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Case studies in perioperative management: Challenges, controversies, and common ground

ABSTRACT

This collection of case studies is designed to illustrate challenging and controversial aspects of perioperative medicine. The authors guide readers through four case narratives punctuated by practical multiple-choice questions followed by the authors' commentary on the evidence supporting various answer choices and related considerations. The objective is to examine issues and key evidence that should inform the decision-making process in important aspects of perioperative management.

CASE 1: RADICAL PROSTATECTOMY IN A MAN WITH ACUTE DEEP VEIN THROMBOSIS

A 69-year-old man is seen in the preoperative clinic 1 week before a scheduled radical prostatectomy. He has been diagnosed with femoral deep vein thrombosis (DVT) following a complaint of calf soreness.

Question 1.1: *How would you treat him for his DVT?*

A. Intravenous (IV) unfractionated heparin (UFH)
B. Low-molecular-weight heparin (LMWH)
C. Inferior vena cava (IVC) filter
D. Combination of pharmacologic therapy and then an IVC filter

Dr. Steven L. Cohn: The latest edition of the American College of Chest Physicians (ACCP) evidence-based guidelines on antithrombotic therapy recommends the use of therapeutic-dose subcutaneous LMWH over IV UFH for initial treatment of acute DVT in the outpatient or inpatient setting.[1] Additionally, indications for an IVC filter include the prevention of pulmonary embolism (PE) in a patient with DVT who requires full-dose anticoagulation but cannot receive it, as would be the case here if the patient proceeds with surgery as scheduled. So if surgery will be postponed, the best option is LMWH; if surgery will not be postponed, the best answer is a combination of pharmacologic therapy with low-dose LMWH and an IVC filter, preferably a retrievable one.[2]

Question 1.2: *You recommend postponing surgery, but the patient is worried about metastatic disease. For how long should surgery be postponed?*

A. 2 weeks
B. 1 month
C. 2 months
D. 3 months
E. 6 months

Dr. Cohn: In the absence of anticoagulation therapy, the risk of venous thromboembolism (VTE) is approximately 40% (~1% per day) during the first month following an acute VTE and then declines markedly, to approximately 10%, during the second and third months following the acute event.[3] Therefore, I would suggest that the patient wait at least 1 month after an acute DVT before undergoing surgery.

Dr. BobbieJean Sweitzer: This patient is in a hypercoagulable state, and the surgery itself will induce excess hypercoagulability. With a femoral DVT already present, his risk of VTE or PE is likely to be greater than 1% per day during the first month. If he does develop a PE, it may potentially be fatal.

Question 1.3: *According to the patient, the surgeon and the internist discussed options, but the surgeon "doesn't believe in filters" and the patient doesn't want to postpone the procedure, despite your recommendation. Two weeks later he shows up for surgery having stopped his LMWH 3 days before. What would you do?*

A. Cancel the surgery and restart full-dose LMWH
B. Proceed with prophylactic-dose LMWH
C. Proceed after giving a full therapeutic dose
D. Insert a filter and give DVT prophylaxis

Dr. Cohn: A bridging protocol should have been discussed with the surgeon and anesthesiologist before the procedure. Therapeutic levels of LMWH persist as long as 18 hours after discontinuation; therefore, the ACCP recommends interrupting LMWH 24 hours before surgery.[4]

Dr. Sweitzer: The lack of a bridging protocol in this case created a problem. The patient was afraid to continue anticoagulation after hearing the internist and surgeon disagree about the plan, and thus stopped it entirely, and he did not want to delay surgery because he was fearful of metastasis. The surgeon was adamant that IVC filters don't work. The internist was concerned that

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the patient was at high risk for a PE. Even though the documented risk of postponing radical prostatectomy for a short time is inconsequential, I was convinced that the patient would not believe this if metastasis were to develop in the future.

