NARRATIVE REVIEW ARTICLE

Patient Selection for Adult Ambulatory Surgery: A Narrative Review

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With migration of medically complex patients undergoing more extensive surgical procedures to the ambulatory setting, selecting the appropriate patient is vital. Patient selection can impact patient safety, efficiency, and reportable outcomes at ambulatory surgery centers (ASCs). Identifying suitability for ambulatory surgery is a dynamic process that depends on a complex interplay between the surgical procedure, patient characteristics, and the expected anesthetic technique (eg, sedation/analgesia, local/regional anesthesia, or general anesthesia). In addition, the type of ambulatory setting (ie, short-stay facilities, hospital-based ambulatory center, freestanding ambulatory center, and office-based surgery) and social factors, such as availability of a responsible individual to take care of the patient at home, can also influence patient selection. The purpose of this review is to present current best evidence that would provide guidance to the ambulatory anesthesiologist in making an informed decision regarding patient selection for surgical procedures in freestanding ambulatory facilities. (Anesth Analg 2021;133:1415–30)

GLOSSARY

AAAHC = Accreditation Association for Ambulatory Healthcare; **ACC** = American College of Cardiology; **ACS-NSQIP** = American College of Surgeons-National Surgical Quality Improvement Program; **AF** = atrial fibrillation; **AHA** = American Heart Association; **ASA** = American Society of Anesthesiologists; **ASA-PS** = American Society of Anesthesiologists physical status; **ASC** = ambulatory surgery center; **AVF** = arteriovenous fistula; **BMI** = body mass index; **BMS** = bare metal stent; **CAD** = coronary artery disease; **CDC** = Centers for Disease Control and Prevention; **CIED** = cardiac implantable electronic device; **CMS** = Centers for Medicare & Medicaid Services; **COPD** = chronic obstructive pulmonary disease; **COVID-19** = coronavirus disease 2019; **DAPT** = dual antiplatelet therapy; **DBP** = diastolic blood pressure; **DES** = drug-eluting stent; **DM** = diabetes mellitus; **ESA** = European Society of Anaesthesiology; **ESC** = European Society of Cardiology; **ESRD** = end-stage renal disease; **FEV1** = forced expiratory volume in 1 second; **HbA1c** = hemoglobin A1c; **HF** = heart failure; **LVEF** = left ventricular ejection fraction; **MACE** = major adverse cardiovascular event; **MH** = malignant hyperthermia; **MHAUS** = Malignant Hyperthermia Association of the United States; **MI** = myocardial infraction; **OSA** = obstructive sleep apnea; **PAP** = positive airway pressure; **RCRI** = Revised Cardiac Risk Index; **SAMBA** = Society for Ambulatory Anesthesia; **SASM** = Society of Anesthesia and Sleep Medicine; **SBP** = systolic blood pressure; **STOP-BANG** = Snoring, Tiredness, Observed apnea, blood Pressure, Body mass index, Age, Neck circumference and Gender; **TIA** = transient ischemic attack; **TJC** = The Joint Commission

Driven by improvements in surgical and anesthetic techniques as well as modifications in postoperative care and health care plan payment patterns (eg, the addition of some procedures to Centers for Medicare & Medicaid Services [CMS] outpatient list), the growth in ambulatory surgery is likely to continue exponentially.[1] Procedures and patients previously deemed unsuitable for the outpatient setting are now increasingly being scheduled for ambulatory surgery.[2] It is therefore incumbent upon the anesthesiologists who practice at these locations to have clearly defined patient selection criteria allowing for safe and efficient care of medically complex patients undergoing extensive surgical procedures with the expectation of discharge to home on the day of surgery.

The process of determining suitability of a patient for surgery as an outpatient is dynamic, involving the complex interplay of several factors such as surgical procedure, patient characteristics, and the expected anesthetic technique (eg, sedation/analgesia, local/regional anesthesia, or general anesthesia). In addition, the type of ambulatory setting (ie, short-stay [23-hour stay] facilities, hospital-based ambulatory center,

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freestanding ambulatory surgery center [ASC], and office-based surgery) and social factors, such as availability of a responsible individual to take care of the patient at home, can also influence patient selection.

This review will examine existing evidence and provide guidance to the ambulatory anesthesiologist in making an informed decision regarding patient selection for adults undergoing surgical procedures in freestanding ASCs. The review will discuss patient comorbidities that are suitable for ASCs, those that may be suitable but the evidence is equivocal or scarce, and those that are unsuitable based on good evidence. Patient selection for other ambulatory settings is not addressed.

PERIOPERATIVE OUTCOMES AND PATIENT SELECTION

Large database studies have found low rates of significant morbidity and mortality after ambulatory surgery.[3–10] The outcome measures of consequence with regard to clinical decision-making in the ambulatory setting include unplanned hospital transfers as well as acute care visits and hospital readmission after discharge from the ambulatory facility. These outcomes may indicate a breach in patient safety and increase health care costs. It is not surprising that the CMS considers all-cause transfer/admission and 7-day risk standardized hospital visit rates as quality measures for payments to ambulatory facilities.[11]

The literature related to these outcome measures that could guide optimal patient selection for ambulatory surgery is sparse and of limited quality due to the retrospective nature of the studies and relatively small effect sizes due to low prevalence of the outcomes of interest. Additionally, analyses of available data provide evidence of association and not causation when detecting risk factors. More importantly, the older retrospective analyses may not always be relevant in the current rapidly changing surgical practice environment. Nevertheless, these data combined with extensive clinical experience can be used to guide decision-making and improve patient safety.

SYSTEM FACTORS AND PATIENT SELECTION

Recommendations and mandates from local, state, and national regulatory organizations influence decision-making regarding patient selection. For example, CMS limits ASCs to providing surgical services that do not require hospitalization and duration of such services would not exceed 24 hours.[12] Also, certain states have restrictions on types and length of procedures or upper and lower age limits for patients who may undergo a procedure in the ambulatory setting. For example, in Pennsylvania, children <6 months of age may not undergo surgery in an ASC.[13] Although these regulatory restrictions may not be based on current evidence, they must be followed.

