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REVIEW

Management of comorbidities in ambulatory anesthesia: a review

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Abstract: Advances in medical science now allow people with significant medical issues to live at home. As the outpatient population ages and surgical techniques advance, the ambulatory anesthesiologist has to be prepared to handle these "walking wounded". The days of restricting ambulatory surgery procedures to American Society of Anesthesiologists class 1 and 2 patients are rapidly fading into the past. To remain competitive and economically viable, the modern ambulatory surgery center needs to expand its practice to include patients with medical comorbidities. In an environment where production and economic pressures exist, maintaining safety and good outcomes in high-risk patients for ambulatory surgery can be arduous. Adding to the complexity of this challenge is the rapid evolution of the therapeutic approaches to a variety of medical issues. For example, there has been a significant increase in the number and types of insulin a diabetic patient might be prescribed in recent years. In the case of the patient with coronary artery disease, the variety of both drug and nondrug eluding stents or new antithrombotic agents has also increased the complexity of perioperative management. Complex patients need careful, timely, and team-based preoperative evaluation by an anesthesia provider who is knowledgeable of outpatient care. Optimizing comorbidities preoperatively is a crucial initial step in minimizing risk. This paper will examine a number of common medical issues and explore their impact on managing outpatient surgical procedures.

Keywords: ambulatory surgery, medical comorbidities, diabetes, coronary artery disease, respiratory disease, obesity

Introduction

Ambulatory surgery (AS) has grown rapidly worldwide. Currently, it is the most widely practiced anesthesia subspecialty in the US; ambulatory anesthesia comprises more than 70% of all anesthetics administered nationwide. At least 50 million ambulatory procedures are performed annually,[1] and in 2013, data from National Anesthesia Clinical Outcomes Registry indicate that 57% of these procedures were performed in a hospital versus a freestanding facility.[2] As numerous studies confirmed the safety of ambulatory practice, a growing number of complicated surgical patients, with significant or multiple comorbidities, are utilizing the outpatient setting. More painful and invasive procedures, such as shoulder and total knee arthroplasty, mastectomy, and advanced laparoscopic surgery, which were previously considered inappropriate for AS, are increasingly performed as day surgeries (DSs).[3–5] In office-based practices, caseload has more than doubled in volume. Ophthalmic, gastrointestinal, and cosmetic procedures comprised the bulk of office-based practice, which has now extended the coverage to podiatry, gynecology, interventional radiology as well as vascular and cardiology procedures.[6–8]

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Providing anesthesia for more complex and longer surgeries with sick and elderly outpatients is a challenging task for the anesthesiologist. A high level of clinical skills and sharp decision-making while managing complex patients may not only improve outcome and safety, but also decrease schedule delays and maintain efficiency. The patient's clinical status is a major consideration in preoperative evaluation. The surgeon's skills and experience, surgical environment, and anesthetic technique should all be considered as well. Appropriate resources and trained personnel must be readily available for adverse events.

Safety and risk evaluation in ambulatory surgery

Investigations evaluating risk and outcomes in AS have centered on identifying what conditions should be considered predictors of adverse events after surgery. Numerous studies indicate that in the presence of comorbidities (particularly cardiovascular and respiratory), the risk of perioperative complications after AS increases. However, evidence to support correlation between outcomes in AS and comorbidities is limited.

A recent large study, using national data from the American College of Surgeons – National Surgical Quality Improvement Program (NSQIP), reported that the incidence of morbidity and mortality within 72 hours of AS in adults (n=244,397) was 0.1% or 1 in 1,053 cases.[9] An earlier investigation reported a death rate per 100,000 procedures of 0.78 in AS centers and 9.2 in offices.[10] These rates confirm findings of earlier single-center studies regarding the safety of AS, reporting rates from 0.09% to 0.60% among common ambulatory procedures.[11–13] High body mass index (BMI; overweight or obese), chronic obstructive pulmonary disease (COPD), hypertension (HTN), history of transient ischemic attack (TIA)/stroke, previous cardiac surgical intervention, and prolonged operative time were identified as independent risk factors for increased perioperative morbidity.[9] The most common morbidities identified were unplanned postoperative intubation, pneumonia, and wound disruption. Earlier investigations[10,14–16] evaluating risk factors from data using the current AS patient-selection model reported that noncompensated, poorly stabilized cardiac and respiratory patients, patients with obstructive sleep apnea (OSA), being >85 years of age, and preterm infants are at high-risk of complication in DS. Unplanned admissions, or return to the hospital, are more frequent after ear, nose and throat, and urology outpatient procedures. Administrative data analyses which focused on readmission outcome noted that prolonged surgical duration, cerebrovascular disease, obesity, and cardiac disease increased the risk after outpatient surgery.[17,18] Whippey et al[17] recently reported that surgeries lasting longer than 1 hour, high ASA (American Society of Anesthesiologists) physical status classification (≥ASA 3), advanced age (80 years or older), and increased BMI were identified as predictors of unplanned hospital admission. A recent large-scale Danish study[19] of a prospective cohort of 57,709 DS procedures collected from eight DS centers over a 3-year period also confirmed the safety of DS, reporting a very low rate of return hospital visits (1.21%). The most common causes of return visits in this investigation were hemorrhage or hematoma (0.5%), infection (0.44%), and thromboembolic events (0.3%). Morbidity was reported as rare, and the procedures with the highest rate of complication were tonsillectomies (11.4%), surgically induced abortions (3.3%), and inguinal hernia repairs (1.23%).

