2 Management of the Cardiac Patient

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Cardiovascular disease represents about 30% of global mortality [1]. A thorough history and physical exam of the cardiac patient should involve appropriate questioning of symptoms and obvious signs of undiagnosed cardiac disease. The physical exam must also include auscultation of the heart for any murmurs, blood pressure in both arms when indicated, and carotid/jugular distention with bruits. In addition, examination of extremities for edema and hepatomegaly would indicate underlying cardiac disease. This chapter will discuss only the most common cardiac issues encountered in daily practice listed under the following subtitles:

1. Hypertension
2. Ischemic heart disease
3. Cardiac arrythmias, pacemakers, and anticoagulation
4. Valvular heart disease
5. Congenital heart disease
6. Anticoagulation
7. Perioperative cardiac risk assessment

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2.1 Hypertension

Hypertension is known to affect over a billion people worldwide with far-reaching consequences of heart disease and stroke in poorly controlled patients [2]. Due to its circadian pattern, blood pressure (BP) can be variable. For morning appointments, the reading can be high and be a normal pattern. It also increases with age and with anxiety. Primary hypertension is defined as a condition without identifiable causative factors. Secondary hypertension, on the other hand, has an identifiable cause. Endocrine and vascular conditions are the predominant causative factors for secondary hypertension. Others include alcoholism and obstructive sleep apnea [3].

Many patients with hypertension remain undiagnosed and poorly controlled in nearly half of them on treatment [4]. Untreated hypertension is one of the most important preventable causes of morbidity and mortality, since it is a major risk factor for stroke, myocardial infarction, heart failure, chronic kidney disease, cognitive decline, and premature death. It is one of the leading causes of death with more than seven million fatalities [5]. According to the Joint National Committee (JNC 8), hypertension is defined as a blood pressure reading >140/90 in otherwise healthy individuals. The committee further defines various stages of hypertension [6] (Table 2.1).

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Table 2.1 Hypertension categories [6]

Definition	Blood pressure measurement
Normal	SBP <120 mmHg and DBP <80 mmHg
Prehypertension	SBP 120–139 mmHg or DBP 80–89 mmHg
Stage I hypertension	SBP 140–159 mmHg or DBP 90–99 mmHg
Stage II hypertension	SBP ≥160 mmHg or DBP ≥100 mmHg
Hypertensive urgency	DBP > 120 mmHg without end-organ damage
Hypertensive emergency	DBP > 120 mmHg with end-organ damage

SBP systolic blood pressure, *DBP* diastolic blood pressure

Proper technique for obtaining accurate blood pressure measurements mandates that a patient be seated quietly for at least 5 min in a chair, feet on the floor and arms supported at heart level. An appropriate-sized cuff, a cuff bladder that encircles at least 80% of the arm, should be used to ensure accuracy, and at least two measurements should be taken during the visit [7]. Oral procedures are inherently associated with elevated levels of anxiety and a potential for increased blood pressure. Such readings should be interpreted with caution since patient's with elevated blood pressure tend to normalize upon administration of anxiolytics [8]. Several antihypertensive medications are available and may have interactions with common drugs used in oral surgical procedures (Table 2.2).

The induction of anesthesia, extubation, surgical pain, hypoxia, hypothermia, and volume overload are the events that could lead to blood pressure elevations and tachycardia [9]. In addition, the use of local anesthesia with epinephrine may potentiate hypertensive state. However, some patients may experience hypotension, cardiac arrythmias, angina pectoris, and myocardial infarction [10]. Injection of local anesthetics with greater concentration of epinephrine can increase blood pressure [11]. However it is open to debate whether such elevations have clinical significance. In addition, maximum dosage of epinephrine for patients with cardiovascular disease has been reported, but these dosage recommendations are based on poorly designed scientific studies and extrapolated data, and the recommendations should be weighed against the likelihood of significant endogenous catecholamine release from inadequate local anesthesia.