Question 1.4: *How would you have managed his anticoagulation perioperatively?*

A. Stop LMWH 12 hours before surgery and restart at full dose 12 to 24 hours after surgery
B. Stop LMWH 24 hours before surgery and restart at full dose 24 hours after surgery
C. Stop LMWH 24 hours before surgery and restart prophylactic dosing 12 to 24 hours after surgery, and then full-dose LMWH in 48 to 72 hours
D. Stop LMWH 24 hours before surgery and restart at full dose 72 hours after surgery

Dr. Cohn: The correct timing for stopping LMWH is 24 hours before surgery. As for how to resume anticoagulation in patients at high risk for VTE or those undergoing major surgery, the latest ACCP guidelines recommend the following[4]:

- Reinitiation of anticoagulation 12 to 24 hours postoperatively, assuming adequate hemostasis in patients not at high risk for bleeding
- Use of a prophylactic dose or no anticoagulation for up to 72 hours if the patient is at high risk for bleeding.

These recommendations are a departure from previous practice, in which we routinely restarted anticoagulation 6 to 12 hours postoperatively.

Dr. Sweitzer: According to guidelines from the American Society of Regional Anesthesia and Pain Medicine (ASRA),[5] if twice-daily LMWH is stopped 24 hours ahead of time (as long as patients have normal renal function), it is safe to perform epidural or spinal anesthesia, if either is an option. If full-dose UFH is used, the partial thromboplastin time (PTT) is monitored and central neuraxial blockade may be done if the PTT is in the normal range, which typically is 2 to 6 hours after UFH is stopped.

Additionally, the platelet count should be checked every 3 days postoperatively while the patient is on UFH or LMWH. It may be just as important to monitor the platelet count preoperatively if the patient has been on UFH or LMWH for an extended duration, especially if a central neuraxial anesthetic technique is planned.

Dr. Cohn: The reason for monitoring the platelet count is the potential for heparin-induced thrombocytopenia in patients on UFH. I recently encountered a patient who developed postoperative heparin-induced thrombocytopenia with thrombosis while on LMWH, which is relatively uncommon compared with UFH.

Case resolution

After much discussion of the risk of a significant PE with the patient, family, urologist, and vascular surgeon, it is decided that a temporary IVC filter will be placed in the operating room immediately after induction of general anesthesia and before the prostatectomy. The operation is delayed about 1 hour to allow this option. The patient is successfully treated and has the IVC filter removed 1 month postoperatively.

CASE 2: RADICAL CYSTECTOMY IN ELDERLY MAN WITH CARDIAC RISK FACTORS

A 78-year-old obese Russian-speaking man is seen in the preoperative clinic prior to a scheduled radical cystectomy for highly invasive bladder cancer. He is a poor historian and argues with the several family members accompanying him, but it is determined that his medical history includes hypertension, diabetes mellitus, a myocardial infarction (MI) 5 years previously (in Russia), and stable angina that is determined to be class II.

He had no previous work-up and no electrocardiogram (ECG). His medications are aspirin, metoprolol, and metformin. His blood pressure is 190/100 mm Hg, heart rate 90 beats per minute, and body mass index 32. On examination, there is no murmur, S3 gallop, or rales. His blood glucose is 220 mg/dL, and his creatinine is slightly elevated (1.4 mg/dL). ECG verifies a prior MI.

Question 2.1: *Which of the following additional tests should be ordered preoperatively?*

A. Hemoglobin (Hb) A_{1c}
B. Lipid profile
C. Both
D. Neither

Dr. Sweitzer: Because the surgery is not elective, no immediate benefit would be achieved by ordering either an HbA_{1c} or a lipid profile. However, if you view the preoperative evaluation as an opportunity to manage risk factors over the long term, then it may be a good idea to order the lipid profile because this patient has rarely engaged the health care system. Likewise, the HbA_{1c} can be ordered to set in place his long-term management. Sometimes we focus on the preoperative visit only in the context of the surgery, but if a test or intervention is appropriate and needed for long-term management, then it is appropriate to do now.