The type of surgical facility also influences patient selection.[14] Unlike an ambulatory surgical facility that is physically connected to a hospital, a freestanding ASC may not be able to perform procedures on and care for patients of higher acuity because of lack of consultation and ancillary services, as well as lack of laboratory or blood bank services. Certain low-risk procedures such as cataract surgery or cystoscopy may be safely performed at freestanding ASCs on higher risk patients who would not qualify for a more invasive procedure at the same facility. Patient selection should be customized to each ASC based on its location and availability of consult and ancillary services.

SURGICAL PROCEDURE AND PATIENT SELECTION

Improvements in surgical technique and equipment have made it possible for surgical procedures that were previously solely performed in the hospital setting to migrate to the ambulatory setting. These include total joint replacement, spine surgery, bariatric surgery, and hysterectomy, to enumerate just a few. Procedure-related factors that may influence perioperative outcomes include invasiveness of the surgical procedure, duration of surgery, potential blood loss and need for blood transfusion (intraoperative and postoperative), ability to control postdischarge pain with oral analgesics and/or local/regional techniques, and need for specialized postoperative care including postoperative parenteral therapy. The limit on duration of surgery remains controversial due to lack of good evidence suggesting that duration of surgery influences rates of transfer, admission, or acute care visits after ambulatory surgery. ASCs are well advised to develop procedure-specific enhanced recovery pathways[15] and patient selection criteria.[16–20]

SOCIAL FACTORS AND PATIENT SELECTION

Social factors that play a role in patient selection include availability of a responsible individual to receive discharge instructions, transport the patient to and from the ASC, and provide any necessary postdischarge care. Although this is outside the focus of this review, the debate regarding the need for a responsible escort is ongoing, as the evidence regarding the safety of discharging a patient home alone is equivocal.[21–23]

The American Society of Anesthesiologists (ASA) recommends that a responsible individual receive discharge instructions and escort the patient who has received sedation or general anesthesia.[24,25] Likewise, regulatory agencies such as Accreditation Association for Ambulatory Healthcare (AAAHC) and The Joint Commission (TJC) recommend that the patient who has received moderate/deep sedation or general or regional anesthesia be discharged

Table 1. ASA-PS Classification

ASA-PS classification	Definition	Adult examples, including, but not limited to
I	A normal healthy patient	Healthy, nonsmoking, no or minimal alcohol use
II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (30 kg/m^2 < body mass index <40 kg/m^2), well-controlled diabetes mellitus or hypertension, mild lung disease
III	A patient with severe systemic disease	Substantive functional limitations; 1 or more moderate to severe diseases. Examples include (but not limited to): poorly controlled diabetes mellitus or hypertension, chronic obstructive pulmonary disease, morbid obesity (body mass index ≥40 kg/m^2), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, end-stage renal disease undergoing regularly scheduled dialysis, history (>3 mo) of myocardial infarction, cerebrovascular accident, transient ischemic attack, or coronary artery disease/stents
IV	A patient with severe systemic disease that is a constant threat to life	Examples include (but not limited to): recent (<3 mo) myocardial infarction, cerebrovascular accident, transient ischemic attack, or coronary artery disease/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, disseminated intravascular coagulation, adult respiratory distress, or end-stage renal disease not undergoing regularly scheduled dialysis
V	A moribund patient who is not expected to survive without the operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
VI	A declared brain-dead patient whose organs are being removed for donor purposes	

Abbreviation: ASA-PS, American Society of Anesthesiologists physical status.
The addition of "E" denotes emergency surgery: an emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part.

in the company of a designated responsible individual unless exempted by the attending physician. According to the Medicare conditions of participation, the ultimate decision rests with the attending anesthesiologist and surgeon.[25]

Poor health literacy of the patient and caregiver is an important consideration because it has been shown to influence compliance with postoperative instructions and is associated with higher rates of acute care visits or readmission to the hospital.[26,27] Thus, these patients may not be suitable for certain types of outpatient procedures that require patient and caregiver investment in the recovery process. Similarly, patients' living conditions can impact postoperative care. Social factors need to be considered when determining where to schedule a patient for surgery (ie, inpatient versus outpatient setting). A large database study of 1,328,708 procedures performed in 86 freestanding ASCs in South Carolina from 2006 to 2013 found that Medicaid insurance and lowest median household income were associated with the highest postoperative acute care use within 7 days.[28] This study highlights the importance of clear communication regarding postoperative follow-up. Although not within the scope of this review, postdischarge disposition (home versus nonhome discharge) may play a role in decision-making as it might influence postoperative outcomes and costs.[29,30]

PATIENT COMORBID CONDITIONS AND PATIENT SELECTION

Several comorbid conditions have been shown to influence postoperative outcomes after outpatient surgery and therefore play a major role in patient selection. Independent factors identified by most studies include ASA physical status (ASA-PS) classification, advanced age, obesity (body mass index [BMI]), obstructive sleep apnea (OSA), cardiac disease, chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), end-stage renal disease (ESRD), transient ischemic attack (TIA)/stroke, chronic opioid use or opioid use disorder, and malignant hyperthermia (MH).

ASA Physical Status

The ASA-PS classification is widely used by anesthesia and nonanesthesia clinicians to assess a patient's overall health (Table 1). The classification system has been subject to criticism due to its subjective nature and lack of interrater reliability in clinical practice.[31] Nevertheless, the ASA-PS has endured and currently is regarded as a predictor of perioperative risk and a marker of overall health.[31,32] The ASA-PS has been associated with mortality, complication rates, costs, and unexpected admissions after ambulatory surgery, and correlates with the Charlson Comorbidity Index and the Revised

Cardiac Risk Index (RCRI).[32,33] The addition of examples to the definitions of the ASA-PS classification[34] was found to improve ASA-PS assignments in 1 study[35] and found to have no impact in another study.[36]

Ambulatory surgery patients are no longer solely ASA-PS I and II, and it is increasingly common and acceptable to encounter patients that are ASA-PS III (Table 2).[37] Although patients with ASA-PS IV or higher are generally not considered suitable candidates for most ambulatory surgical procedures at ASCs, those with stable comorbid conditions may undergo low-risk procedures such as cataract surgery performed under topical or local anesthesia with the caveat that visual outcomes tend to be poorer in patients with higher ASA-PS.[38]