Table 2.2 Drug interactions of various antihypertensive agents

Drug group	Drug interactions
Beta-blockers	NSAIDs decrease their effect, decrease the metabolism of amide anesthetics
ACE inhibitors	NSAIDs decrease their effect, risk of angioedema
Diuretics	NSAIDs decrease their effect; erythromycin and fluconazole levels are elevated
Angiotensin II receptor blockers	NSAIDs decrease their effect, may interfere with fluconazole, indomethacin, and cimetidine
Calcium channel blockers	Increased sedation with benzodiazepines, altered drug levels with cimetidine and erythromycin
Alpha blockers	NSAIDs decrease their effect

NSAID nonsteroidal anti-inflammatory drugs, *ACE* angiotensin-converting enzyme

Hypertensive emergencies (i.e., severe elevations in BP [>180/110 mmHg] complicated by evidence of impending or progressive end-organ damage) require immediate BP reduction to prevent or limit end-organ damage. Blood pressure should be reduced by 10–15% (maximum of 20%) in a controlled fashion within the first hour with a continued decrease towards 160/100 mmHg over the next 2–6 h as tolerated by the patient. There was no benefit to deferring long-term treatment of patients with hypertension with diastolic blood pressures between 110 and 130 mmHg and no previous cardiac conditions [12]. Strategies may include having the patient take their usual daily medications, if not already done, as well as anxiety and stress reduction breathing and/or mindfulness exercises. If intravenous (IV) sedation is part of the treatment plan, then often the IV medications will result in blood pressure reduction, but ketamine should be avoided in these cases due to its propensity to increase blood pressure.

2.1.1 Ischemic Heart Disease

Cardiovascular disease remains a major cause of morbidity and mortality, particularly ischemic heart disease (IHD), a common cardiac condition [13]. Angina and myocardial infarction are known diseases as a result of IHD.

2.2 Angina Pectoris

Angina pectoris is classically described as a substernal pressure or squeezing sensation due to increased oxygen demand on the myocardium. The pain can also radiate to the neck and arms and usually is relieved at rest. Sublingual nitroglycerin (NTG) quickly resolves those symptoms, and then it is safe to proceed with the procedure. Coronary atherosclerosis is the common cause for angina. Angina in the dental office is most often a result of anxiety and fear resulting in tachycardia and angina. These patients are usually on nitrates and are prone to the risk of hypotension. If the symptoms persist despite rest and treatment with nitrates, a concern for myocardial infarction should be suspected.

2.3 Myocardial Infarction

Myocardial infarction is a condition due to ischemic death of the myocardium which is often not relieved with nitrates. In addition, patients complain of chest pain, nausea, pallor, and diaphoresis. MI usually results from a ruptured atherosclerotic plaque which then obstructs the coronary vessels leading to obstruction and ischemia. This is a medical emergency, and appropriate emergency activation should commence for timely thrombolysis. Differences between MI and angina are listed in Table 2.3.

Table 2.3 Differences between angina and myocardial infarction

	Myocardial infarction	Angina
Degree of ischemia	Complete	Partial
Myocardial injury	Yes	No
Symptoms relief with NTG	No	Yes
Duration of pain	>30 min	<30 m
EKG changes	ST-elevation, pathological Q-waves	ST-segment alterations

NTG nitroglycerin, *EKG* electrocardiogram

2.4 Perioperative Myocardial Infarction (PMI)

Acute coronary syndrome occurs when an unstable plaque ruptures leading to acute coronary thrombosis, ischemia, and infarction. Physiological and emotional stresses are known to predispose patients to PMI. Tachycardia and hypertension which are common in the perioperative period may lead to rupture of plaques. Anxiety and stress response to surgery leads to a surge in catecholamines that leads to increased ionotropic and chronotropic effects on the heart. This causes coronary oxygen supply-demand imbalance which can also lead to PMI. Perioperative tachycardia is the most common cause of oxygen supply-demand imbalance. Stress-induced coronary vasoconstriction can also impair coronary perfusion leading to PMI. Heart failure is another common condition in patients with coronary artery disease. This condition can be aggravated by ischemia and volume overload, leading to cardiac decompensation and subsequent PMI. Contrary to popular belief, these patients are in fact better served with anxiolytic techniques such as nitrous oxide or sedation protocols safely [14].

During the 1980s, the rule prevailed to wait 6 months after a myocardial infarction before embarking on noncardiac surgery [15]. This recommendation was based on risk of cardiac events for general surgical procedures under general anesthesia [16]. Studies have shown that the cardiac risk after a previous infarction is less related to the age of the infarction than to the functional status of the ventricles [17]. In that context, a small infarction without residual angina in the context of a good functional status allows essential noncardiac surgery as soon as 6 weeks after the ischemic episode [18]. Current practice guidelines consider the period within 6 weeks of infarction as a time of high risk for a perioperative cardiac event, because it is the mean healing time of the infarct-related lesion [19]. The period from 6 weeks to 3 months is considered as intermediate risk for cardiac complication. In patients with ischemic event-related complications such as arrhythmias, ventricular dysfunction, or continued medical therapy, this risk period is extended beyond 3 months after the ischemic event. In uncomplicated cases, there is no reason for delaying surgery more than 3 months after an ischemic attack.