Dr. Cohn: There is no evidence to support using the preoperative HbA_{1c} to alter management decisions. I would not postpone surgery based on the HbA_{1c} value, as I would if his glucose level were 600 mg/dL. Most of the studies that have assessed postoperative complications based on preoperative HbA_{1c} did not control for postoperative glucose levels. The incidence of complications varies based on the type of complication and the type of surgery.

Similarly, I would not use lipid values to guide management of this patient. Studies suggest that perioperative statin therapy may reduce postoperative morbidity and mortality in patients undergoing vascular surgery (see article by Poldermans on page S79 of this supplement), but our patient already has indications for a statin—a remote MI and diabetes—independent of what his lipid values are.

Question 2.2: *How would you manage his elevated blood pressure (190/100 mm Hg)?*

A. Discontinue metoprolol and start a different antihypertensive drug
B. Increase the metoprolol dose
C. Continue metoprolol and add a second drug
D. Observe him on his current regimen

Dr. Cohn: I would increase the dose of metoprolol and consider adding another drug, in view of his heart rate (90 beats per minute) and his cardiac status. Beta-blocker therapy should not be discontinued because doing so in the perioperative period is associated with an increased risk of adverse events such as cardiac death and MI.

Dr. Sweitzer: I would push up the metoprolol a bit to reduce the heart rate, knowing that beta-blockers are probably not the most efficacious antihypertensive agents. I would caution against starting an angiotensin-converting enzyme (ACE) inhibitor or an angiotensin receptor blocker (ARB) because he is scheduled to undergo a fairly significant procedure with expected blood loss and fluid shifts, and either of those agents in combination with a beta-blocker would be challenging to manage on the day of surgery.

Question 2.3: *How would you manage his metformin perioperatively?*

A. Discontinue it 48 hours preoperatively
B. Discontinue it 24 hours preoperatively
C. Withhold it on the morning of surgery
D. Continue it on the morning of surgery

Dr. Sweitzer: We routinely advise patients to hold all their oral diabetes medications the morning of surgery, primarily because many anesthesiologists are uncertain about the differing risks of hypoglycemia associated with the various oral agents.

Most of us will never see a patient who has lactic acidosis from metformin use. A systematic literature review and analysis found no increase in the risk of lactic acidosis with metformin compared with other oral hypoglycemics,[6] so fear of lactic acidosis is not a valid reason to discontinue metformin. In fact, I think it is inappropriate to ever postpone or cancel surgery simply because the patient inadvertently took metformin on the morning of surgery. Some may argue that patients with renal insufficiency are at higher risk of lactic acidosis from metformin use on the morning of surgery, but keep in mind that renal insufficiency is a relative contraindication to metformin use in the first place. Unless the patient is scheduled for a bilateral nephrectomy, his or her renal function is not going to be acutely reduced enough to enable a morning dose of metformin to cause lactic acidosis.

Dr. Cohn: Additionally, in a recent study of patients undergoing coronary artery bypass graft surgery (CABG), there was no increased risk of in-hospital morbidity or mortality in patients who received metformin on the morning of surgery,[7] although I typically stop it 24 hours before major surgery.

Question 2.4: *With respect to statin therapy, which course would you choose preoperatively?*

A. Start a statin at a low dose
B. Start a statin at an intermediate dose
C. Start a statin at a high dose
D. Do not start a statin

Dr. Cohn: The answer to this question is not clear cut. The reason not to start a prophylactic statin would be the lack of evidence of benefit in patients undergoing noncardiac, nonvascular surgery, although there is evidence of potential benefit in patients undergoing vascular surgery.* The arguments in favor of starting a statin are that this patient has independent indications for a statin and the planned surgery is a high-risk procedure.

