member of the health care team (anesthesiologist, primary care physician, surgeon, or anticoagulation service staff) and provides patient education.

**Results and Conclusions:** This process facilitates the utilization of these guidelines, with improved patient outcomes.

**9 Use of the Motivator/Hygiene Theory of Motivation to Guide Quality Efforts**

**Ronald Kratz**  
*Riverside Anesthesia Associates, Mechanicsburg, PA*

**Background:** Effectively improving quality in perioperative health care systems requires motivating caregivers from different disciplines to work toward the same goal. To succeed, clinical supervisors need effective tools for motivating team members.

**Purpose:** This abstract will describe the motivator/hygiene theory of motivation and apply it to the quality effort of maintaining perioperative normothermia.

**Description:** The motivator/hygiene theory was described by Frederick Herzberg, who felt that humans have a unique ability to experience psychological growth, and are motivated to do so.<sup>1</sup> People desire opportunities to develop a sense of responsibility and achievement along with the chance to grow and learn. Supervisors will motivate others as they provide them the avenue to achieve, increase responsibility, and provide opportunities for personal growth and advancement.

Humans are also demotivated by pain, and they desire to minimize it whenever possible. Demotivators are extrinsic to the work itself, and include system policy and administration, supervision, interpersonal relationships, working conditions, salary, and security. The best way to handle demotivators is to make them as unintrusive as possible. Thus, motivators and demotivators are

not opposites but separate entities. Effective motivation occurs when motivators are increased and demotivators are decreased.

**Results and Conclusions:** Perioperative normothermia has been identified as a quality indicator, as it has been associated with decreased risks of infection, bleeding, and cardiovascular events.<sup>2</sup> Motivator/hygiene theory would suggest that an approach of designing new policies related to room temperature and warming devices (policy and administration) while telling the staff exactly how to implement them (supervision) will not be effective. Instead, if present, the culture of punishment for exposing quality defects (supervision, working conditions) must be abolished. Next, emphasis should be given to the desire to help patients by providing the highest-quality care (work itself, achievement), the opportunity to learn new ways of keeping patients warm (job growth), and recognition when milestones are reached (recognition, achievement). Staff should be involved in the design and implementation of the effort. Managers will discover that as they work to develop staff instead of controlling them, the team effort will improve remarkably due to the increased motivation of all.

1. Herzberg F. *One more time—how do you motivate employees?* *Harvard Business Review* 1968; republished in January 2003 (reprint R0301F, pp. 1–12).
2. *American Society of Anesthesiologists. Quality incentives in anesthesiology.* Available at: <http://www.asahq.org/Washington/qualityincentivesdoc.pdf>. Accessed June 9, 2007.

**10 A Novel Care Model Coordinating Inpatient and Outpatient Perioperative Care, Utilizing a Computerized Patient Tracking System**

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**Background:** Coordination of inpatient and outpatient care is an increasingly important part of perioperative medicine. Most models of care involve an inpatient consultant who is different from the preoperative evaluator. As patients in the postoperative period are often altered in physiology and mental status, an accurate assessment is difficult without knowledge of their preoperative condition. Outpatient providers are often unaware when patients are being admitted for surgery, and are usually unable to follow patients perioperatively.

**Purpose:** To describe a novel care model in which the same physician provides outpatient and inpatient perioperative consultation. We describe a database and tracking system that facilitates this approach.

**Description:** Under the model practiced at the University of Washington, the physician seeing a patient in the preoperative clinic becomes that patient's primary inpatient medical consultant. Depending on the patient's health, the complexity of the operation, and its urgency, the time between preoperative evaluation and surgery varies greatly. The primary consultant coordinates preoperative care and provides inpatient consultation after surgery.

In order for surgery dates and patient admissions to be tracked, a database was developed containing the patient's name, the consult physician, and the expected surgery date. This database is checked daily against the operative schedule using a comparative program. Each provider's patient panel is cross-referenced with the surgery schedule, and a list of upcoming admissions is generated. Patients previously seen by the medicine consult service who are undergoing subsequent operations are identified and flagged for the continuity provider to review, and they are seen again in consultation if requested.

**Results and Conclusions:** A model of care emphasizing coordination of inpatient and outpatient medical consultation maximizes the benefit of preoperative evaluation, providing conti-

nunity and improving patient care. From the patient's perspective, in a busy teaching hospital with multiple changing providers, the medical consultant provides an often-lacking familiar face. A database advising providers of upcoming admissions is vital to the practice of this care model, and is also used to track pending test results, generate a patient list to improve

billing capture, and identify patients for research purposes. From the provider's perspective, the program allows providers to know which patients to see and how busy the upcoming days will be. We believe our model is both unique and desirable, and should be considered at other hospitals with dedicated medicine consult services.

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### 11 The Development of an Admitting Team

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**Background:** Patients are scheduled to visit the Weiner Center for Preoperative Evaluation (CPE) 1 day to 3 weeks prior to surgery. There was not a formal structure in place for communication between the preoperative and perioperative areas. In the past, an e-mail about specific patient concerns was sent to the nurse in charge in the post-anesthesia care unit (PACU), but this person may not have always been available to receive the e-mail and act on it in a timely manner.

**Purpose:** Our objective was twofold: (1) to create a team approach to communicate patient information and perioperative

needs to make the patient's surgery safer and less stressful for both the patient and staff; and (2) to increase collaboration between the different perioperative areas.

**Description:** A team was created with nurses representing the CPE, day surgery unit, preoperative holding unit, and PACU. The team created guidelines and a system for communicating patient issues. An e-mail list was created including nurses from these different perioperative areas (BWH RN SURGICAL ADMIT TEAM). The staff in CPE are now able to communicate with a larger team to make sure patient concerns are responded to in a timely manner.