Patient selection in ambulatory surgery

In the 1970s, when AS was newly introduced, simple procedures and healthy patients were eligible for AS. Only those cases that involved minimal blood loss or fluid shift, had procedure times of <90 minutes, used simple equipment, and entailed minimal postoperative care and pain that could be treated with oral medications were considered.[10,20] Today, the only requirement to be accepted for AS is the patient's ability to go home safely on the same day of surgery. A survey[21] of Canadian anesthesiologists (n=1,377, 58% responders) indicated that more than 75% of the anesthesiologists would administer anesthesia to an ASA3 ambulatory patient, including one with stable congestive heart failure (CHF), low-grade angina pectoris (AP), asymptomatic valvular heart disease, a previous myocardial infarction (MI) older than 6 months, or one with sleep apnea without the use of narcotics. A similar proportion of the anesthesiologists considered patients with unstable angina, cardiovascular or respiratory complications, or the morbidly obese with comorbidities, as unsuitable for ambulatory procedures. If procedure and personnel were also considered, however, many AS centers would accept a patient with OSA who could receive lower-extremity regional anesthetic plus an appropriate intravenous (IV) sedation and analgesia.

Age is generally not considered a major criterion for patient selection for DS. The elderly patient can safely undergo outpatient surgery depending upon the complexity of the procedure and the optimization of the patient's comorbid condition. Patients with higher ASA classification but with stable comorbidities may be considered for DS. Except if severe or end stage, preoperative coexisting diseases might not be a contraindication to DS, provided there is good patient compliance to perioperative instructions and a supportive perioperative care organization. Appropriate preoperative medical therapy of comorbidity must be maintained during the perioperative period as interruption could exacerbate an otherwise stable chronic medical condition.

Management of comorbidities in ambulatory anesthesia

Conditions that were reported in association with increased risk in adult outpatients thus far include HTN, coronary artery disease (CAD), CHF, prior TIA/stroke or cardiac surgical intervention, asthma, COPD, obesity, sleep apnea, smoking, and gastroesophageal reflux.[9,17,22–26] Overall, the most encountered adverse events were cardiovascular – in cardiac patients; or postoperative respiratory – in asthmatic, morbidly obese, and sleep apnea patients.[10] Recognition and optimization of comorbid medical conditions in advance of the day of surgery is crucial because it enables implementation of perioperative preventative measures that minimize adverse events. Prevention of postoperative exacerbation of chronic disease is important and requires expertise to achieve a good outcome.

Hypertension and cardiovascular disease

Cardiovascular comorbidities such as HTN, ischemic heart disease (IHD), arrhythmia, and CHF are common among the DS population. CAD, valvular disease (particularly aortic), and CHF are considered the most challenging.

Approximately 30% of patients who undergo surgery annually in the US have IHD. Data remain limited in terms of risk of cardiac events in AS. Surgical risk in cardiac patients has been largely evaluated in terms of the type of surgery. Currently, most outpatient procedures, including laparoscopic surgery, are now considered low-risk ($<1\%$ cardiac events).[10] Although the general mortality rate from CAD (acute MI) remains significant, early therapeutic interventions such as angioplasty, thrombolysis, aspirin, heparin, and statin therapy have led to the steady decline of mortality rates from MI.[27,28] Hence, patients with IHD are now at much lesser risk of perioperative adverse events after surgery than in the past. Aggressive reperfusion therapy for patients with IHD lowers mortality rate threefold to 6.5%, from a 15% to 20% mortality rate, compared to patients who do not receive reperfusion therapy.

Hypertension

In the patient with HTN, the goals of preoperative evaluation include assessment of 1) adequacy of control of blood pressure (BP), 2) whether the antihypertensive treatment is effective, and 3) the presence of target-organ damage.[29] To date, evidence is lacking to demonstrate that the incidence of postoperative complications is increased when hypertensive patients undergo elective surgery; however, in the presence of end-organ damage, HTN does increase the risk of surgery.[30,31] AS patients, like inpatients, should continue to take β-blockers and calcium channel blockers (CCBs), but not angiotensin-converting enzyme (ACE) inhibitors, on the day of surgery.[32] Studies have shown that patients who are on long-term treatment, with ACE inhibitors and angiotensin receptor blockers, experience hypotension that requires vasopressor treatment more often after induction of anesthesia, than those in whom such medications have been withheld on the day of surgery.[33–35] Withdrawal of hypertensive medications during the preoperative period may result in rebound HTN that may require immediate treatment. Although the presence of labile BP during the perioperative period has been shown to increase the risk of stroke, acute kidney injury (AKI), and 30-day mortality in patients undergoing cardiac surgery,[36] evidence is limited in the ambulatory patient population.