In cohort studies, perioperative death rates have been lower in statin recipients than in those not taking a statin.[8] In the Dutch Echographic Cardiac Risk Evaluation Applying Stress Echo III (DECREASE III), which randomized noncardiac vascular surgery patients to perioperative fluvastatin or placebo, rates of MI and the composite end point of nonfatal MI or cardiovascular death were significantly lower in the statin group than in the placebo group.[9]

Question 2.5: *Which of the following cardiac tests would you order preoperatively?*

A. Exercise ECG
B. Dobutamine stress echocardiogram
C. Dipyridamole nuclear imaging
D. Coronary angiography
E. No further cardiac testing

Dr. Cohn: I wouldn't do any cardiac testing since this patient needs surgery for his malignancy and the results of

* *Editor's note:* In the time since this summit, results of the DECREASE-IV trial were published (Dunkelgrun et al, *Ann Surg* 2009; 249:921–926), showing a statisically nonsignificant trend toward improved outcomes at 30 days with fluvastatin in intermediate-risk patients undergoing noncardiovascular surgery.

any testing would be highly unlikely to change management, in terms of canceling the surgery. This approach is consistent with the 2007 guidelines on perioperative cardiovascular evaluation for noncardiac surgery issued by the American College of Cardiology (ACC) and the American Heart Association (AHA).[10]

Dr. Sweitzer: I would differ on this question. This patient has not been evaluated adequately for his coronary artery disease. He has poor functional capacity that complicates assessment of his symptoms. He also has diabetes, so he is more likely to have silent myocardial ischemia. At age 78, he is understandably concerned about his survival: radical cystectomy is a major operation associated with significant blood loss, fluid shifts, and a long-term recuperative state. In this case, a cardiac evaluation may change management, not in terms of considering coronary revascularization before the surgery, but in terms of affecting the assessment of his chance of surviving this major operation, his life span following the operation, and his quality of life. For example, a highly positive dobutamine stress echocardiogram or certain wall motion abnormalities would suggest that he might not be protected even by optimal perioperative medical management.

Question 2.6: *Which of the following would you do preoperatively to assess pulmonary risk?*

A. Obtain pulmonary function tests
B. Order a sleep study
C. Both
D. Neither

Dr. Sweitzer: There is no evidence supporting routine pulmonary function tests for patients undergoing procedures other than lung resection. If obstructive sleep apnea were suspected, I would order a sleep study only if I had access to one quickly to avoid delaying the surgery. Cancer surgery should never be delayed to get a sleep study. However, if this patient were seen in the primary care clinic, I would order a sleep study and, if indicated, put him on continuous positive airway pressure (CPAP). Whether or not preoperative CPAP makes a difference hasn't been shown. No randomized controlled trials have been conducted, but there are some suggestions that the risks of ischemia and atrial arrhythmias in patients with known coronary artery disease can be reduced with CPAP. It is not always easy to initiate CPAP postoperatively because the number of CPAP machines is limited and titration by a respiratory technician is required, which is typically done in a sleep lab.

How the case was actually managed

Neither an HbA_{1c} measurement nor a lipid profile was ordered preoperatively, for lack of supportive evidence. The patient was continued on his beta-blocker and the dosage was increased sufficiently to control his blood pressure and heart rate. Metformin was continued, and statin therapy was begun preoperatively in light of the patient's independent indications for it and the high-risk nature of the procedure. Stress testing was not ordered, in light of the lack of indication, given the patient's stable angina. The patient refused a sleep study. The operation was lengthy and involved significant blood loss. The patient had a complicated postoperative course and ultimately died from multiorgan failure.