Age

The aging world population has resulted in larger numbers of older patients presenting for ambulatory surgery. Aging is associated with comorbid conditions. The physiological effects of aging combined with the stress of surgery and anesthesia would be expected to adversely impact recovery. Several observational trials have reported an association between increasing age and increased adverse outcomes after ambulatory surgery,[3–8,39,40] particularly with age >80 years. However, it is increasingly realized that rather than age, patients' comorbidities including preoperative cognitive dysfunction, functional impairment, and frailty are associated with increased postoperative morbidity.[41–45] A recent study found that 16% of older patients presenting for outpatient surgery had

Table 2. Summary of Recommendations

Comorbidity	Summary of recommendations
ASA physical status	• ASA physical status III patients should have optimized stable comorbidities • ASA physical status IV patients with stable comorbid conditions may undergo low-risk procedures such as cataract surgery performed under topical/local/regional anesthesia
Age/frailty	• Age alone should not be an exclusion factor. Consider comorbid conditions, frailty, cognitive status, surgical, anesthetic, and social factors such as lack of home care support or unwillingness of patient to comply
Obesity	• BMI <40 kg/m^2: suitable for ambulatory surgery • BMI 40–50 kg/m^2: optimize comorbidities and screen for obstructive sleep apnea • BMI >50 kg/m^2: schedule as outpatient for low-risk procedures in the absence of severe cardiopulmonary comorbidities
Obstructive sleep apnea	• Screen for obstructive sleep apnea and optimize comorbidities • Preoperative sleep study is not required • Encourage positive airway pressure use in compliant patients • Pain control with multimodal nonopioid analgesia
Cardiac disease	• Asymptomatic cardiac patients do not require cardiac testing • Do not postpone surgery based solely on a blood pressure values. Delay only for patients with malignant hypertension (diastolic blood pressure >110 mm Hg) with acute end-organ damage • Exclude for at least 30 d after acute myocardial infarction • Exclude only for patients with decompensated, new onset, or untreated heart failure as well as symptomatic patients with low (<35%) left ventricular ejection fraction • Exclude symptomatic (fatigue, dizziness, syncope, palpitations, chest pain, and shortness of breath) patients with new onset atrial fibrillation • Exclude symptomatic (chest pain, dyspnea, syncope, and poor exercise tolerance) patients severe valvular heart disease • Patients with coronary stents are suitable if comorbidity burden is low, sufficient time has elapsed since stent implantation (30 d for BMS, 6 mo for newer DES, 12 mo for older DES) allowing for interruption of dual antiplatelet therapy, patient has transitioned to a state of stable ischemic coronary disease, or if procedure is noninvasive, allowing continuation of dual antiplatelet therapy with low risk of bleeding. • Patients with cardiac electronic implantable devices are suitable if the potential for electromagnetic interference is low, and with ability to manage the device if use of magnet or reprogramming is necessary
Chronic obstructive pulmonary disease	• Exclude severe disease. Encourage smoking cessation, optimize bronchodilator therapy, treat respiratory infection
Diabetes mellitus	• Continue antidiabetic drugs, as appropriate • Resume oral intake and hypoglycemic regimen as soon as possible postoperatively • Exclude unstable metabolic conditions such as diabetic ketoacidosis, and nonketotic hyperosmolar states
End-stage renal disease	• Exclude if not on dialysis, optimize comorbidities, accept chronic anemia and asymptomatic hyperkalemia ($K \leq 6.0$)
Previous stroke/transient ischemic attack	• Delay elective surgery for at least 9 mo • Manage antiplatelet therapy
Malignant hyperthermia susceptible	• Proceed as outpatient using nontriggering anesthetics • Malignant hyperthermia cart and dantrolene available in facility
Chronic pain/opioid use disorder	• Procedures with expected mild/moderate pain manageable with nonopioid analgesia including local/regional analgesia may be scheduled as outpatient • Procedures with expected severe pain or requiring tapering of maintenance regimens should be scheduled as inpatient

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; BMS, bare metal stent; DES, drug-eluting stent.

preoperative cognitive impairment.[46] Multivariable factors associated with preoperative cognitive impairment included non-Hispanic ethnicity, African American race, prior stroke, preoperative functional dependence, and lower socioeconomic status and education level.[46]

Frailty is associated with increased perioperative morbidity and readmissions after ambulatory procedures independent of age, comorbidities, and anesthesia type.[42–45] Frailty encompasses multiple dimensions including functional capacity, nutritional status, mental health, and cognition and renders an individual less tolerant to external stress. Unfortunately, there are currently over 60 instruments to measure frailty with no consensus on a simple bedside assessment test of frailty.[43,47] Nevertheless, the Clinical Frailty Scale is easy to administer and provides prognostic information (Figure 1).[47,48]

Overall, a patient's age should not be the sole consideration in determining suitability of surgery in an ASC (Table 2). Additional factors such as the presence of uncontrolled comorbid conditions (ie, ASA-PS), preoperative cognitive function, frailty, and invasiveness of the surgical procedure should also be considered. It can be argued that outpatient surgery may be beneficial for older patients by allowing them to recover in a familiar environment. A small study (n = 372) of older patients undergoing minor surgery under general anesthesia found a lower risk of postoperative cognitive dysfunction in outpatients compared with inpatients.[49] More importantly, social circumstances such as availability of an appropriate caregiver, the process of informed consent and power of attorney documentation, and the risks and benefits of the procedure and the need, if any, for enhanced support at home should be considered.

Obesity

The prevalence of obesity is increasing worldwide.[50] Obesity is associated with increased comorbidities that are likely to adversely impact perioperative outcomes.[51,52] A systematic review from 2013 concluded that there was insufficient evidence at that time to make strong recommendations about selection of obese patients for ambulatory surgery.[53] Studies included were observational cohort studies and were heterogeneous with respect to anesthetic technique and surgical procedures. The authors did suggest that patients with BMI ≤40 kg/m^2 could undergo ambulatory surgery if comorbidities are optimized before surgery. In contrast, super obesity (BMI >50 kg/m^2) was associated with increased postoperative morbidity and mortality and therefore caution should be used when selecting these patients for ambulatory surgery.[53] For patients with BMI between 40 and 50 kg/m^2, thorough preoperative assessment should identify obesity-related comorbid conditions with the goal of excluding patients with obesity-hypoventilation syndrome, severe pulmonary hypertension, severe coronary artery disease (CAD), or heart failure (HF). In addition, there was emphasis on identifying patients with OSA.