During anesthesia, the goal is to prevent extreme swings in BP, as hypertensive patients are known to exhibit exaggerated BP response to anesthetic drugs. Regardless of preoperative treatment of BP to normotensive levels, direct laryngoscopy and tracheal intubation may still result in substantial increase in BP.[37] The anesthetic is designed to blunt hypertensive responses during anesthesia, and the patient is monitored to detect myocardial ischemia. Postoperatively, monitoring of end-organ function is continued, and periods of BP elevation must be anticipated.

Patients with pulmonary HTN (mean pulmonary artery pressure of >25 mm Hg at rest or >30 mm Hg with exercise) should continue all long-term pulmonary vasodilator therapies throughout the perioperative period.[38] Pulmonary vasodilator medications currently used for pulmonary HTN include CCBs, prostacyclins, nitric oxide, endothelin receptor blockers, and phosphodiesterase inhibitors.[39] Patients with pulmonary HTN are at increased risk of right heart failure and sudden death during the perioperative period.[40]

Coronary artery disease or ischemic heart disease

Surgical patients with CAD or IHD need optimization to have a good postoperative outcome. The overall goal of treatment of chronic stable angina is to achieve complete or almost complete elimination of angina chest pain and to return to normal activities with minimal side effects.[41] Being cognizant of conditions that may exacerbate or worsen an otherwise stable angina, such as fever, infection, tachycardia, anemia, heart failure, thyrotoxicosis, or cocaine use, is helpful in identifying surgical patients with CAD who may have an exacerbation of their chronic disease. In the presence of IHD, HTN increases the risk of coronary events as a result of increased myocardial oxygen demand, left ventricular hypertrophy, and direct vascular injury.[42] Treatment of HTN to normotensive levels decreases the risk of stroke, MI, and heart failure. β-Blockers and CCBs, in addition to lifestyle modifications, are used in the treatment of HTN in patients with AP.[43] When HTN is accompanied by ventricular dysfunction, the use of an ACE inhibitor or angiotensin receptor blocker is recommended. Hypotension in the context of IHD is typically caused by presence of left or right ventricular dysfunction or cardiac dysrhythmias.

Medications that are currently used in the treatment of HTN in patients with AP include nitrates, β-blockers, CCBs, and antiplatelet drugs (APDs). β-Blockers are known to be more effective than CCBs in reducing the incidence of MI.[44] Perioperative use of β-blockers is recommended by the American Heart Association and the American College of Cardiology in patients already on β-blockers or in high-risk patients undergoing noncardiac procedure to decrease the risk of MI or myocardial ischemia.[45,46] Because of the risk of stroke, severe bradycardia, or severe hypotension, β-blockers should be used with caution in patients not previously treated with β-blockers or in patients undergoing intermediate- or low-risk noncardiac surgery. Abrupt withdrawal of β-blockers after prolonged administration can worsen ischemia in patients with stable chronic angina. CCBs decrease smooth muscle tone, dilate coronary arteries, decrease myocardial contractility and oxygen consumption, and decrease systemic BP. Various CCBs such as amlodipine, nicardipine, felodipine, isradipine, and long-acting nifedipine are potent vasodilators and are effective in treating both HTN and angina. Unlike short-acting CCBs, such as verapamil and diltiazem, long-acting CCBs are comparable to β-blockers in relieving angina pain and are uniquely effective in decreasing the frequency and severity of Prinzmetal variant (vasospastic) angina. CCBs are contraindicated in patients with severe CHF or severe aortic stenosis.

Diet and statin therapy are used to lower cholesterol greater than 130 mg/dL. The use of statins to lower cholesterol, particularly low-density lipoprotein (LDL) is associated with a significant decrease in the risk of death resulting from cardiac events.[41] The goal is to decrease levels of LDL to less than 100 mg/dL, and there is a known additional benefit in lowering LDL further, to less than 70 mg/dL, in patients with IHD.[28]

Antiplatelet therapy is important in the management of IHD. Acute coronary syndrome is a hypercoagulable state, resulting from focal disruption of an atheromatous plaque that triggers a coagulation cascade, leading to a thrombus formation that occludes the coronary artery. The formation and presence of "vulnerable plaques" in CAD, which are most likely to rupture and form an occlusive thrombus, predicts a greater risk of MI regardless of the degree of coronary artery stenosis. It is important to know that acute MI is most often caused by rupture of plaque in a partly stenosed coronary artery with less than 50% blockage.

Currently, three classes of APDs are commonly used in the management of IHD: aspirin, thienopyridines (clopidogrel and prasugrel), and platelet glycoprotein IIb/IIIa inhibitors (eptifibatide, tirofiban, and abciximab). A fourth class that affects platelet cAMP (dipyridamole) is currently not widely used.