CASE 3: OPERATIONS OF VARIABLE RISK IN ELDERLY MAN WITH ACTIVE CARDIAC CONDITION

Scenario A: *A 75-year-old man with diabetes, class III angina, and Q waves in inferior leads on his ECG is scheduled for elective femoropopliteal bypass surgery. His medications include isosorbide mononitrate (120 mg), amlodipine (10 mg), metoprolol controlled release (100 mg), atorvastatin (80 mg), insulin, and aspirin (81 mg). His heart rate is 64 beats per minute, blood pressure is controlled at 120/80 mm Hg, low-density lipoprotein cholesterol is 80 mg/dL, and creatinine is 1.5 µmol/L.*

Scenario B: *Consider the same patient undergoing elective cholecystectomy instead of a femoropopliteal bypass.*

Scenario C: *Consider the same patient scheduled for a cystoscopy instead of the other procedures. He had one episode of gross hematuria 1 week ago that resolved. Work-up by his urologist included a urinalysis and culture that were normal, cytology that was negative for malignancy, and a sonogram and computed tomography scan that were both negative. He has had no further bleeding and is not anemic. The urologist wants to do the cystoscopy for the sake of completeness.*

Question 3.1: *What would be your preoperative course of action in the above scenarios?*

A. Order a dobutamine stress echocardiogram
B. Order nuclear imaging with dipyridamole or adenosine
C. Order coronary angiography
D. Order a resting two-dimensional echocardiogram
E. Continue his current medications and send to surgery with no further testing

Dr. Cohn: This is a man with an active cardiac condition and class III angina, which is considered severe angina in the ACC/AHA 2007 guidelines on perioperative cardiac evaluation and care.[10] The guidelines' recommendation is to delay surgery for further evaluation and treatment. He is already on maximal medical therapy, which has failed to control his symptoms. He has poor exercise capacity. The only difference among the case scenarios is a variation in surgical risk.

This patient has independent indications for coronary angiography *regardless of whether or not he's undergoing surgery*. He deserves evaluation for possible revascularization to improve his quality of life and symptoms.

I would send the patient to the catheterization lab in every one of these instances, with the possible exception of the cystoscopy scenario, where one could argue that revascularization with stenting would require antiplatelet therapy that might increase the bleeding risk, and also that the antiplatelet therapy would have to be interrupted for the cystoscopy, potentially increasing thrombotic risk.

Dr. Sweitzer: I disagree. The ACC/AHA 2007 guidelines do not recommend going directly to catheterization but rather recommend delaying surgery for further evaluation and treatment.[10] We must ask whether this patient is truly receiving optimal medical management. After all, he is not on an ACE inhibitor or an ARB.

We must also consider whether the surgery is truly elective. In the first scenario, if he has peripheral vascular disease, he is likely to develop gangrene and have a further decrease in exercise capacity, which reduces his functional ability and increases his risk of comorbid conditions. He is at significant risk of developing worsening renal insufficiency or renal failure if he undergoes angiography. Coronary revascularization will delay treatment of his peripheral vascular disease. The Coronary Artery Revascularization Prophylaxis (CARP) trial showed no benefit of coronary revascularization relative to medical management in patients undergoing vascular surgery,[11] as is planned for this patient. I believe one must balance two competing risks and have an in-depth discussion with the patient.

In the second scenario, not treating gallstones or preventing cholelithiasis poses more risk to the health of this diabetic patient than does elective surgery if he needs a cholecystectomy. Emergency surgery, especially for acute cholecystitis, also significantly increases the risk of a cardiac event.

In the third scenario, the cystoscopy may uncover bladder cancer, which may be adversely affected by a delay of surgery. Regardless, the patient had gross hematuria and would be at risk for further bleeding should he undergo stenting with the requisite antiplatelet therapy.

Catheterization is not normally recommended unless CABG or stenting is being considered, yet I have seen no data that either of these procedures prolongs life except in very limited circumstances such as left main disease treated with bypass grafting. Though it is true that CABG reduces the incidence and severity of angina, it does not modify the physiologic cause of angina but rather may result in symptom improvement by damaging somatic nerve fibers to the heart. Putting a stent in this patient would be like applying a bandage: his symptoms will likely recur if he does not receive optimal medical management.