Heart failure is an outcome of IHD and is associated with significant morbidity and mortality. Signs and symptoms include shortness of breath, rales, extremity edema, elevated jugular pulse, and fatigue. Heart failure is a major independent predictor of adverse perioperative outcome in noncardiac surgery. It carries a greater perioperative risk than ischemic heart disease. In the Framingham study, the overall mortality at 2 years was 25%. The overall prevalence in the general population is 1–2% [20]. This patient population must be expected to be taking multiple, long-term medications, including angiotensin-converting enzyme (ACE) inhibitors, angiotensin II receptor blockers, b-blockers, aldosterone antagonists, and diuretics, all with associated side effects (mostly electrolyte disturbances, renal insufficiency, and intraoperative therapy-resistant hypotension). The most important consideration when categorizing heart failure is whether left ventricular ejection fraction (LVEF) is preserved or reduced (less than 50%). A reduced LVEF in systolic heart failure is a powerful predictor of mortality. As many as 40–50% of patients with heart failure have diastolic heart failure with preserved left ventricular function [21, 22]. The New York Heart Association classification system is the simplest and most widely used method to gauge symptom severity [23].

2.5 Local Anesthesia in Cardiac Patients

When properly injected, vasopressors in local anesthesia can cause clinically insignificant arrythmias, and several systematic reviews have shown that the use of low concentration vasopressors in local anesthesia is safe for cardiac patients [24]. Despite the lack of absolute scientific evidence, various authors and guidelines recommend limiting the quantity or advise against the use of local anesthetics with vasopressors in these patients. However, there recommendations ignore the fundamental role that vasoconstrictors prolong the effects of local anesthetics. A patient who experiences pain and anxiety due to lack of appropriate local anesthesia can release endogenous catecholamines that could increase up to 10 times the base level and may reach significantly concentrations than the very low concentration of epinephrine used in local anesthesia [25]. The most frequent complications in cardiac patients after local anesthesia with a vasoconstrictor agent were identified on EKG as arrythmias. Most of these arrhythmias were clinically insignificant. The use of ≤4 carpules of lidocaine with epinephrine 1:100000 as a local anesthetic seems to be relatively safe for cardiovascular compromised patients [24].

2.6 Cardiac Arrythmias/ Implantable Electronic Cardiac Devices

Cardiac arrythmias occur when there is an abnormality in impulse generation or conduction or both. Benign arrythmias sometimes occur in patients without cardiac disease and rarely pose a problem. Many episodes are asymptomatic, and extra beats are very common in normal people. However, tachyarrhythmias are often associated with a diminished cardiac output leading to symptoms like angina, dyspnea, palpitations, or syncope. These patients present with implanted electronic cardiac devices to manage arrythmias. Approximately 250,000 implantable cardiovascular electronic devices are placed each year in the United States [26]. Patient with implantable cardiac devices should provide the details of implantation date, device manufacturer, mode of the implant, model number, and serial number. Cardiac arrythmias are most commonly seen in surgical procedures under local anesthesia with or without vasoconstrictors [27]. Patients with preexisting rhythm disorders or heart failure are more prone to such arrythmias [28]. Insufficient local anesthesia and lighter plane of general anesthesia are the most common intraoperative factors leading to cardiac arrythmias. Effective pain and anxiety control are important in such patients.

2.6.1 Automated Implantable Cardioverter Defibrillators (AICD) and Pacemakers

AICD have been widely used in patients with a higher risk of sudden cardiac death due to ventricular fibrillation and tachyarrhythmias. These devices deliver shock immediately upon sensing such arrythmia providing defibrillation and cardioversion [29]. Symptomatic bradycardia is often managed by a pacemaker. Various types of pacemakers are available and implanted by the individual needs of the patients. Pacemakers have cardiac leads and the pulse generators. The leads may be single or dual lead depending on whether the atria or ventricles are paced. They can also be dual lead where both the chambers are stimulated. In addition, there are also biventricular pacing devices. In patients with implanted cardiac devices, caution should be exercised in the use of anesthetic adjunctive agents such as anticholinergics, beta-blockers, local anesthetics, and vasopressor agents [30]. Malfunction of pacemakers may lead to symptomatic bradycardias or tachycardias, although upper rate-limiting programming is done in recent devices to limit such tachyarrhythmias. Antiarrhythmic drugs may be considered to covert such rhythms [31].