Preoperative evaluation concentrates on clinical course, patient functional status, and surgery involvement. Stability of angina in patients with IHD must be assessed (eg, any change of frequency and duration of angina pain from their baseline, exertion or exercise capacity prior to pain onset, medications to relieve pain, and other associated symptoms). If instability is suspected or if recent symptom changes, such as alteration in workload that induces chest pain is present, refer patient for cardiac evaluation or defer surgery as inpatient, as appropriate. In patients who had a recent MI, it is currently assumed to wait at least 30 days after MI prior to DS, provided the patient's functional status is adequate and angina symptoms have resolved.[42]

There is a paucity of evidence regarding which anesthesia technique is most beneficial in cardiac patients. Regardless, the fundamental goals of anesthetic management include avoiding hypotension, bradycardia, and factors that increase myocardial oxygen consumption such as HTN, tachycardia, pain, or stress; preventing hypoxia; and maintaining coronary perfusion.

Early diagnosis and prompt treatment of perioperative MI reduces morbidity and mortality.[44,47] Anesthesia providers are in a unique position to facilitate prompt diagnosis and initial treatment of perioperative ischemia.

Troponin (T or I) is a cardiac-specific (protein) biochemical marker for acute MI. Its circulating level increases early in MI, typically within 3 hours after myocardial injury, and remains elevated for 7–10 days. Troponin is more specific than CK-MB for detecting MI. Elevated troponin levels and ECG are known powerful predictors of adverse cardiac events in patients with angina pain. The degree of elevation of the biomarker from normal reference range defines the presence of and parallels the magnitude of the infarction. Chest pain that emerges during the perioperative period is of particular concern. Almost two-thirds of patients who develop a perioperative MI describe either 1) a new-onset angina pain, 2) a change in their angina pattern, or 3) a more severe-than-baseline angina pain. In many ways, the surgical procedure may be viewed as a stress test that either the patient passes or fails. If they fail it (ie, cardiac instability, intraoperative or postop angina), admission overnight should be seriously considered.

Acute management of heart disease exacerbations

In patients suspected of having ischemia or MI during the perioperative period, initial steps of management include oxygen administration, evaluation of hemodynamic stability, and obtaining a 12-lead ECG. Pain relief, with IV morphine and/or sublingual nitroglycerin, is important to reduce catecholamine release and consequent increase in myocardial oxygen requirements. β-Blockers are administered early to relieve ischemic chest pain, reduce infarct size (by reducing heart rate, BP, and myocardial contractility), and prevent life-threatening dysrhythmias.[43] However, β-blockers should not be used if a patient is unstable hemodynamically, in heart failure, low cardiac output state, heart block, or if at risk of cardiogenic shock.[46] Administration of β-blockers is associated with a significant decrease in early (inhospital) and long-term mortality and MI.[43,46] Aspirin (clopidogrel or prasugrel, if intolerant to aspirin) is administered to reduce further thrombus formation in the coronary artery. If urgent surgical intervention is likely, use of platelet glycoprotein IIb/IIIa inhibitor is recommended. It is critical to reestablish blood flow in the obstructed coronary artery as soon as possible because time to reperfusion strongly influences the outcome of acute MI.[44] Reperfusion can be achieved with pharmacologic thrombolysis or coronary angioplasty, with or without placement of intracoronary stent.

In the absence of ventricular dysrhythmias, prophylactic administration of lidocaine or antidysrhythmic drugs is not recommended. CCBs should not be administered routinely but be reserved for patients with persistent myocardial ischemia despite optimal use of aspirin, β-blockers, nitrates, and heparin. Routine administration of magnesium is also not recommended but is indicated in patients with torsades de pointes ventricular tachycardia.

Thrombolytic therapy (TT) with streptokinase, tissue plasminogen activator, reteplase, or tenecteplase, is administered within 30–60 minutes of hospital arrival (if patient, not hospital based), or within 12 hours of symptom onset. Clot dissolution restores normal antegrade blood flow in the occluded artery. Thrombolysis is more difficult to achieve if delayed. Intracranial hemorrhage is the most feared complication of TT and is more likely to occur in the elderly (>75 years), in individuals with uncontrolled HTN, recent surgery, or recent gastrointestinal bleeding. TT is not indicated in unstable angina or non-ST elevation MI and has been shown to increase mortality in these cases.

When feasible, angioplasty or percutaneous coronary intervention (PCI) is a preferred procedure in the treatment of an ischemic process. It must be performed within 90 minutes of hospital arrival and within 12 hours of onset. It is the treatment of choice in patients with severe heart failure, pulmonary edema, or if TT is contraindicated. About 5% of patients who undergo immediate PCI require emergency cardiac surgery due to anatomic reasons or technique failure. Coronary stent placement, in combination with use of APDs during emergency PCI, allows a maximum chance of achieving normal antegrade coronary blood flow and may reduce the likelihood of a subsequent revascularization procedure. Emergency coronary artery bypass grafting is normally reserved for patients who failed angioplasty and those with infarction-related ventricular septal rupture or mitral regurgitation.