**Results and Conclusions:** Utilizing a team approach provides an improved method of communication between the different perioperative departments and provides for a smoother and safer admission process for patients.

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### 12 Improve Communication Among Caregivers: Eliminating Unauthorized Abbreviations on Hospital Medical Records

**Magdalena G. Smith, Maura Walsh, Laurie Walsh, Marjorie Guglin, Dio Sumaygaysay, Evangelina Sapalasan, Frances Haug, Olivia Voellmicke, Mahin Sanjari, Nancy Cimitile, Mariya Chernyatskaya**

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**Background:** One of the Joint Commission's seven National Patient Safety Goals is to improve the effectiveness of communication among caregivers by eliminating unauthorized abbreviations on hospital medical records. Unauthorized abbreviations cause confusion and compromise patient safety.

**Purpose:** To achieve 100% compliance with the "do not abbreviate" policy in all handwritten orders, preprinted forms, electronic records, medication administration records, and perioperative documentation records.

**Description:** The perioperative department formed a "Do Not Abbreviate" Task Force Committee with representatives from the following areas: preadmission testing, same-day surgery, ambulatory

surgery, operating room, and post-anesthesia care unit (PACU). The committee meets once a month and randomly reviews 100 medical records per month. Initial efforts focused on identifying commonly used unauthorized abbreviations, the frequent offenders, and factors contributing to staff noncompliance with the policy; before changes were made, compliance was only 69%.

**Results and Conclusions:** Changes made included revision of the doctor order sheets, progress notes, and medication administration records with the "do not abbreviate" list stamped upon them. The unauthorized abbreviations were eliminated from all electronic records. Physician offices were notified about the "do not abbreviate" policy, and pharmacy was directed not to accept any orders with unauthorized abbreviations and to require that orders be corrected before medications are dispensed. Signs and mouse pads containing the "do not abbreviate" list were distributed. The staffs were made aware of the project through in-service programs, and results were displayed as a dashboard in all unit informational bulletin boards.

After redesign implementation, the compliance rate went up 100%. We will continue to monitor to maintain 100% compliance and we will reeducate the staff as needed.

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### 13 Improve Preadmission Testing Process

**Magdalena G. Smith, Tak Tam, Rita Medrozo, Maura Walsh, Laurie Walsh, Marjorie Guglin**

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**Background:** The preadmission testing department coordinates preoperative anesthesia and nursing assessment for both ambulatory and same-day surgery patients. The process was too long and was causing patient dissatisfaction.

**Purpose:** To make the preadmission testing process more effi-

cient and reduce waiting time to less than 90 minutes.

**Description:** A performance improvement team was formed consisting of anesthesiology, nursing, registration, scheduling, and ancillary personnel. The problem was presented to management. The GE facilitators analyzed the problem with the team. They identified the reasons for prolonged waiting times (> 90 minutes), which included patients not having order forms from their physicians, health care providers not following their allotted appointment times, and the lack of a designated anesthesiologist to oversee preadmission testing.

**Results and Conclusions:** The staff was made aware of the



project through in-service programs and poster board displays with progress updates. Physician offices were notified regarding the new guidelines and preadmission testing schedules. A new software program, My Medical File (MMF), was implemented to obtain order forms from the physicians. The anesthesiology department designated an office in the department with one attending physician, one resident, and a newly hired nurse practitioner to oversee patients in the preadmission testing area.

Through staff cooperation, hard work, and proactive administrative support, preadmission testing now runs smoothly and waiting time has been reduced to 62 minutes. Obtaining order forms from physicians via the new MMF software program reduces patients' waiting time. It also increases the secretary's efficiency and reduces the number of telephone calls made to obtain order forms. The team will continue to monitor and will conduct patient and staff satisfaction surveys.

## Perioperative Clinical Vignettes

### 14 Chronic Renal Insufficiency: An Oft-Forgotten Component of the Revised Cardiac Risk Index

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**Case Presentation:** A 62-year-old woman with a history of hypertension, type 2 diabetes, and chronic kidney disease (CKD) with a creatinine of 2.5 mg/dL visits her physician's office for preoperative assessment. She is to undergo a colectomy in 2 weeks for a recently diagnosed nonmetastatic colon carcinoma. Physical examination is otherwise unrevealing. Laboratory data are unremarkable. Her medications consist of glargine insulin and meal-time lispro insulin coverage, amlodipine, atorvastatin, and lisinopril. She can climb two flights of stairs without any chest pain or shortness of breath. Based upon her well-controlled hypertension and diabetes and her good functional capacity, the physician "clears" the patient for the planned operative procedure. Based upon the data presented above, would you have done anything differently?

**Discussion:** The case described above reflects a scenario commonly encountered by physicians performing preoperative assessments. This patient would probably have benefited from perioperative beta-blockers based upon the currently available evidence. Beta-blockers are most commonly prescribed perioperatively

based upon the Revised Cardiac Risk Index (RCRI), which assigns 1 point each for a history of myocardial infarction (MI) or coronary artery disease (definition is quite specific and does not include people with prior revascularization and no prior MI), congestive heart failure, cerebrovascular accident or transient ischemic attack, surgical risk (1 point is given if surgery is deemed high-risk based on estimated blood loss), and CKD with a creatinine greater than 2.0 mg/dL.