Several recent studies have evaluated the influence of BMI and outcomes after ambulatory surgery.[54–57] A study assessing a matched cohort of obese and nonobese patients from the National Survey of Ambulatory Surgery database found no association between BMI and the incidence of adverse postoperative outcomes, delayed discharge, and unplanned hospital admission.[54] Another study evaluating the association between BMI and 30-day readmission rate found that a BMI ≥50 kg/m^2 may be used as a sole cutoff for selecting patients undergoing ambulatory joint arthroscopy.[55] In contrast, a study of ambulatory hernia repair cases (n = 214,125) from the 2012–2016 American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) found that there was no association between BMI and readmissions at 24 hours and 2 days after surgery.[56] Also, there was no clear cutoff value of BMI that could be used to determine appropriateness of patient selection in the ambulatory setting.[56]

Overall, BMI should not be the sole determining factor in patient selection and should be considered in conjunction with the type of surgical procedure, the extent and number of comorbidities, and functional capacity, as well as equipment constraints since most equipment have weight limits (Table 2). The super morbidly obese (ie, BMI >50 kg/m^2) should be chosen carefully as they have higher incidence of perioperative complications and readmission rates.[53–56] Of note, BMI is an inaccurate indicator of adiposity since it makes no distinction between lean muscle mass and body fat.[57,58] Other measures of adiposity such as waist circumference and waist hip ratio seem to be useful in the perioperative setting.[59] Thus, future studies should assess the association between combination of BMI and waist circumference and postoperative outcomes.[60]

Obstructive Sleep Apnea

OSA is the most common type of sleep-disordered breathing characterized by partial or total airway collapse leading to hypopnea, apnea, hypoxia, hypercapnia, and sleep fragmentation. In the United States, an estimated 13% of men and 6% of women between the ages of 30 and 70 years have moderate to severe sleep-disordered breathing.[61] Although OSA can exist in patients with normal BMI, it is strongly associated with obesity. Numerous studies in hospitalized patients have reported association between OSA and adverse perioperative outcomes including reintubation, need

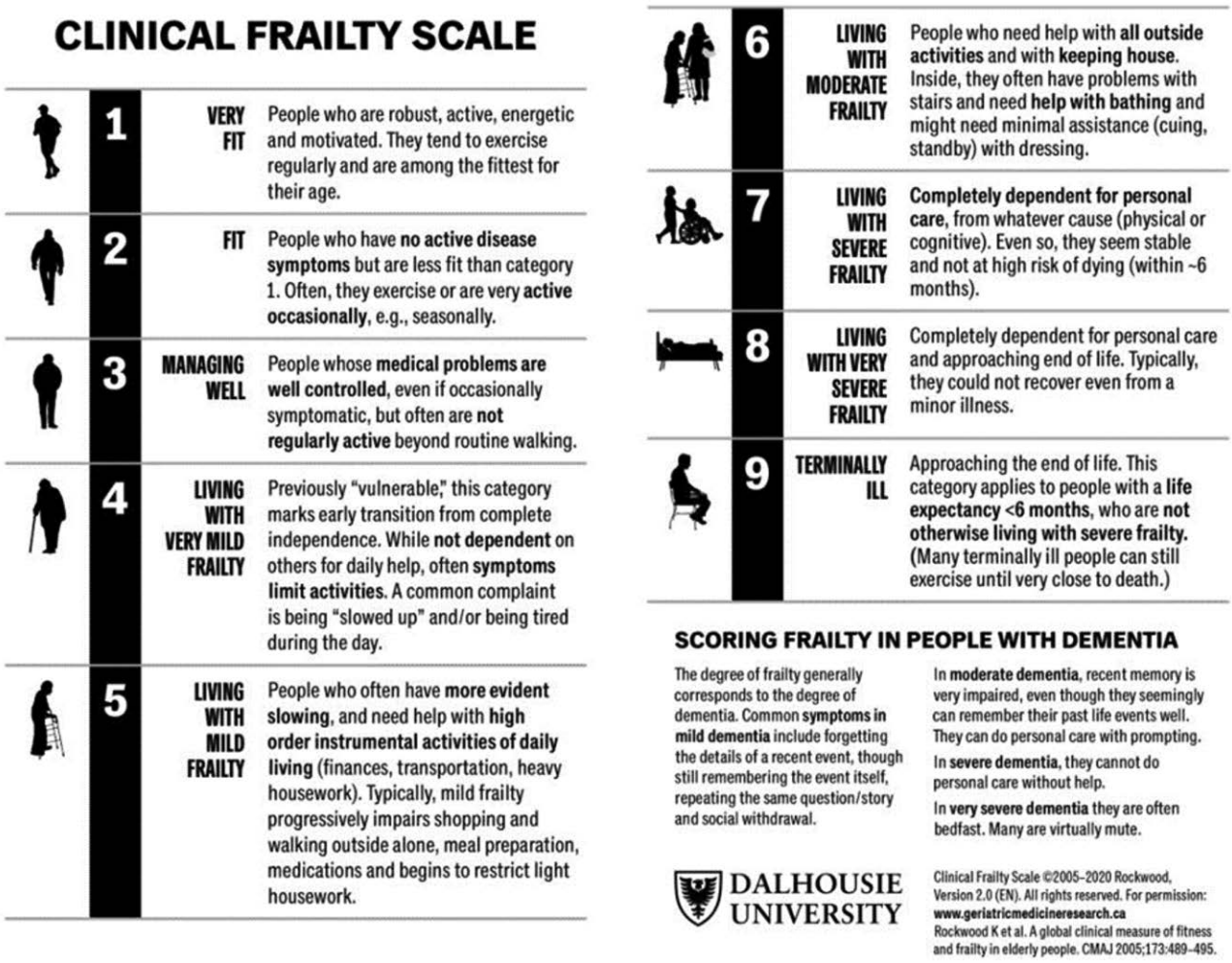

Figure 1. Clinical Frailty Scale. Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7458601/figure/f1-cgj-23-210/. Reprinted with permission.

for noninvasive ventilation, and adverse cardiac outcomes.[62,63] However, the evidence linking OSA with perioperative complications is marred by inconsistent quality, heterogeneity, and inability to clearly establish OSA, as opposed to the various comorbidities associated with it, as an independent risk factor for adverse outcomes. The vast majority of surgical patients do not have an established diagnosis of OSA or, if they do, are not compliant with prescribed positive airway pressure (PAP) therapy.[64,65]

Because undiagnosed OSA is common, and failure to recognize OSA preoperatively is one of the major causes of perioperative complications, the Society for Ambulatory Anesthesia (SAMBA) and the Society of Anesthesia and Sleep Medicine (SASM) recommend screening patients for OSA.[64,65] Of the variety of screening tools available,[66–68] the Snoring, Tiredness, Observed apnea, blood Pressure, Body mass index, Age, Neck circumference and Gender questionnaire is the most validated and studied in the surgical populations and recommended by both SAMBA and SASM. A score of 5 or higher indicates a presumptive diagnosis of OSA.