In a 2007 science advisory, several major medical societies cautioned against percutaneous coronary intervention (PCI) with drug-eluting stent placement in patients expected to undergo noncardiac surgery that would require interruption of antiplatelet therapy in the following 12 months (and against PCI with bare metal stent placement in patients undergoing such surgery in the following 4 to 6 weeks).[12] Therefore, I would not recommend catheterization for a patient whose noncardiac disease is likely to require surgery in the very near future, as is the case in each of the surgical scenarios above. One could consider noninvasive stress testing, which would be a safer approach and would almost certainly identify either significant stenosis of the left main coronary artery or three-vessel disease, which would be the only possible reasons to recommend CABG. I don't believe there is any role for PCI for this patient.

Dr. Cohn: I argue for symptom relief even if it doesn't prolong life. This patient cannot walk across the room without having symptoms despite taking multiple medications. I think he deserves a chance at revascularization if the angiogram shows he has a stenosis amenable to it, but I agree that a drug-eluting stent should not be placed if we know that he will undergo surgery within a few months.

CASE 4: VENTRAL HERNIA REPAIR IN A MIDDLE-AGED WOMAN

A 60-year-old woman is scheduled for ventral hernia repair. Her medical history is unremarkable, with the exception of hypertension. She denies any bleeding problems and had no complications after a laparoscopic cholecystectomy 10 years ago. She has no family history of bleeding disorders.

Question 4.1: *Would you order a prothrombin time (PT)/partial thromboplastin time (PTT)?*

A. Yes
B. No

Dr. Cohn: I would not.

Dr. Sweitzer: I agree.

Question 4.2: *Although not requested, a PT/PTT was ordered anyway. The PT is normal (12.2 sec/12 sec) and the PTT is abnormal (40 sec/25 sec). What is the most likely cause of the PTT abnormality?*

A. Laboratory error
B. Factor VII deficiency
C. Factor IX deficiency
D. Factor XI deficiency
E. Factor XII deficiency

Dr. Cohn: The most likely cause is a sample with insufficient blood in the tube. The test wasn't indicated in the first place, but now it must be done again.

Question 4.3: *The PTT is repeated and remains abnormal:*

42 sec/25 sec. Mixing studies correct the abnormality to 29 sec/25 sec. Based on this information, what is the most likely cause of the PTT abnormality?

A. Laboratory error
B. Lupus anticoagulant
C. Prekallikrein factor deficiency
D. Factor XII deficiency

Dr. Cohn: This is not a case of lupus anticoagulant because the abnormal PTT was corrected by the mixing study. Causes of a prolonged PTT include deficiencies of factors XII, XI, and IX, so factor XII deficiency is the most likely explanation, though a deficiency higher up the coagulation cascade (ie, prekallikrein factor deficiency) is possible. In the absence of any personal or family bleeding history, it is unlikely to be a deficiency of factors VII or IX (the hemophiliac) or of factor XI, so a deficiency of factor XII or one of the prekallikrein factors is more likely.

Dr. Sweitzer: A mixing study is indeed the appropriate first step. It is ordered from the lab and involves mixing the patient's blood with normal plasma and incubating the mixture. If the mixture corrects the PTT result, as was the case with this patient, it indicates a coagulation factor deficiency in the patient's blood; if it doesn't correct, that should prompt evaluation for lupus anticoagulant or the presence of some other protein or hormone that's prolonging the PTT.

Question 4.4: *How would you manage this patient perioperatively?*

A. Fresh frozen plasma
B. Platelet transfusion
C. Cryoprecipitate
D. Factor VII
E. No treatment necessary

Dr. Cohn: No treatment is necessary. Factor XII deficiency does not cause bleeding, regardless of the PTT. Factor XI deficiency is associated with bleeding, but usually there is a family history or a personal history of bleeding with surgery.