This patient's RCRI score is at least 2 (insulin-requiring diabetes and CKD with creatinine > 2.0 mg/dL) and may be 3 if the surgery turns out to be high-risk. The physician failed to take into account the patient's elevated creatinine level, which is clearly known to confer increased perioperative cardiovascular risk. Anecdotally speaking, since CKD is not considered a classical risk factor for cardiovascular disease, it is often forgotten or ignored in the perioperative risk equation.

**Conclusion:** CKD with a creatinine level greater than 2 mg/dL is an often forgotten perioperative cardiovascular risk factor, and some patients with this risk factor can benefit significantly from perioperative beta-blockers. It is important to keep in mind that atenolol is excreted predominantly from the kidneys and may not be an ideal choice in this subset of eligible patients, especially in the very elderly, because of prolonged peri- and postoperative bradycardia and hypotension.

### 15 When Is a Stress Test Indicated in Patients with Chronic Kidney Disease Evaluated for Noncardiac Surgery?

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**Case Presentation:** A 67-year-old African American male with past medical history of hypertension, hyperlipidemia, and chronic kidney disease with a baseline creatinine of 2.4 mg/dL is undergoing preoperative evaluation for colectomy due to colon cancer. He is able to walk one to two blocks at ground level but is not able to climb a flight of stairs due to shortness of breath. He denies chest pain and has no history of coronary artery disease. Does he need a stress test for preoperative evaluation of cardiovascular risk?

**Discussion:** According to the 2002 ACC/AHA Guideline Update for Perioperative Cardiovascular Evaluation for Noncardiac Surgery, this patient will need a cardiac stress test before surgery. The guidelines use a clinical shortcut to noninvasive cardiac testing that includes high-risk surgery, intermediate clinical predictors, and poor functional class (< 4 metabolic equivalents

[METs]). If a patient has 2 out of 3 of these variables, he or she will need a stress test before surgery. The intermediate clinical predictors include Canadian class 1 or 2 angina, prior myocardial infarction based on history or pathologic Q waves, compensated or prior heart failure, diabetes, or renal insufficiency (defined as creatinine level > 2 mg/dL).

Our patient has a physical activity level of less than 4 METs, and his creatinine level of 2.4 mg d/L is an intermediate clinical predictor for adverse cardiovascular outcome. According to the guidelines, he will need a cardiac stress test prior to surgery. It is important to remember that the guidelines shortcut is valid for patients who are scheduled to have high-risk or intermediate-risk surgery. Patients scheduled for low-risk surgery can usually proceed with the operation without the need for a stress test first.

**Conclusion:** Chronic kidney disease with serum creatinine greater than 2 mg/dL is an important and often overlooked intermediate predictor of adverse cardiovascular outcome after noncardiac surgery, in the same class as angina pectoris, prior myocardial infarction, heart failure, and diabetes. If such patients also have poor functional activity, they should be referred for a cardiac stress test prior to surgery in order to assess their cardiovascular risk more precisely.

## 16 When to Correct Hyperkalemia in Patients with Chronic Kidney Disease Prior to Noncardiac Surgery?

Vesselin Dimov<sup>1</sup>, Kalina Uzunova-Dimova<sup>2</sup>, Ajay Kumar<sup>1</sup>, Anitha Rajamanickam<sup>1</sup>, Mitko Badov<sup>3</sup>

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**Case Presentation:** A 42-year-old male with past medical history of type 1 diabetes mellitus, hypertension, and chronic kidney disease with a creatinine level of 3.0 mg/dL is undergoing preoperative evaluation for back surgery. His potassium level is 5.8 mEq/L. His medication list includes insulin, amlodipine, atenolol, and clonidine. Electrocardiogram does not show changes related to hyperkalemia. Does his potassium level need to be corrected prior to surgery?

**Discussion:** Perioperative hyperkalemia may be exacerbated or precipitated by blood transfusions, acidosis, ACE inhibitors, beta-blockers, tissue trauma during surgery, rhabdomyolysis, and the use of Ringer lactate solution as a replacement fluid. Preoperative hyperkalemia is seen in 19% to 38% of patients with chronic kidney disease. There is no evidence-based recommendation for safe preoperative potassium values. One study published in 1974 suggested avoiding general anesthesia in patients with chronic kidney disease and a potassium level greater than 5.5 mEq/L.

Preoperative evaluation of patients with elevated serum potas-

sium traditionally includes a 12-lead electrocardiogram to assess the physiologic effect of hyperkalemia. Chronic dialysis patients often develop a tolerance to elevated serum potassium, and electrocardiographic changes may not be seen until the potassium exceeds 6.0 mEq/L. If the 12-lead electrocardiogram reveals features of hyperkalemia and dialysis cannot be performed before the surgery, medical management should be used.

Intravenous glucose and insulin is the most effective method to drive potassium into the cells in patients with end-stage renal disease. Sodium bicarbonate is generally of little benefit unless the patient has moderate to severe metabolic acidosis. Other treatment modalities, which include inhaled beta-adrenergic agonists and cation exchange resins, are less effective. Treatment with intravenous calcium is reserved for severe hyperkalemia. A cation exchange resin (Kayexalate) is a rare cause of intestinal necrosis, especially within the first week after surgery. It is important to review the type of intraoperative fluid with the anesthesiology and surgical teams. The most commonly used intravenous fluid during surgery in patients without renal impairment is Ringer lactate solution, which contains potassium. To avoid hyperkalemia, the preferred solution in patients with chronic kidney disease is isotonic saline.

**Conclusion:** Although no recommendation exists for a safe serum potassium level in the perioperative period, a potassium level of less than 5.5 mEq/L is generally advisable.