If OSA is suspected based on screening tools (presumptive diagnosis), there is insufficient evidence to delay or cancel a procedure to obtain a polysomnography or PAP therapy.[64,65] However, it is important to carefully evaluate for and ensure optimization of comorbidities. The SASM guidelines recommend additional testing for OSA patients who present with signs of hypoventilation or hypoxia or poorly controlled systemic comorbidities.[65] Patients compliant with PAP therapy should be instructed to use their device postoperatively, when appropriate. Patients unable or unwilling to use PAP therapy or those with a presumptive diagnosis of OSA may be considered for ambulatory surgery if their comorbid conditions are optimized and if postoperative pain relief can be provided predominantly with nonopioid analgesic techniques (Table 2; Figure 2).[64]

The OSA patients undergoing airway surgery may be at higher risk of complications due to airway swelling and bleeding exacerbating the OSA. A recent consensus statement recommends an overnight clinical setting for the following procedures:

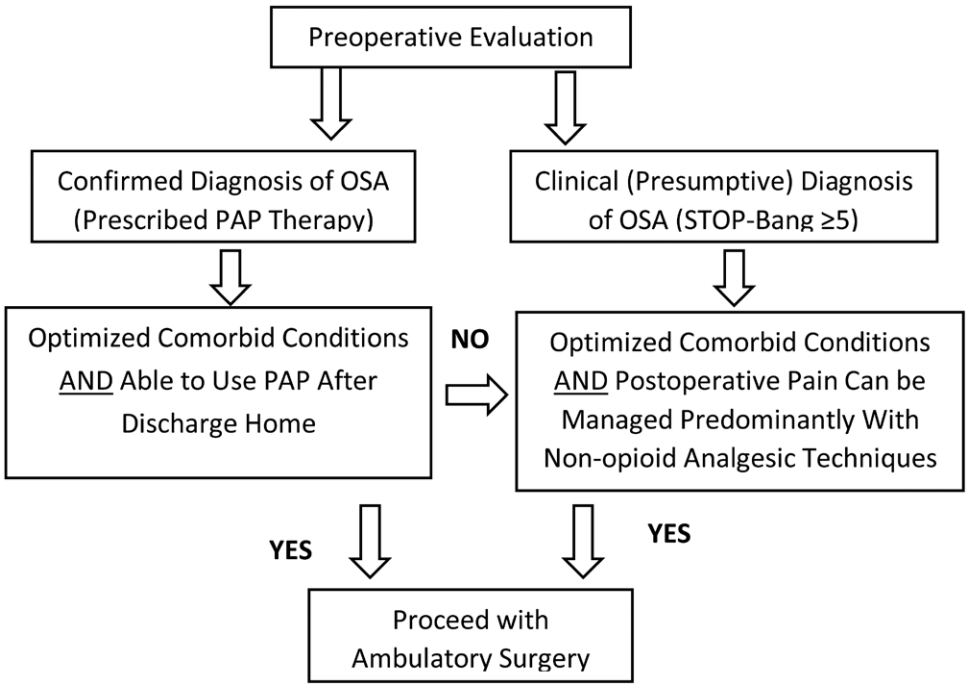

Figure 2. Decision-making in preoperative selection of a patient with obstructive sleep apnea scheduled for ambulatory surgery. Modified with permission from Joshi et al.[64] OSA indicates obstructive sleep apnea; PAP, positive airway pressure; STOP-BANG, Snoring, Tiredness, Observed apnea, blood Pressure, Body mass index, Age, Neck circumference and Gender.

maxillomandibular advancement, lower invasive pharyngeal surgery, and some invasive palatal surgeries.[69] Outpatient setting may be suitable for the following: minimally invasive surgery, nasal surgery, and hypoglossal nerve stimulation.[69] It is also important when caring for these patients to be prepared to manage difficult intubation and extubation. Analysis of ASC-NSQIP database found that the complications and 30-day readmission rates after airway surgery for OSA are low.[70] Also, there were no significant differences in the composite outcome of 30-day readmissions, reoperations, or complications between inpatient and outpatient settings. Patients with high ASA-PS (III or IV) and/or DM scheduled for airway procedures that include base-of-tongue surgery or long multiple operations may be at higher risk of postoperative complications, which could be used for triaging patients to the inpatient versus outpatient setting.[70]

Cardiac Disease

A variety of chronic conditions affecting the cardiovascular system such as hypertension, CAD, HF, atrial fibrillation (AF), and valvular heart disease, as well as the presence of coronary artery stents, and cardiac implantable electronic devices (CIEDs) may impact the suitability of patients for outpatient surgery. It is important to assess for the presence and severity of these conditions when selecting patients for outpatient surgery.

Hypertension. Typically, preoperative diastolic blood pressure (DBP) >110 mm Hg and/or systolic blood pressure (SBP) >200 mm Hg are used to determine suitability for elective surgery because they have been linked to increased risk of perioperative complications, including dysrhythmias, myocardial ischemia or infarction, stroke, and renal failure.[71,72] Furthermore, exaggerated hypertensive responses to airway manipulation and surgical stimulation as well as labile intraoperative blood pressure may occur in patients with poorly treated or untreated hypertension. However, there is little evidence to support that hypertension increases adverse events in patients undergoing ambulatory surgery. The Association of Anaesthetists of Great Britain and Ireland and the British Hypertension Society recommends that patients with poorly controlled blood pressures despite appropriate management presenting with blood pressure readings <180/110 mm Hg in the preoperative clinic may be reasonable candidates for elective surgery.[73] The Perioperative Quality Initiative consensus statement on preoperative blood pressure, risk and outcomes for elective surgery states that elective surgery should not be cancelled based solely on blood pressure values.[74] Also, there is insufficient evidence to support lowering blood pressure in the immediate preoperative period to minimize perioperative risk. Surgery should be delayed only for patients with malignant hypertension defined as DBP >110 mm Hg with acute end-organ damage or symptoms thereof.