CHF has been shown to be one of the independent predictors of adverse cardiac events after surgery.[48] Subsequently, CHF has been regarded as more of a risk[49] factor for adverse cardiac events than CAD. Patients with S3 gallop would have an 11 point score, the highest value assigned to any risk factor using the Multifactorial Risk Index by Goldman et al.[50]

The valvular disorder aortic stenosis is the most predictive comorbidity of perioperative adverse events, particularly when symptoms (angina, CHF) appear. Symptomatic patients necessitate cardiac evaluation and aggressive perioperative management, but administering anesthesia in the outpatient setting is strongly discouraged. Heart transplant patients may present to AS as they develop[51] biliary disorder requiring laparoscopic cholecystectomy. Their clinical course may be complicated by the lack of heart rate-mediated adjustments to their cardiac output. It is advisable to assure the availability of an external pacemaker or isoprenaline (Isuprel, Hospira, Lake Forest, IL, USA) before proceeding with their surgery.

Anticoagulation and other perioperative issues in the cardiac patient

Because of increased risk of bleeding or thrombosis during the 1st month after coronary stent insertion, a minimum of 30 days is advised prior to outpatient surgery. Patients with coronary stents undergoing noncardiac surgery are at risk for stent thrombosis and a major cardiovascular event with interruption of dual antiplatelet (aspirin and clopidogrel) therapy.[52] Bridging with low molecular-weight (LMW) heparins may poorly protect against adverse cardiovascular events.[53] In situations where clopidogrel therapy needs to be temporarily discontinued because of risk of bleeding, continuation of aspirin is strongly recommended to decrease the chance of thrombosis. Maintaining APD therapy throughout the operative period appears generally safe in many outpatient procedures and should be maintained in all situations in which the risk of surgical hemorrhage is low. The next major risk factor for stent thrombosis is the time interval between stent placement and the intended surgery. This time interval is inversely related to the risk of thrombotic complication, with the highest mortality rate occurring less than a month after stent placement. For patients with the drug-eluting type of stent, it is recommended that elective surgery be delayed for at least a year, and a minimum of 6 weeks for patients with bare-metal stents. Vigilant perioperative monitoring is the key for prompt recognition of myocardial ischemia and/or infarction due to thrombosis, to initiate rapid triage for PCI procedure for coronary occlusion intervention. One must be very cautious with the use of neuraxial anesthetic because of the risk of epidural hematoma.

Withholding anticoagulation places patients with mechanical heart valves or atrial fibrillation at risk (~5%–8% risk) of arteriovenous thromboembolism as a result of a rebound hypercoagulable state and prothrombotic effects of surgery. In patients who are scheduled for minor surgery, in which blood loss is expected to be minimal, anticoagulation may be continued. In major surgery, warfarin is typically discontinued 3–5 days preoperatively, with IV unfractionated heparin or subcutaneous (subQ) LMW heparin begun and continued until the day before or the day of surgery. Postoperatively, heparin is resumed when the risk of bleeding has lessened. Elective surgery should be avoided when possible in the first month after an acute episode of arterial or venous thromboembolism.

In parturients with prosthetic valves, anticoagulation therapy is particularly important because the incidence of arterial embolization is greatly increased during pregnancy. Unfortunately, warfarin administration during the first trimester can be associated with fetal defects and fetal death. Hence, warfarin is discontinued during pregnancy, and subQ standard or low-dose LMW heparin is administered until delivery. Low-dose aspirin can be used in conjunction with heparin therapy as it is safe for the mother and fetus.

Patients with an implantable cardiac defibrillator scheduled for surgical procedures may be performed as an outpatient, with a preference by many providers to use an integrated facility (AS center within a hospital) versus office-based or free-standing facility. Over the years, caring for a patient with an implantable cardiac defibrillator has become easier with a growing consensus among device manufacturers regarding device capabilities and settings. This is especially important regarding the effect of magnets when used to deactivate the defibrillator component, which has in the past varied greatly among manufacturers. It can be quite helpful to have the input from the patient's cardiologist and the device manufacturer regarding these issues.

Respiratory disease

Asthma and COPD have been shown by several studies to be associated with increased complications perioperatively,[54–56] but data are scant in the AS population.

Airway responsiveness remains a major concern in the perioperative management of patients with bronchial asthma and COPD. An evidence-based approach to perioperative care is desirable to guide management of respiratory disorders. To date, perioperative management and optimization[57,58] strategies include: 1) adequate control of airway hyperreactivity and respiratory infection, 2) aggressive use of β_2-adrenergic agonists (or leukotriene antagonists)[59] and systemic administration of steroids for the treatment of exacerbation, 3) smoking cessation, and 4) evidence-based anesthetic technique, including intra- and postoperative use of oxygen and selective use of volatile agents.

Ambulatory patients with COPD must be carefully evaluated to assess the reversible component of disease. The use of preoperative pulmonary function testing with and without bronchodilators[60] is widely used in severe COPD to determine the reversibility of obstruction. A marked decrease in FEV_1 (forced expiratory volume in 1 second) (<0.75 of vital capacity) was demonstrated to be a predictor of respiratory complications and mortality,[54] but other spirometry results[61] were not. Hypercapnia and hypoxemia of the arterial blood gas have been shown to be useful in predicting increased perioperative risk. All reversible components including bronchospasm, infection, secretion, and atelectasis should be treated with bronchodilators, antibiotics, and pulmonary therapy prior to surgery.