## 17 What Is the Optimal Time Frame for Performing Hemodialysis in Patients with End-Stage Renal Disease Prior to Surgery?

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**Case Presentation:** A 67-year-old African American female with past medical history of type 2 diabetes mellitus, hypertension, hyperlipidemia, coronary artery disease, and end-stage renal disease (ESRD), for which she undergoes hemodialysis on Tuesdays, Thursdays, and Saturdays, is scheduled for total knee replacement on a Tuesday. Her medications include insulin, simvastatin, metoprolol, clonidine, amlodipine, and diphenhydramine. Physical examination is unremarkable, and laboratory results do not show significant abnormalities. What is the optimal time frame for performing hemodialysis in patients with ESRD prior to surgery?

**Discussion:** Uremia causes platelet dysfunction, which can result in increased perioperative bleeding. Several medications

have only minor platelet effects in patients without uremia but can have exaggerated effects in ESRD, for example, diphenhydramine (Benadryl), nonsteroidal anti-inflammatory drugs, chlorthalidone (Dacorin), and cimetidine (Tagamet). Patients with ESRD should undergo dialysis on the day before surgery to correct hyperkalemia and fluid overload and to minimize uremic complications. Due to the routine use of heparin during hemodialysis, an interim of at least 12 hours is recommended before surgery can be performed safely. In the postoperative period, patients should undergo heparin-free dialysis for at least 24 hours. Studies failed to document a significant improvement in mortality with daily dialysis for a few days prior to surgery or with intraoperative hemodialysis, and therefore this modality of intensive dialysis cannot be recommended. Patients with peritoneal dialysis who are undergoing abdominal surgery should be changed to hemodialysis until wound healing is complete. Peritoneal dialysis can be continued for patients undergoing nonabdominal surgery.

**Conclusion:** Patients with ESRD should undergo dialysis on the day before surgery to correct and minimize uremic complications.

## 18 A Recent Vascular Graft in a Patient with End-Stage Renal Disease on Hemodialysis and the Need for Preoperative Antibiotic Prophylaxis

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**Case Presentation:** A 56-year-old Caucasian male with past medical history of type 2 diabetes mellitus, hypertension, hyperlipidemia, and end-stage renal disease on hemodialysis is undergoing preoperative evaluation for colectomy for colon cancer. He had a synthetic graft placed for hemodialysis access 3 months ago, and

the graft has been functioning normally since then. Physical examination is remarkable for a well-healed incision on the left arm and a vascular graft with good pulse and bruit. The rest of the physical examination is normal. Laboratory results do not show significant abnormalities. His medication list includes insulin, atorvastatin, aspirin, atenolol, lisinopril, and calcium acetate. Does this patient need antibiotic prophylaxis against vascular graft infection prior to colon surgery?

**Discussion:** Patients with recently placed synthetic vascular access grafts (< 1 year) should be prescribed antibiotic prophylaxis using standard endocarditis regimens even for minor procedures (eg, dental cleaning). Antibiotics prevent bacterial seeding of the grafts

before full epithelialization has taken place. Antibiotic infusion should be completed at least 1 hour prior to the start of surgery to achieve optimal peak tissue level during the procedure. It is important to remember to place a sign by the bedside to inform health

care providers that blood draws and intravenous lines should be avoided on the side of a current or future hemodialysis access site.

**Conclusion:** Antibiotic prophylaxis is recommended up to 1 year after placement of a synthetic vascular graft.

## 19 Postoperative Risk of Acute Kidney Injury in Patients with Chronic Kidney Disease

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**Case Presentation:** A 76-year-old Caucasian male with past medical history of type 2 diabetes mellitus, chronic obstructive pulmonary disease (COPD), hypertension, and chronic kidney disease is diagnosed with severe triple-vessel coronary artery disease. He is scheduled to have coronary artery bypass graft (CABG) surgery next month and is referred for preoperative evaluation. Physical examination is unremarkable and laboratory results do not show any acute abnormalities. His serum creatinine has been in the range of 1.4 to 1.6 mg/dL for the last 2 years. The patient and his family are worried about worsening of his kidney function after the surgery. What is the risk that postoperative acute kidney injury (AKI) will develop in this patient with chronic kidney disease who will undergo CABG?

**Discussion:** Most clinical studies define postoperative AKI as an increase in serum creatinine of more than 25% to 50% from baseline values within 1 week after surgery. AKI requiring dialysis develops in 1% to 5% of patients after cardiac surgery, and is strongly

associated with increased perioperative morbidity and mortality. A recent study by Thakar et al (2005) retrospectively evaluated more than 33,000 patients who underwent open heart surgery at Cleveland Clinic and provided good clinical evidence regarding risk factors for AKI. Risk factors for postoperative AKI after cardiac surgery included higher serum creatinine level (> 1.2 mg/dL), diabetes, COPD, previous cardiac surgery, markers of severe cardiovascular disease, and female gender, as well as intraoperative factors such as longer cardiopulmonary bypass time. Each risk factor was assigned a number of points, which were then computed to calculate a total score. The frequency of AKI among these categories varied from 0.4% for the lowest risk score to 22.1% for the highest score. Our patient has a 6-point score, which translates to 7.8% risk of developing AKI after surgery. This is higher than the usually reported frequency of postoperative ARF of less than 5%.

**Conclusion:** Identification of patients who are likely to develop AKI after surgery is important, as it enables physicians to improve patient care and to inform patients about their individual risk. Currently, a risk score for postoperative AKI has been developed only for cardiac surgery, and no sufficiently powered study has yet been completed in patients undergoing noncardiac surgery.