Coronary Artery Disease. The risk of ischemic heart disease needs to be stratified before deciding if a patient

is suitable for ambulatory surgery. Risk stratification is based on published algorithms, risk index calculators, the patient's functional capacity, and the invasiveness of the surgical procedure. A stepwise approach to cardiac risk stratification recommended by the American College of Cardiology (ACC)/American Heart Association (AHA) guideline is commonly used.[75] For asymptomatic patients presenting for elective surgery, a key step in the algorithm is the calculation of the risk of perioperative major adverse cardiac events (MACE) based on combined clinical and surgical risk factors. Patients undergoing procedures of low invasiveness do not require cardiac testing because the risk of cardiac complications after this type of outpatient surgery is very low (<1%). Patients with a calculated risk of MACE <1% and with at least moderate functional capacity (≥4 metabolic equivalents) can also proceed with surgery without further testing. Other risk calculators include the NSQIP database risk model (www.riskcalculator.facs.org) and the RCRI.[76,77] Patients who had a recent coronary event deserve further considerations. Elective surgery should be delayed at least 30 days after acute myocardial infarction.

Heart Failure. The literature on outcomes in patients with HF after ambulatory surgery is scarce.[78] While there are no data specific to ambulatory surgery, HF was a significant risk factor for postoperative morbidity and mortality even in asymptomatic patients and those with preserved ejection fraction.[16,79] A large prospective matched-control study showed greater risks of all-cause and cardiac mortality, cardiovascular and HF hospitalizations in patients with decreased (<35%) left ventricular ejection fractions (LVEF) in any clinical setting.[80] Therefore, patients with decompensated, new onset, or untreated HF should be optimized before proceeding to ambulatory surgery. Similarly, it may be prudent to avoid invasive surgical procedures in patients with very low LVEF in freestanding ASCs.

Atrial Fibrillation. In addition to decreased ventricular function and HF, AF is associated with increased risk of stroke and is found in one-third of all ischemic strokes.[81] When AF is chronic and optimized, it seems reasonable to allow patients to have surgical procedures done in outpatient settings. In contrast, new-onset AF has been associated with increased incidence of perioperative morbidity and mortality.[82] Therefore, patients with symptomatic (fatigue, dizziness, syncope, palpitations, chest pain, and shortness of breath) new-onset AF may not be suitable for ambulatory surgery.

Many patients with chronic AF are treated with warfarin, or non–vitamin K oral anticoagulants, including dabigatran, rivaroxaban, apixaban, and edoxaban for stroke prevention. These medications may need to be discontinued before surgical procedures that involve risk of perioperative bleeding or hematoma. The most recent ACC/AHA guidelines indicate that "for patients with AF without mechanical heart valves who require interruption of warfarin for procedures, decisions about bridging therapy (unfractionated heparin or low-molecular-weight heparin) should balance the risks of stroke and bleeding and the duration of time a patient will not be anticoagulated."[83] For outpatient surgery, bridging is generally not required or recommended because of low risk of stroke after short interruption of oral anticoagulant. The decision on when to withhold oral anticoagulants before surgery depends on various factors, including the type of medication, the bleeding risk of the procedure, the expected clearance time of the drug, and the patient's kidney function. Warfarin should be stopped about 5 to 6 days before surgery. In patients with normal renal function, dabigatran, rivaroxaban, apixaban, and edoxaban should be stopped 2 days before low-bleeding risk surgical procedures and 3 days before high-bleeding risk surgery.[84,85] Patients receiving neuraxial anesthesia should interrupt dabigatran 4 to 5 days before surgery and apixaban and rivaroxaban at least 3 days before surgery.[86]

Valvular Heart Disease. Patients may present to outpatient procedures with heart murmurs that have not been previously diagnosed. A diastolic murmur may be caused by mitral stenosis, while a systolic murmur may be a sign of aortic or pulmonic stenosis, mitral or tricuspid regurgitation, ventricular septal defect, or hypertrophic cardiomyopathy. Patients with mild or asymptomatic valvular disease are usually at low risk of perioperative complications and may be appropriate candidates for outpatient procedures. Patients with severe aortic or mitral valve stenosis are of particular concern. Echocardiographic criteria for severe aortic stenosis include a valve area ≤1.0 cm^2, a maximum flow velocity <4 m/s, or mean pressure gradient >40 mm Hg. Severe mitral stenosis is characterized as a valve area ≤1.5 cm^2 with pulmonary artery systolic pressure >30 mm Hg. Patients with echocardiographic signs of severe valvular disease may still proceed to ambulatory surgery for minor procedures if they are asymptomatic and have normal ventricular function. However, patients with symptoms of chest pain, dyspnea, syncope, and poor exercise tolerance are not suitable candidates for ambulatory surgery.[87]

Coronary Artery Stents. Patients with coronary artery stents receive dual antiplatelet therapy (DAPT) for a minimum of 30 days after bare metal stent

(BMS) implantation, 12 months after older drug-eluting stent (DES), and 6 months after newer DES.[88] Appropriate selection of patients with coronary stents for ambulatory procedure requires consideration of factors that affect the balance between the risk of stent thrombosis due to interruption of DAPT and the thrombogenic effects of surgery, and the risk of perioperative bleeding complications that may occur if DAPT is continued.[75,89,90] The invasiveness and complexity of the surgical procedure is one of the main determinants of suitability for ambulatory surgery because it influences not only the risk of stent thrombosis but also the risk of perioperative bleeding complications.[91] Ambulatory surgery may be suitable in patients with lower comorbidity burden, if they can safely continue DAPT (eg, cataract surgery under topical/regional anesthesia) or after longer time since stent implantation (typically those receiving only aspirin therapy).