Stopping smoking is strongly encouraged because it has been shown to reduce the risk of perioperative complications.[62] A randomized controlled study by Lindstrom et al[63] demonstrated that smoking cessation intervention with discontinuation of smoking 4 weeks prior to surgery in general and orthopedic cases could be an effective tool to reduce postoperative complication. Prior recommendations had varied from 2 weeks prior to surgery to 6–8 weeks prior to surgery, to allow the ciliary epithelium to recover normal function and decrease mucus production during anesthesia. Interestingly, it has been shown that undergoing surgery is associated with an increased likelihood of smoking cessation in the older US population; however, it is more likely in association with major surgery than with outpatient surgery.[64] Regardless of the presence of smoking in patients with a reversible component of airway hyperresponsiveness and/or obstructive disease, a 48-hour course of systemic corticosteroid and β_2-adrenergic agonist is recommended.[65] Furthermore, short-term administration of steroids has not been found to have an adverse effect on wound healing or infection control.[66–68]

In the presence of bronchial hyperreactivity, significant bronchospasm caused by airway instrumentation remains a major anesthetic concern. Preoperative treatment with an inhaled β_2-sympathomimetic, in combination with systemic corticosteroids, has been demonstrated to be more effective than pretreatment with inhaled β_2-agonist alone. Silvanus et al[65] showed that preoperative treatment with combined corticosteroid and salbutamol minimizes intubation-evoked bronchoconstriction much more effectively than pretreatment with inhaled β_2-sympathomimetic salbutamol alone. In the same study, pretreatment with either salbutamol alone or salbutamol–methylprednisolone combination significantly and similarly improves lung function within a day. However, only the combined regimen decreases the incidence of wheezing after tracheal intubation.

The use of laryngeal mask airway for general anesthesia has less laryngeal stimulation than tracheal intubation, thus lowering the risk of bronchospasm. Drugs causing histamine release are avoided. If appropriate, use of regional anesthesia is preferred. One should exercise caution with supraclavicular or interscalene blocks because a pneumothorax could have dramatic effects in the presence of COPD or asthma.

Another major concern for surgical patients is postoperative reintubation after planned extubation (RAP) following general anesthesia. A recent retrospective study[69] of a cohort of >220,000 patients (recorded from a quality assurance database) who underwent endotracheal intubation for general anesthesia indicated that 0.06% sustained postoperative RAP. Risk factors identified for RAP include COPD, pneumonia, systemic inflammatory response, and airway surgery. From the data, a RAP index was created taking into account higher ASA classification, conscious disturbance, COPD, pneumonia, systemic inflammatory response, room air SpO_2 <95%, hypothermia, airway surgery, and head and neck surgery. The RAP index was shown to have a high predictive value (receiver operating characteristic curve =0.873) regarding the likelihood that a patient would require reintubation.

Hepatic disease

Data indicate that the elderly patient with cirrhosis undergoing major surgery is at higher risk of death for up to 90 days postoperatively;[70] however, there is a paucity of research in this regard in AS patients. In an investigation evaluating operative mortality risk in patients with cirrhosis undergoing orthopedic, major digestive, and cardiovascular procedures, Teh et al[70] indicated that factors such as MELD (model for end-stage liver disease) score, age, and ASA class can quantify the risk of mortality postoperatively in patients with cirrhosis and can guide decision making as to whether elective surgical procedures should be delayed until after liver transplantation. In this study, the 30-day mortality ranged from 5.7% (MELD score <8) to more than 50% (MELD score >20).

Renal impairment

Preventing acute renal failure in the postoperative period is an important consideration in perioperative management, particularly in the elderly and those with preexisting renal insufficiency (RI), diabetes, and long-standing HTN.[71,72] In these patients, optimization strategies include BP control, avoidance of fasting-induced hypovolemia,[73] glucose monitoring, and estimation of creatinine clearance.[74] Using a large national clinical data set (American College of Surgeons – NSQIP) of general surgery procedures performed in 121 US medical centers, Kheterpal et al[72] determined the incidence, risk factors, and mortality impact of AKI after general surgery. The investigators identified eleven independent preoperative predictors of postoperative AKI, namely, age 56 years or older, male sex, HTN, diabetes mellitus (DM) necessitating oral therapy, DM necessitating insulin therapy, active CHF, ascites, mild preoperative RI, moderate preoperative RI, emergency surgery, and intraperitoneal surgery. From this data set, the complication rate for AKI was 1.0%, but increases to 9% with the presence of the above listed risk factors.

Diabetes mellitus

DM is one of the five leading causes of premature death worldwide. With a prevalence that has been rapidly increasing, more than 300 million people have diabetes across the globe.[75] In the US, it was the seventh leading cause of death in 2010. About 29 million Americans have diabetes, with an estimated incidence in the US of 9.3% in 2012[76] (4%–5% in UK), an incidence that has nearly doubled since the mid-1970s. Approximately 90% of DM patients are non-insulin dependent, and most are elderly and overweight.