## 20 Preoperative Hypoglycemia in a Patient on Detemir Insulin

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**Case Presentation:** A 34-year-old type 2 diabetic female presented to the preoperative medical optimization clinic (PMOC) prior to gynecological surgery. She was on an insulin regimen of 55 units of detemir (Levemir) SQ in the morning and 5 units of glulisine (Apidra) SQ before meals. This had been recently changed from NovoLog 70/30, 30 units in the AM and 20 units in the PM. Physical exam was unremarkable. Weight was 98 kilograms and height was 160 centimeters (body mass index of 38). Serum glucose was 220 mg/dL.

Preoperative instructions were to take the usual dose of basal insulin on the morning of surgery, but none of the short-acting insulin.

On arrival in the surgical suite on the morning of surgery, the patient's blood glucose was 68 mg/dL. She was given D5W intravenously at a rate of 250 mL/hr. There was an initial increase of glucose to 156 mg/dL, but 3 hours later, glucose was 47 mg/dL. A bolus of 15 mL of dextrose 50% was given intravenously, but the

glucose level only increased to 64 mg/dL. One hour later, it was again found to be low, at 46 mg/dL, and surgery was cancelled. Further dextrose infusion brought the glucose to 168 mg/dL.

**Discussion:** The benefits of perioperative glycemic control are well established. Preoperative admission is increasingly rare, so glycemic control must usually be provided on an outpatient basis with variations of the patient's usual insulin regimen. Basal insulins, including detemir, have become increasingly common, and while very effective in providing basal control, they can cause hypoglycemia if used incorrectly. In this case, the patient's basal insulin exceeded her basal insulin requirement. It had likely been inappropriately increased in an attempt to control elevated postprandial glucose levels, rather than using an adequate dose of the short-acting insulin for that purpose. The preoperative fast then precipitated prolonged hypoglycemia.

**Conclusion:** Although the use of traditional insulins may necessitate reductions in dose due to fasting prior to a surgical procedure, long-acting basal insulins are intended to provide glucose control in the absence of caloric intake. Therefore, while the dose should generally be maintained perioperatively, if long-acting insulin has been inappropriately used to provide postprandial glucose control, recalcitrant hypoglycemia may develop.

## 21 Evaluation of Mobitz I Atrioventricular Block in a Preoperative Patient

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**Case Presentation:** M.M., a 26-year-old athlete training for the Olympic trials in rowing, presented to a local emergency depart-

ment with a complaint of right arm swelling. He was found to have a subclavian vein thrombosis that was treated with thrombolysis. Further evaluation revealed thoracic outlet syndrome. He was scheduled for first rib resection. An electrocardiogram (ECG) was obtained in the Center for Preoperative Evaluation (routine for all thoracic surgery patients per thoracic surgeons). The ECG revealed SR at a rate of 47 bpm. A second-degree atri-

oventricular (AV) block was present (Mobitz I).

**Discussion:** Mobitz I second-degree AV block (Wenckebach block) is characterized by an increasing prolongation of the PR interval that results in a single nonconducted P wave with no QRS complex generated. An episode of Mobitz I block consists of 3 to 5 beats and then the nonconducted beat. The block is usually in the AV node, and occasionally in the His-Purkinje system. The AV node is innervated by both sympathetic and parasympathetic fibers. Mobitz II AV block is characterized by constant PR and RR intervals with every second, third, or fourth P wave being nonconducted (2:1 block, 3:1 block, etc.) Mobitz II block is rarely seen in healthy young people; however, Mobitz I AV block can be seen in 2.4% of trained, fit athletes. The mechanism is the high vagal tone seen in trained athletes. Most

of these individuals are asymptomatic. Mobitz I block is not associated with increased morbidity or mortality in the absence of organic heart disease, and there is no risk of progression to a Mobitz II AV block or complete heart block. By contrast, patients with Mobitz II AV block do carry a risk of progression to complete heart block. Often in the trained athlete, normal conduction occurs with activity as the heart rate increases and sympathetic tone is enhanced.

**Conclusion:** Mobitz I block (Wenckebach block) in an otherwise healthy, young, asymptomatic individual, particularly a highly trained athlete, is a benign condition. No further testing or laboratory data are required prior to planned surgery. In this case, the surgery went forward uneventfully and the patient recovered from the first rib resection without incident.

## 22 Perioperative Cardiac Arrest in a Patient with Aortic Stenosis: Is It Preventable?

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**Case Presentation:** A 73-year-old female presented to the hospital with femur fracture. She reported a history of hypertension and valve abnormality. She admitted to worsening dyspnea over the past several months but had not yet seen her doctor about it. She denied chest pain. Her medications were lisinopril and hydrochlorothiazide. On admission, her blood pressure was 116/68 mm Hg, heart rate was 92 bpm, and Hgb/Hct was 10.3/29.4 and stable. On exam, her lungs were clear, rhythm was regular with normal S<sub>1</sub> and S<sub>2</sub> and SEM 2/6, and she had 1+ edema in both legs. Her electrocardiogram revealed sinus rhythm with left bundle branch block and left ventricular hypertrophy.

She was scheduled for urgent surgery for repair of the femur fracture. In the operating room, she was agitated and was given midazolam 2 mg prior to arterial line placement. After the midazolam the patient became combative, and reversal with

flumazenil was administered. The patient developed bradycardia followed by cardiopulmonary arrest and was placed on emergency cardiopulmonary bypass. An echocardiogram after the arrest revealed severe aortic stenosis with valve area less than 0.7 cm<sup>2</sup>.