Screening coagulation studies are not usually indicated in a patient without a personal or family history of bleeding, liver disease, alcohol or drug use, or current anticoagulant therapy. Such studies are usually normal in such patients, and when they are not, it's usually because of a lab error or a disease (hypercoagulable state) or factor deficiency that does not cause bleeding

Dr. Sweitzer: However, if the PTT is prolonged, the cause should be identified, because if the patient is sent to the operating room without an explanation for the prolongation, the perioperative team might think the patient has a bleeding problem and use fresh frozen plasma too readily. Fresh frozen plasma is not appropriate for everyone and may actually make a potentially hypercoagulable state worse.

DISCUSSION

Question from the audience: It was said that use of ACE inhibitors and ARBs should be avoided around the time of surgery. I've done an extensive literature search and found minimal to no evidence to support this practice. To the contrary, I found fairly good evidence to indicate that heart failure can be exacerbated significantly and acutely, as early as within 24 hours, when patients are taken off their ACE inhibitor or ARB. I would like your viewpoint on this basic pathology in perioperative medicine.

Dr. Cohn: The literature on the use of ACE inhibitors or ARBs prior to noncardiac surgery consists of five studies with fewer than 500 patients in total, as recently reviewed by Rosenman et al.[13] Although there was no excess of death or MI associated with taking these medications on the morning of surgery, they did increase the need for fluid and pressors.

Dr. Sweitzer: Patients with hypertension have bigger variations of blood pressure, both hypo- and hypertension, in the perioperative period. For this reason, it was standard of care 30 years ago to stop all antihypertensive drugs, including beta-blockers, preoperatively. We soon found that although this practice prevented many episodes of hypotension, it increased the occurrence of perioperative hypertension and the likelihood of cardiac events. It then became standard of care to always continue antihypertensive drugs on the morning of surgery. In the late 1980s and early 1990s, several studies showed that ACE inhibitors and ARBs were associated with a more profound drop in blood pressure upon induction of general anesthesia compared with other antihypertensives.

The usual ways we treat drops in blood pressure—with phenylephrine and ephedrine—are not very effective in treating hypotension associated with general anesthesia in patients taking ACE inhibitors or ARBs. Vasopressin is effective in treating refractory hypotension during surgery, but anesthesiologists don't use it often. Reducing the doses of induction agents is another means of attenuating the hypotension induced by ACE inhibitors and ARBs.

We should not routinely stop ACE inhibitors and ARBs on the day of surgery, particularly in patients being treated for heart failure, angina, or a prior MI. My bias is to selectively hold ACE inhibitors and ARBs on the morning of surgery in patients who are undergoing a significant operation with a high likelihood of hypotension, have well-controlled preoperative blood pressure, are taking multiple antihypertensive agents, and do not

have heart failure. Otherwise, patients should continue their ACE inhibitors and ARBs on the morning of surgery, and the anesthesiologist should be prepared for significant hypotension upon induction of anesthesia, alter anesthesia induction doses accordingly, have vasopressin handy, and avoid the temptation to treat hypotension with fluids or repeated doses of phenylephrine and ephedrine. The previous comment about concerns with ACE inhibitors and ARBs was in the context of *initiating* new therapies in the immediate preoperative period.

Question from the audience: Urinalysis is ordered for many patients undergoing orthopedic surgery, and invariably some bacteriuria is found. Can you comment on the value of urinalysis and subsequent treatment of abnormal results?

Dr. Cohn: I believe you should never order a urinalysis in an asymptomatic patient, with the exception of patients undergoing procedures that involve genitourinary or gynecologic instrumentation. Ordering a urinalysis before joint replacement has been promoted in the orthopedic literature on the theoretical grounds that bacteria might somehow seed and colonize the joint. Orthopedic surgeons like to do it, but I disregard their requests for it.

Dr. Sweitzer: One study showed that we'd need to spend $1.5 million on screening urinalysis for asymptomatic patients scheduled for joint replacement surgery in order to prevent one joint infection.[14]

Dr. Cohn: Also, patients are going to get their one dose of cephalosporin before surgery anyway, and that will probably knock out any bacteria that would be found on urinalysis.