Complications and comorbid conditions associated with DM include, but are not limited to, hypoglycemia, HTN, dyslipidemia, cardiovascular disease, heart attack, stroke, blindness and eye problems, kidney disease, and amputations. Regardless of medical specialty, DM is known to be associated with increased inhospital morbidity and increased duration of hospital stay.[75,77] Multiple studies have shown that diabetic patients undergoing major surgery, cardiac or noncardiac, are at increased risk of mortality and morbidity.[78–80]

Although patients with DM often have one or more comorbidities, DM is not a contraindication to outpatient surgery. A consensus statement on perioperative blood glucose management published by the Society of Ambulatory Anesthesia (SAMBA, USA), as well as by the National Health Services (NHS) Diabetes in the UK,[81] provides guidelines to help improve perioperative care of ambulatory patients with diabetes.[82] Consensus outlines a conceptual model of care for all diabetic patients undergoing elective surgery, beginning at the primary care referral to preoperative assessment, admission, through recovery, postoperative care, and discharge. The model was criticized for its limitations, including the consideration that urgent and emergency procedures have been increasing in many hospitals.[75] It is important to note that the recommendations from both guidelines are largely based on expert opinion, as there is limited evidence due to lack of supporting studies.

Preoperative evaluation of DM patients includes assessment of their fasting blood glucose level and optimizing their treatment using either hypoglycemic medications and/or parenteral insulin. When glucose concentrations are significantly elevated, IV or subQ insulin is utilized.[83] The ambulatory surgical facility must have the necessary equipment to monitor blood glucose levels. The importance of frequent postoperative assessment of blood glucose levels in reducing infectious complications has been previously demonstrated.[84]

Areas of clinical controversy in managing surgical patients with diabetes have been addressed.[75] These include ideal blood glucose range (and measurement error), utility of preoperative glycated hemoglobin (HbA_{1c}), preoperative dose of long-acting insulin, and perioperative use of metformin. Literature on the use of dexamethasone,[85] as well as the choice of IV fluid in the diabetic patient,[86] has recently been published.

The American Association of Clinical Endocrinologists with the American Diabetes Association Consensus Statement[87] is nearly in conformity with the NHS guidelines regarding the ideal inhospital glucose range for noncritically ill DM patients: 6–10 mmol/L (in the US, the lower limit is 5.6 mmol/L or 100 mg/dL). There is substantial evidence that good glycemic control decreases perioperative infection, morbidity, and mortality.[79,80] According to the NHS guidelines, a range of 4–12 mmol/L (70–215 mg/dL) is also acceptable. Some experts argue against the use of this extended range. In vitro data demonstrate that the upper limit of 12 mmol/L (215 mg/dL) results in a constellation of changes in endothelial function, impaired neutrophil function, decreased complement activity, expression of adhesion molecules, and enhanced cytokine synthesis, all of which facilitate inflammation exacerbation and thereby increase infection.[88] Likewise, experts argue against the lower limit of 4 mmol/L (70 mg/dL) as it is close to glucose values that may induce hypoglycemia in some DM patients. Health care providers are reminded that although published guidelines can help in clinical decision-making and maintaining a high standard of care, guidelines should not be regarded as rigid algorithms that should be followed blindly.

It has been suggested that preoperative HbA_{1c} values be determined not only in DM patients undergoing major surgery but also in all elective surgical patients with DM.

This approach was proposed not only to influence the timing of elective surgery but also to help identify surgical patients with undiagnosed DM as well. There is evidence to show that delaying major surgery until glycemic control is improved helps decrease serious morbidity and mortality.

Current data indicate that there is a relationship between good preoperative glycemic control, as determined by HbA_{1c} concentrations, and reduced incidence of systemic and surgical complications, lower mortality, and shorter hospital stay. In addition, the association between inadequate preoperative glucose control and adverse outcomes has also been demonstrated in several surgical specialties such as cardiac,[89] vascular,[90] colorectal,[91] orthopedics,[92] and neurosurgery.[93] HbA_{1c} values >8.6% (70 mmol/L) were associated with a fourfold increase in mortality after cardiac surgery.[89]

The utility of HbA_{1c} was recently highlighted by its integration into the guidelines for the diagnosis of DM in the UK,[94] following the recommendations of the world health organization. A HbA_{1c} value of >6.5% (48 mmol/L) on repeated testing was defined as being a diagnostic of DM, and values ranging between 6.0% and 6.4% (42–47 mmol/L) as an indication of high risk for DM, and values in the range 4.0%–6.0% (20–42 mmol/L) to be in the diabetic range. Additionally, HbA_{1c} concentrations of 6.5%–7.5% (48–58 mmol/L) were considered as the target for diabetic patients, with the higher levels accepted for patients at risk for hypoglycemia.

Opinions regarding the optimal dose of perioperative long-acting insulin vary. As basal insulin preparations were introduced, insulin therapy has changed in many diabetic patients.[75] The use of long-acting insulin in combination with short-acting analogs has enabled type 1 DM patients to attempt to simulate the nondiabetic state by controlling both basal and postprandial insulin needs. Type 2 diabetic patients who have difficulty controlling their glucose level increasingly use long-acting insulin formulations.