**Discussion:** Aortic stenosis is the most common valvular disease in the elderly. Management of these patients in the perioperative period requires understanding of the valvular disease and the hemodynamic alterations that result. In this patient undergoing urgent but not emergency surgery, based on the history and the physical examination, further evaluation was warranted and should have focused on the severity of the disease, myocardial function, and the presence of coronary artery disease and other organ system disease. The preoperative assessment should direct the timing of the planned surgery, the appropriate therapy, including medical optimization, and the need for preoperative surgical intervention as well as the perioperative monitoring and selection of anesthetic techniques.

**Conclusion:** The risks of noncardiac surgery in patients with aortic stenosis remain high despite advances in anesthetic techniques, and heightened awareness is needed in the perioperative management of these patients.

## 23 Antiplatelet Therapy Interruption and Perioperative Stent Thrombosis: Too Much, Too Early

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**Case Presentation:** A 53-year-old man with hypertension, hypercholesterolemia, and coronary artery disease (CAD) was scheduled for gastrectomy for gastric cancer. He had undergone placement of a tacrolimus drug-eluting stent (DES) after evaluation for chest pain 9 months prior and was placed on aspirin and clopidogrel. Seven months after the stent placement, the antiplatelet therapy was held for 10 days for diagnostic laparoscopy without complications. The patient held the aspirin and clopidogrel a week before the planned gastrectomy per instructions from the surgeon and, as the surgery was rescheduled, continued to hold them for 19 days. After an uncomplicated intraoperative course, on the first postoperative day, the patient developed electrocardiogram changes and cardiac enzyme elevation consistent with myocardial infarction (MI). Cardiac catheterization revealed occlusion of the DES.

**Discussion:** Stent thrombosis is a complication of DES and bare metal stents (BMS) with significant mortality. Delayed thrombosis is more prevalent with DES. Dual-antiplatelet therapy reduces the incidence of thrombosis, and the recommended duration of therapy

for DES has been extended to 12 months. Premature interruption of antiplatelet therapy results in increased risk of stent thrombosis. The management of patients with CAD and indications for percutaneous coronary intervention in the perioperative period requires coordination between the surgeon and preoperative physician. In this case, unnecessarily prolonged interruption of antiplatelet agents should have been avoided and aspirin continuation considered.

Prior to placement of a stent, the potential need for surgical interventions in the next 12 months should be considered and, if such procedures are planned, a BMS may be preferable. Consideration should be given to completing health maintenance interventions prior to placement of a DES. Premature interruption of dual-antiplatelet therapy should be avoided, the duration of such interruption should be minimized, and therapy should be restarted promptly. A risk/benefit assessment of continuation of aspirin alone during the perioperative period should be done. Elective procedures should be postponed until the appropriate course of antiplatelet therapy has been completed.

**Conclusion:** Stent thrombosis is a catastrophic event that frequently leads to MI and/or death. A dual-antiplatelet regimen markedly reduces this complication, and interruption of the therapy in the perioperative period requires consideration of bleeding and thrombosis risks and coordination among all perioperative teams.

## Research in Perioperative Medicine

### 24 Use of an At-Home Internet-Based Patient Evaluation Tool for Preoperative Assessment

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**Background:** Use of a computer interface by the patient at home before the preoperative assessment visit allows submission of information that streamlines the visit. Information could be incorporated into the preoperative surgical, anesthesia, and nursing assessments and confirmed by the provider during the visit or by phone. In this study, we examined the utility of such an Internet-based questionnaire. We identified demographics of individuals most likely to use such evaluations as well as what helpful elements could be collected.

**Methods:** From 2001 to 2005, patients scheduled for elective surgery at Brigham and Women's Hospital were given directions for completing an online questionnaire at home. All were informed of questionnaire availability; completion was not mandatory. Patients answered 34 online questions, addressing specific medications and dosages, physicians and specialists, previous testing, medical history, and specific concerns. Questionnaires were submitted securely and accessed via a secure password by providers in the preoperative clinic. Other information obtained included the need for more patient

education about the surgery and anesthesia. All information was available to the provider prior to the preoperative interview.

**Results:** A total of 3,003 patients completed the questionnaire, which was about 5% of all patients seen during the time period studied. Of the patients completing the questionnaire, 54.1% were between the ages of 40 and 59 years, 65% were female, 94% provided an e-mail address for contact, and 98% provided call-back information. Over half the patients reported the name and contact information of at least one specialist. Over 63% noted previous electrocardiograms (ECGs), and 34.7% reported having an ECG done within the past year. Thirty-two percent reported having undergone cardiac testing other than ECGs, and 24% reported a previous history of anesthesia-related problems.

**Conclusion:** Significant information can be obtained with an at-home Internet-based patient assessment tool. Patients can fill out medication lists at home with access to their bottles. This can streamline the visit and assure accurate completion of JCAHO-required medicine reconciliation. Information about dates of previous ECGs, cardiac testing, and other testing allows providers to obtain these results prior to the visit, streamlining assessment and reducing unnecessary repetition. The provider also has access to specific patient concerns regarding the procedure and the need for more instruction in certain areas. Further development of such systems and incorporation into online assessments will greatly aid in achieving efficient and optimal assessment prior to surgical procedures.

### 25 The Utility of a Preoperative Clinic Questionnaire to Predict Postoperative Delirium Risk

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**Background:** Postoperative delirium (POD) has been associated with worse surgical outcomes, longer hospital stays, and decreased patient satisfaction. Preventive interventions may decrease the risk of developing POD. Identifying patients at risk for POD would allow interventions that may improve outcomes. We hypothesized that patient and family questionnaires could be easily administered during the preoperative visit in order to identify patients at risk for POD.