Cardiac Implantable Electronic Devices. Patients with CIEDs have a high burden of cardiovascular comorbidities, including advanced CAD, cardiomyopathy, and survival from sudden cardiac arrest, thus placing them at a high risk of perioperative complications.[92–94] However, not all patients with CIED are contraindicated for the ambulatory setting. Suitability of patients with CIEDs for ambulatory surgery should be determined based on a combination of factors, including the potential for electromagnetic interference, the type, location and invasiveness of the procedure, the CIED type, and indication for CIED implantation as well as the patient's cardiovascular risk factors.[95] Safe care of CIED patients requires a thorough preoperative evaluation, ability to manage unforeseen events, and postdischarge follow-up by the patients' primary physician and/or cardiologist. Technical support from a CIED team or device manufacturer may be necessary preoperatively to reprogram the device (turn off the antiarrhythmia functions or pace in asynchronous mode) as well as verify the integrity of the CIED function and restore it to the preoperative parameters before discharge home.[96–98] Of note, postoperative interrogation for integrity of modern CIEDs can be performed remotely.

Chronic Obstructive Pulmonary Disease

COPD has been identified as an independent risk factor for adverse outcomes after ambulatory surgery.[4–6,99] A recent systematic review and meta-analysis concluded that frailty is common in individuals with COPD.[100] Selecting a patient with COPD for ambulatory surgery requires consideration of the severity of the disease including symptoms and functional capacity restriction as well as assessment of compliance with therapy. Patients with severely diminished forced expiratory volume in 1 second (FEV1 < 0.75 of vital capacity) are at risk for respiratory complications and probably not good candidates for outpatient surgery.[101] Modifiable components of the comorbidity including smoking, reversible airway obstruction, and acute respiratory illness or infection should be optimized and treated before ambulatory surgery. Use of home oxygen is not a contraindication to outpatient surgery in an otherwise well-optimized patient.[101]

Diabetes Mellitus

The Centers for Disease Control and Prevention (CDC) National Diabetes Statistics Reports estimate that 10.5% of the US population has DM and 34.5% of the adult US population has prediabetes. DM usually coexists with a variety of comorbidities including obesity, CAD, hyperlipidemia, gastroesophageal reflux, gastroparesis, and neuropathy, all of which can impact perioperative outcomes. In addition, DM patients have higher risk of poor wound healing and surgical site infections. A question frequently asked by clinicians and patients is whether there is a preoperative blood glucose level above which one should postpone elective surgery. Although threshold values of blood glucose or glycosylated hemoglobin A1c (HbA1c) levels above which elective ambulatory surgery should be postponed have not been determined, a consensus statement from SAMBA recommends that in patients with good long-term blood glucose control, surgery should be postponed only in patients with significant complications of hyperglycemia such as severe dehydration, ketoacidosis, and hyperosmolar nonketotic states.[102] The adequacy of preoperative blood glucose control can be assessed by measurement of HbA1c levels.

The ambulatory setting provides an advantage in managing DM in terms of minimal disruption of oral intake and quick resumption of home medications. The principal aims in the management of the diabetic patient in the ambulatory setting are maintenance of appropriate blood glucose control, avoiding hypoglycemia, minimizing changes to antidiabetic therapy, and resuming oral intake as soon as possible after surgery.[102] Detailed description of the perioperative management of the DM patient is out of the scope of this review.

End-Stage Renal Disease

The number of patients with ESRD in the United States was 746,557 in 2017, and increased by 2.6% compared with 2016.[103] Both chronic kidney disease and ESRD are associated with significant health consequences for patients including HF, hypertension, hyperlipidemia, DM, cognitive decline, physical limitations, and mortality.[104] ESRD patients frequently present for a

variety of ambulatory procedures including vascular access, cataract surgery, and urologic procedures.

A study of the safety of elective outpatient laparoscopic cholecystectomy found higher complication rates in patients on dialysis and identified HF and prior cardiac surgery as independent predictors of longer length of stay and mortality.[105] This highlights the importance of careful patient selection in patients with ESRD. Considerations for safe management of these patients in the ambulatory setting include optimization of comorbid conditions while accepting chronic anemia and chronic cardiac ischemia, dialysis on or the day before surgery while accepting most recent postdialysis laboratory values, and anticipation of difficult intravenous access. Of note, asymptomatic hyperkalemia may not be an absolute contraindication to vascular access surgery.[106]

Previous studies have demonstrated the safety of arteriovenous fistula (AVF) creation surgery in the outpatient setting, particularly when performed under local or regional anesthesia.[107–109] A recent comparison of postoperative complications after AVF surgery in the inpatient and outpatient setting showed a significantly lower rate of admissions and total hospital visits within 7 days for outpatient AVF creation.[110] Although patients undergoing access creation surgery in an ambulatory setting have a high risk of 30-day readmission, it is primarily due to causes unrelated to their surgery.[111]

TIA and Stroke

Patients who have had a stroke or TIA remain at an elevated risk for postoperative MACE or mortality when they undergo subsequent elective surgery.[112,113] Patients who have had a stroke or TIA <3 months ago are by definition ASA-PS IV (Table 1) and may not be good candidates for elective surgery. A large, Danish cohort study examined the risk of postoperative MACE including ischemic stroke, acute myocardial infraction (MI), and cardiovascular mortality and all-cause mortality up to 30 days after surgery in all adult patients undergoing elective noncardiac surgery.[112] Compared with patients without stroke, odds ratios for MACE were 14.23 for stroke <3 months before surgery, 4.85 for stroke 3 to 6 months prior, 3.04 for stroke 6 to 12 months prior, and 2.47 for stroke >12 months prior. MACE risks were at least as high for low risk and intermediate risk as they were for high-risk surgery.[112] Even after 12 months, the risk of MACE remains twice as high in this population.[113] It was recommended that elective surgery be delayed at least 9 months in this population.