The NHS guidelines recommend that the usual dose of long-acting insulin be used prior to surgery regardless of whether there is a short or long interval of fasting.[81] A similar recommendation was provided by SAMBA guidelines for AS.[82] Both NHS and SAMBA guidelines assume that the dose of long-acting insulin may need to be decreased in patients who experience a significant drop in overnight glucose values, those who miss meals, or those who snack in addition to regular meals. NHS suggests that the usual dose of long-acting insulin be decreased by a third in such patients. One must be mindful that the evidence was very limited at the time of the proposal by NHS. A recent study[95] investigated 400 type 1 and 2 diabetic patients undergoing elective noncardiac procedures to identify which dose (80% of usual dose, dose provided by primary physician, or a simple dose derived locally) of insulin glargine is appropriate before surgery. No significant differences were found among the three groups in the number of patients achieving glucose levels between 5.5 and 9.9 mmol/L regardless of whether glargine was used alone or in combination with bolus insulin. In addition, similar glucose levels were achieved despite notable differences in the preoperative dose used by each group (80%, 64%, 54%, respectively). Hypo- or hyperglycemia was uncommon. Investigators of this study suggested that, despite the need for further research on this matter, using 80% of the usual evening dose of insulin is a safe, simple, and effective approach.

Morbid obesity and obstructive sleep apnea

Morbidly obese patients (BMI >40 kg/m^2) with optimized comorbid conditions could safely undergo AS, but not those who are super obese (BMI >50 kg/m^2). Previous studies have identified obesity and OSA as risk factors for perioperative complications. However, other studies[96–100] have indicated that neither obesity nor OSA influences perioperative complications or unplanned admission after AS. The rates of postoperative HTN, hypotension, hypoxia, cancelation of surgery, delayed discharge, and unplanned hospital admission after DS in the morbidly obese were shown not to differ from that of the nonobese.[100] From this data, although the outpatient morbidly obese patients were noted to be younger, they had more comorbidities than their nonobese counterparts. Lastly, a recent evaluation of 1,487 patients with incident heart failure[101] reported that being overweight (BMI 25 to <30 kg/m^2) or obese (BMI ≥30 kg/m^2) appears to have a protective association with survival and lower mortality after the development of heart failure.

Approximately 60%–70% of morbidly obese patients have sleep-disordered breathing such as OSA and obesity-related hypoventilation syndrome. OSA is a sleep disorder that entails frequent episodes of partial or complete upper airway collapse during sleep. Recognized as an important cause of morbidity and mortality, some studies have shown that it is also an independent risk factor for HTN, cardiovascular disease, and stroke.[102] Patients affected by OSA are more prone to perioperative complications such as HTN, dysrhythmia, desaturation, airway obstruction, or reintubation.[103] Sedative and opioid drugs may exacerbate sleep-related apneic episodes. Regional anesthesia is an alternative when appropriate, to circumvent difficulties in airway control and potentially lessen the respiratory effects of general anesthesia.

OSA is often undiagnosed or underestimated. Patients with OSA are mainly categorized into: 1) documented OSA with use of continuous positive airway pressure (CPAP) or other devices at home, 2) mild OSA not requiring CPAP, and 3) undiagnosed – not been evaluated by polysomnography. Polysomnography assigns an apneic/hypopneic index (AHI) number indicating the degree of severity of OSA: mild (AHI =5–15), moderate (AHI =16–30), or severe OSA (AHI >30).[104] Most ambulatory centers accept patients with suspected OSA without prior polysomnography studies.

Data support that OSA patients are at high risk for severe, and even fatal, postoperative complications if not adequately monitored and managed,[105,106] but no evidence exists regarding the relationship of severity of OSA to the risk of complications. OSA patients with inadequately treated comorbid conditions should not be operated in an outpatient setting.[99] An algorithm for evaluating and preparing patients with OSA for AS has been published.[107]

Diagnosed OSA patients who use CPAP machines and are able to use their CPAP device in the postoperative period may be considered for outpatient procedure if their comorbid medical conditions are optimized. Patients with a presumed diagnosis of OSA (ie, based on screening tools such as STOP-BANG [snoring, tiredness during day time, observed apnea, high BP, BMI, age, neck circumference, gender] questionnaire) may be considered for outpatient surgery if their comorbid conditions are optimized and if their postoperative pain relief can be provided predominantly by nonopioid analgesic techniques. Patients who will likely require opioids for pain after discharge should be able and willing to use CPAP postoperatively. For OSA patients undergoing upper airway procedures, there is no recommended guideline as evidence is limited,[99] and clinical decision should be made on an individualized basis.

Summary

The "sick" outpatient can represent a significant challenge to a busy AS center. The most common comorbidities include HTN, diabetes, CAD, pulmonary dysfunction (COPD and OSA), and obesity. This article has reviewed some of the preoperative evaluation, intraoperative management, and postoperative follow-up that may be required. While this population may represent a significant challenge, it has been our experience that they also can be among the most rewarding to care for.

Disclosure

The authors report no conflicts of interest in this work.

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