**Methods:** Patients 60 years or older having elective hip or shoulder arthroplasty were included at the time of the preoperative visit. Two questionnaires were completed, one by the patient and one by a family member or close acquaintance. Questions attempted to identify impairments in cognitive or functional status as well as previous history of POD. After surgery, each patient was evaluated postoperatively, hospital records were reviewed for signs of delirium, and interventions were noted.

**Results:** Of the 81 patients evaluated, 24 (29.6%) had delirium postoperatively. Those who developed delirium were significantly less likely to be discharged home versus a rehabilitation facility than those who did not develop delirium (29.7% vs 63.6%;  $P < .005$ ). Average length of stay was 6.5 days for patients with POD as compared with 5.3 days for those without delirium ( $P < .02$ ). Patients who had perfect scores on the questionnaires included 28 in the group without delirium compared with 2 in the group with POD, giving a negative predictive value of 93.3%. The positive predictive value was 43.1%. Patients who had 1 or more incorrect answers or a history of POD included 22/24 in the group with POD and 29/57 in the group without delirium ( $P < .002$ ). This gave a sensitivity of 91.7% and a specificity of 49.3%.

**Conclusion:** An easy tool can be used to predict POD, and can be especially helpful for identifying patients who are not likely to develop delirium. This would be useful in planning postoperative care. While sensitive, the questionnaires had limited specificity, suggesting that although they could be used as an initial screening tool, further work-up would be needed to identify high-risk patients.

In conclusion, POD is attributable to multiple perioperative and medical factors with no single question or test being definitive in predicting delirium.

### 26 A Drug by Any Other Name: Preoperative Insulin Regimens

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**Background:** Insulin products were most often cited in errors that resulted in harm, according to the MEDMARX error

reporting system. With the rapid proliferation of insulin medications, it is difficult to be familiar with the nuances of particular agents. Recognition of a drug and its anesthetic implications is critical. Confusion among various insulin regimens and unfamiliarity with their mechanisms of action add to the complexity of perioperative management of patients receiving insulin. Preoperative conversions of insulin regimens are complicated,

and changes in brand, type, and/or species source may necessitate a change in dosage.<sup>1-3</sup> Hypoglycemic reactions have been reported in patients who were switched from pork to human insulin.<sup>3</sup> Following subcutaneous administration, human insulin is absorbed more rapidly than pork insulin.<sup>4</sup> Some insulin preparations, such as isophane (typically annotated “N”), should never be administered intravenously. As part of a clinical trial investigating perioperative glycemic control, we recorded the insulin regimens of our patients.

**Methods:** The IRB approved this prospective observational study. Written informed consent was obtained from patients at the time of enrollment in the preoperative anesthesia clinic.

**Results:** Data from 409 patients were analyzed. More than 25 versions of insulin or insulin combinations were noted.

**Conclusion:** Newer insulins and combinations of insulins are being prescribed to manage diabetic patients. Unfamiliarity with insulins adds to the complexity of perioperative glycemic control, and may be a source of medication administration error or unwanted

side effects. It may be difficult for caregivers to anticipate onset times, peak effects, or duration of action of the medications. Insulins with different durations have similar-sounding names. Lantus (long-acting) may be confused with Lente (intermediate-acting). Humulin U, Humulin R, Humulin N, Humulin 50/50, and Humulin 70/30 are rapid-acting, short-acting, intermediate, and combinations of the former in different ratios, respectively.

Tools such as a database of photographs, electronic access to outside pharmacy records 24/7, and instructing patients to bring their insulin vials with them on the day of surgery may allow for accurate identification of medications.

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4. Ebihara A, Kondo K, Ohashi K, Kosaka K, Kuzuya T, Matsuda A. Comparative clinical pharmacology of human insulin (Novo) and porcine insulin in normal subjects. *Diabetes Care* 1983; 6(Suppl 1):17-22.

## 27 Preoperative Cardiovascular Risk Factor Assessment in Morbidly Obese Patients with an Abnormal Electrocardiogram

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**Background:** Obesity is an increasing epidemiologic concern and an independent risk factor for cardiovascular disease. However, there are no data available for patients with morbid obesity (body mass index > 40). We sought to evaluate the common cardiovascular risk factors among these patient populations.

**Methods:** We assessed 101 consecutive morbidly obese patients with an abnormal electrocardiogram (ECG) who were referred to our center for cardiac clearance prior to weight-loss surgery. We collected the demographics and pertinent medical history. We also collected the available lipid profile from these patients. Patients with recent myocardial infarction were excluded from the study.

**Results:** There were a total of 1,132 weight-loss surgeries per-

formed, from which 101 morbidly obese patients were analyzed. Of these 101 patients, 84.1% were female. The age distribution was 21 to 61 years, with a mean age of 37.5 years. The majority of patients had hypertension (57.4%), and a few had stable coronary artery disease (5.9%). Diabetes and smoking were seen in 29.7% and 22.7%, respectively. Normal sinus rhythm was seen in 98% of patients; 2% had atrial fibrillation. Poor (or reverse) R wave progression was seen in 53.4% of patients, whereas left anterior fascicular block was seen in 8%. Left axis deviation and left anterior fascicular block was seen in 18.8%. There were 96 lipid profiles available for the analysis, and they revealed the following:

- 64.6% of patients had total cholesterol > 200 mg/dL
- 94.8% of patients had LDL cholesterol > 100 mg/dL
- 54.1% of patients had triglycerides > 150 mg/dL
- 75.0% of patients had HDL cholesterol < 40 mg/dL.