These patients are also on antiplatelet therapy. The 2014 ACC/AHA guidelines and the 2014 European Society of Cardiology (ESC)/European Society of Anaesthesiology (ESA) guidelines both conclude that the perioperative management of aspirin should be based on a comprehensive individual risk-benefit assessment, weighing the perioperative bleeding risk associated with both the type of surgery and patient factors against the thrombotic risk.[75,114]

Chronic Opioid Use or Opioid Use Disorder

With the increasing prevalence of opioid use disorder, ambulatory facilities are seeing a greater proportion of patients with preexisting chronic pain with opioid use disorder. These patients present a unique challenge in terms of perioperative pain management. Preoperative opioid use is reported to be a risk factor for postoperative complications and need for revision surgery.[115]

Safe management of these patients in the ambulatory setting requires careful coordination of care between the anesthesiologist, the surgeon, and the pain physician.[116] Whether these patients are suitable for the ambulatory setting is determined by considering the degree of anticipated postoperative pain, feasibility of multimodal analgesia including local/regional analgesia, and patient expectations. It is recommended that these patients continue their pain medications or maintenance medications preoperatively, and perioperative analgesia be administered by a combination of nonopioid analgesics and local/regional analgesia.[117,118]

Most medication-assisted treatment strategies for patients with opioid use disorder consist of either buprenorphine or methadone. Buprenorphine has several advantages over methadone for the treatment of opioid use disorder, including less potential for abuse and greater flexibility in prescribing.[119] The pharmacokinetic properties that make buprenorphine safe also interfere with effectiveness of simultaneously administered opioids for acute pain. Since the passage of the Drug Addiction Treatment Act of 2000, sublingual buprenorphine/naloxone (Suboxone, Reckitt Benckiser Pharmaceuticals, Slough, England, United Kingdom) and sublingual buprenorphine (Subutex, Reckitt Benckiser Pharmaceuticals, Slough, England, United Kingdom) have been used for outpatient opioid detoxification, addiction therapy, and chronic pain treatment.[119,120] There is no high-level evidence on optimal acute pain management strategies for patients taking buprenorphine.[120] We recommend that for procedures with mild to moderate anticipated pain, amenable to oral nonopioid analgesics or for procedures with pain likely to be well controlled with local/regional analgesia, patients may continue buprenorphine preoperatively and be managed in the ambulatory setting. For more severely painful procedures or if tapering of buprenorphine is required, consultation with the pain physician and the inpatient setting may be preferable.

Methadone is a synthetic mu-opioid agonist. It also antagonizes *N*-methyl-D-aspartate receptor and inhibits the reuptake of serotonin and norepinephrine. Preoperative methadone should be continued and acute pain be managed by a combination of nonopioid and/or local/regional analgesia with the caveat that if the patient requires opioid analgesics postoperatively, the dose required may be higher. Be mindful that methadone can lead to serotonin syndrome if given with other serotonergic drugs such as serotonin and norepinephrine reuptake inhibitors.[121] In addition, there are concerns of QT interval prolongation, which might result in Torsades de Point and sudden cardiac death. The American Pain Society and Heart Rhythm Society recommend baseline electrocardiogram in patients with the following risk factors: age >68 years, female gender, history of liver disease, history of electrolyte abnormalities, structural heart disease, genetic predisposition, concomitant use of QT-prolonging drugs, or previous history of syncope.[122] These factors could be included in preoperative screening.

Considerations for patients on naltrexone are as follows: while patients may be resistant to opioids during treatment with naltrexone, they may become extremely opioid sensitive once stopping it. The current recommendation is to discontinue oral naltrexone 72 hours before surgery and depot naltrexone 1 month before elective surgery, if possible. Nonopioid analgesic regimens are preferable and if not possible, the patient should be managed in an inpatient setting.[123]

Malignant Hyperthermia

MH is a rare but potentially fatal pharmacogenetic disorder triggered by exposure to inhaled anesthetics and succinylcholine. Analysis of the New York State Ambulatory Surgery Dataset for the years 2002–2011 found a prevalence of recorded MH diagnosis in ASC patients of approximately 1 per 500,000.[124] A position statement from SAMBA and the ASA Ambulatory Surgical Care Committee states that MH susceptible patients can safely undergo a surgical procedure in a freestanding ASC as long as the patient is administered a nontriggering anesthetic.[125] Preoperative dantrolene prophylaxis, point of care blood gas analysis, and extended observation in recovery are not indicated. It is recommended that all anesthetizing facilities prepare for the eventuality of a MH event.[126] Simulation drills based on best practices are recommended as they minimize human errors, enhance communication and teamwork, reduce organizational failures, and reduce variability in patient care.[127]

The Malignant Hyperthermia Association of the United States (MHAUS) recommendation of stocking dantrolene in facilities that administer triggering agents is advised because the cost of delaying dantrolene administration can have catastrophic repercussions as the likelihood of a complication increased 1.61 times for every 30-minute increase in time between the first sign of MH and the time of the first dantrolene dose.[128,129] It is also recommended that ambulatory facilities have a protocol for preparing the anesthesia workstation for an MH-susceptible patient and a transfer protocol from the ASC to the hospital, if the patient displays symptoms and signs suspicious for MH.[130,131]

SUMMARY

The process of patient selection for ambulatory surgery needs to be a careful consideration of the interplay of patient, procedure, anesthetic, social, and system factors (Table 2). Development of prediction tools that would allow determination of procedure suitability and patient eligibility for the ambulatory setting should improve patient safety.[10] Procedure-related predictors of adverse outcomes could be used to determine the optimal surgical setting as well as allow triaging of high-risk patients for preoperative optimization.[13] Developing and implementing protocols (or clinical pathways) for patient selection and prehabilitation would further enhance patient safety and efficiency.[15] This requires a multidisciplinary approach in which the anesthesiologist should take a lead in collaborating with the surgeons and the perioperative nurses.[15,132] Conundrums likely to be faced by ambulatory anesthesiologists in the near future include caring for recently hospitalized patients, patients using medical or recreational marijuana, patients with learning disabilities and or psychiatric illnesses, and patients with post–coronavirus disease 2019 (COVID-19) syndrome. While none of these conditions preclude outpatient surgery, these patients may require specific preparation and considerations before and on the day of surgery. In the future, as more patients and surgical procedures are moved from inpatient to outpatient facilities, it is advisable to develop procedure-specific exclusion criteria for patients that are not candidates for ambulatory surgery. A pragmatic question to ask is: Will postoperative hospitalization influence patient care or perioperative outcome? If no improvement would be achieved, then the patient should undergo the procedure on an ambulatory basis.

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