Question from the audience: Can you clarify how the 2007 ACC/AHA perioperative guidelines define an active cardiac condition? The patient in your third case report had class III angina, or angina with less than usual activities, but nothing was presented to suggest that his symptoms were unstable. I would suggest that despite his class III symptoms, his angina was stable, and I would have continued down the algorithm rather than defining his cardiac condition as active and considering an intervention.

Dr. Cohn: An active cardiac condition is defined by the ACC as unstable coronary syndromes, which include acute (within the prior 7 days) or recent (within the prior 30 days) MI, unstable angina, and severe (class III or IV) angina.

DISCLOSURES

Both authors have indicated that they have no financial relationships with commercial interests that have a direct bearing on the subject matter of this article.

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REFERENCES

1. **Kearon C, Kahn SR, Agnelli G, Goldhaber S, Raskob GE, Comerota AJ.** Antithrombotic therapy for venous thromboembolic disease. American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 2008; 133(6 suppl):454S–545S.
2. **Geerts WH, Bergqvist D, Pineo GF, et al.** Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 2008; 133(6 suppl):381S–453S.
3. **Kearon C, Hirsh J.** Management of anticoagulation before and after elective surgery. N Engl J Med 1997; 336:1506–1511.
4. **Douketis JD, Berger PB, Dunn AS, et al.** The perioperative management of antithrombotic therapy: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). Chest 2008; 133(6 suppl):299S–339S.
5. **Horlocker TT, Wedel DJ, Benzon H, et al.** Regional anesthesia in the anticoagulated patient: defining the risks (the second ASRA Consensus Conference on Neuraxial Anesthesia and Anticoagulation). Regional Anesthesia & Pain Medicine. 2003; 28:172–197. Available at: http://www.asra.com/consensus-statements/2.html. Accessed May 11, 2009.
6. **Salpeter S, Gryeber E, Pasternak G, Salpeter E.** Risk of fatal and nonfatal lactic acidosis with metformin use in type 2 diabetes mellitus. Cochrane Syst Rev 2006; (1):CD002967.
7. **Duncan AI, Koch CG, Xu M, et al.** Recent metformin ingestion does not increase in-hospital morbidity or mortality after cardiac surgery. Anesth Analg 2007; 104:42–50.
8. **Kapoor AS, Kanji H, Buckingham J, Devereaux PJ, McAlister FA.** Strength of evidence for perioperative use of statins to reduce cardiovascular risk: systematic review of controlled studies. BMJ 2006; 333:1149.
9. **Poldermans D.** Fluvastatin XL use is associated with improved cardiac outcome after major vascular surgery: results from a randomized placebo controlled trial. Presented at: European Society of Cardiology Congress 2008; September 1, 2008; Munich, Germany.
10. **Fleisher LA, Beckman JA, Brown KA, et al.** ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery. J Am Coll Cardiol 2007; 50:e159–e242.
11. **McFalls EO, Ward HB, Moritz TE, et al.** Coronary-artery revascularization before elective major vascular surgery. N Engl J Med 2004; 351:2795–2804.
12. **Grines CL, Bonow RO, Casey DE Jr, et al.** Prevention of premature discontinuation of dual antiplatelet therapy in patients with coronary artery stents: a science advisory from the American Heart Association, American College of Cardiology, Society for Cardiovascular Angiography and Interventions, American College of Surgeons, and American Dental Association, with representation from the American College of Physicians. Circulation 2007; 115:813–818.
13. **Rosenman DJ, McDonald FS, Ebbert JO, Erwin PJ, LaBella M, Montori VM.** Clinical consequences of withholding versus administering renin-agiotensin-aldosterone system antagonists in the preoperative period. J Hosp Med 2008; 3:319–325.
14. **Lawrence VA, Gafni A, Gross M.** The unproven utility of the preoperative urinalysis: economic evaluation. J Clin Epidemiol 1989; 42:1185–1192.

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