The LDL:HDL ratio ranged from 0.67 to 5.81; 62.5% of the morbidly obese patients had an LDL:HDL ratio greater than 2.5.

**Conclusion:** Significant cardiovascular risk factors were identified in these morbidly obese patients, even though they were younger in age. Abnormal lipid profiles were seen in almost every patient. Interestingly, there was also an elevated number of left anterior fascicular blocks, which may postulate to early coronary artery disease.

## 28 Cardiac Testing Prior to Nonvascular Surgery: The Results from a Newly Formed Preoperative Clinic

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**Background:** Routine stress testing for risk assessment prior to vascular surgery has fallen out of favor in recent years, given aggressive beta-blockade. Recent studies suggest that drug-eluting coronary stents require uninterrupted dual-antiplatelet therapy. Stress testing in patients undergoing nonvascular surgery has not been similarly studied. The question we asked is whether it is helpful to routinely perform stress testing in nonvascular surgery patients per ACC/AHA guidelines and how often interventions are needed as a result of such testing.

**Methods:** A retrospective chart review was performed for all

Pre-operative Evaluation Clinic (POEC) patients. Only higher than intermediate risk surgery patients requiring a cardiac test for risk assessment were included in the analysis. The cardiac tests included were Persantine 99m-Tc sestamibi tomoscintigraphy, dobutamine stress echocardiography, and treadmill stress testing, in addition to age- and disease-specific electrocardiograms. Consequent coronary angiographies and interventions were followed if such were performed.

**Results:** Since the POEC inception in July 2006, a total of 790 patients were seen, of whom 87 (11%) required a stress test. All 87 patients were older than 55 years of age; 2 were women. The Table gives a breakdown of these patients according to type of surgery. Thirteen (14.94%) of the 87 patients had a positive stress test. Coronary angiography was performed in all 4 patients (4.5%) who needed an intervention, resulting in an average

delay in surgery of 3 months. The resulting intervention was either percutaneous coronary intervention or coronary artery bypass grafting.

**Conclusion:** In patients undergoing nonvascular surgical procedures (with greater than intermediate risk), the incidence of positive cardiac tests was low and intervention was seldom needed. The average surgical delay in patients undergoing testing was 3 months. In the vascular surgery population, preoperative stress testing has been replaced by aggressive beta-blockade with no increase in postoperative cardiac complications. A similar strategy may be beneficial in the nonvascular surgical population. A similar study is warranted in this patient population.

## 29 Which Is Better—Half-Dose or No Insulin on Day of Surgery?

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**Background:** Hyperglycemia is associated with adverse outcomes in intensive care units, after myocardial infarction and stroke. Elevated perioperative glucose levels are associated with cardiac, respiratory, and neurologic morbidity. Tight control of intraoperative glucose improves outcomes after CABG. Perioperative normoglycemia is difficult because of medications (catecholamines, steroids), stress response, acute illness, anesthetic masking of hypoglycemic symptoms, fasting, and outpatient surgery. The American College of Endocrinology targets a fasting glucose of 110 mg/dL and a maximum of 180 mg/dL in noncritically ill patients.<sup>1</sup> We attempted to determine the effects of insulin dosing.

**Methods:** After IRB approval, 265 type 2 diabetics prescribed chronic morning intermediate- or long-acting insulin were randomized to either half their usual dose or no insulin before arrival at the hospital for surgery. Patients took no short-acting insulin preparations the day of surgery. Glucose was determined upon hospital arrival. Glucose levels were compared using chi-square tests, Fisher's exact test, and logistic regression. Multivariate logistic models adjusted the treatment effect for age, sex, diabetes duration, Hgb<sub>A1c</sub>, and time of day. Significant covariates ( $P < .05$ ) were included if they modified the treatment effect. Analysis was conducted on an intent-to-treat basis, regardless of compliance with insulin instructions. The final analysis was done on 220 patients (45 patients had surgery cancelled or incomplete data).

**Results:** Patients taking half their morning insulin on the day

**TABLE**  
**SURGICAL DEMOGRAPHICS OF PATIENTS REQUIRING A STRESS TEST**

Type of surgery	No. of patients
Major orthopedic	37
General surgery	19
Urologic	12
Ear/nose/throat	5
Other	6
Neurosurgery	8

of surgery had better preoperative glucose levels than patients taking no insulin (Table). The strong association remained after adjustment for patient characteristics and time of day. A glucose level of 60 mg/dL or less occurred in 4 patients in the half-dose group; 1 patient had hypoglycemia before insulin and did not take insulin.

The odds of having a preoperative glucose level of 110 mg/dL or less were 3 times greater in the half-dose group than in the no-insulin group (OR [SE] = 2.97 [1.60, 5.52],  $P < .001$ ), adjusted for age, gender, and diabetes duration. The OR for a glucose level of 180 mg/dL or less was 2.44 (SE = 1.25, 4.76) ( $P = .009$ ).

**Conclusion:** Administering half the usual morning dose of intermediate- or long-acting insulin on the day of surgery improves glucose control with low risk of hypoglycemia. Insulin dosing on the day of surgery is a significant determinant of preoperative glucose.

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**TABLE**  
**PREOPERATIVE GLUCOSE LEVELS ACCORDING TO TREATMENT GROUP**

Preoperative glucose	Treatment group		P value
	Half dose (n = 107)	No insulin (n = 113)	
< 60 mg/dL	4 (3.7%)	0 (0%)	.054
≤ 110 mg/dL	44 (41%)	21 (19%)	< .001
≤ 180 mg/dL	88 (82%)	75 (66%)	.007

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