Electromagnetic interference with these cardiac devices is a concern when cautery devices or lasers are used in these patients. The grounding pad of the cautery device should be placed as far away as possible from the pacemaker/ICD. In addition, use of bipolar cautery is recommended over monopolar cautery. To reduce the risk of interference, an external magnet placement may allow for asynchronous cardiac pacing. This depends on the type of pacemaker, and the manufacturing company should be contacted for guidance [32]. However, this approach is seldom employed nowadays.

Review of the EKG or consultation with the cardiology team can determine whether the patient is device dependent; information of the procedure, patient positioning, and anticipated sources of intraoperative electromagnetic interference should be discussed. Specific recommendations from a cardiologist regarding the cardiac device should be carefully documented [33]. Battery function of these devices is another concern. Usually, the lithium-ion batteries in the devices last over 10 years. Patients should be asked about the year of placement and if there has been any replacement of the devices for a changed battery.

2.7 Valvular Heart Disease

According to the American Heart Association, approximately five million people are diagnosed with valvular heart disease in the United States each year. Valvular heart disease is a common condition which can either be stenosis or regurgitation. Most commonly, the aortic and mitral valves are involved resulting in a heart murmur. It is not uncommon to detect murmurs during physical exam which have not been detected in the past. While most murmurs are benign and asymptomatic, a high-grade murmur warrants further evaluation by a cardiologist. Aortic valve stenosis is an independent risk factor for cardiac morbidity and mortality. Prosthetic heart valves require long-term anticoagulation depending whether they are mechanical or biological. The risk of thromboembolism is significantly higher in patients with mechanical prosthesis, particularly the mitral valve due to relatively low flow compared to aortic valve. These patients are anticoagulated, and any interruption of anticoagulation can predispose them to thrombosis. If there is appropriate indication to discontinue anticoagulants prior to extensive maxillofacial surgery, such a decision should be made in consultation with the patient's cardiologist or primary care provider. Valvular heart disease poses a risk for developing bacterial endocarditis and exacerbat-

Table 2.4 Cardiac risk stratification of patient with congenital heart disease [35]

Type of condition	Low risk	Moderate risk	High risk
Conduction defects		Wolff-Parkinson-White syndrome	
		Long QT syndrome	
		Pacemaker dependence	
Structural lesions	Repaired ASD or VSD	Simple unrepaired lesions, such as atrial or ventricular septal defect	Unrepaired complex cardiac lesions
	Mild regurgitation or stenosis of a single valve	Complex cardiac defects with full repair Single ventricle with Glenn or Fontan palliation	Systemic arterial to pulmonary arterial shunts Severe valvular disease
Pulmonary hypertension		New York Heart Association functional class 1 Normal cardiac index	Pulmonary artery pressure equal to or higher than systemic Decreased cardiac index Severe heart failure
Miscellaneous		Heart or lung transplant	Ventricular assist devices William's syndrome Hypertrophic obstructive cardiomyopathy

ing a preexisting congestive heart failure. According to the recent ACC/AHA guidelines, endocarditis prophylaxis before invasive oral procedures is recommended in patients with valvular heart disease [34].

2.7.1 Recommendations for Endocarditis Prophylaxis [34]

1. Prosthetic cardiac valves, including transcatheter-implanted prostheses and homografts
2. Prosthetic material used for cardiac valve repair, such as annuloplasty rings and chords
3. Previous infective endocarditis (IE)
4. Unrepaired cyanotic congenital heart disease or repaired congenital heart disease, with residual shunts or valvular regurgitation at the site of, or adjacent to the site of, a prosthetic patch or prosthetic device
5. Cardiac transplant with valve regurgitation attributed to a structurally abnormal valve

2.8 Congenital Heart Disease

Congenital heart disease represents a common developmental anomaly. Atrial septal defect (ASD), ventricular septal defect (VSD), patent ductus arteriosus (PDA), congenital pulmonary stenosis, and aortic stenosis are some of the common conditions. A majority of these are repaired early in life upon detection, although some may go undiagnosed until later in life and some into adulthood. Saettele et al. developed a risk stratification chart (Table 2.4) of patients with congenital heart disease undergoing major surgery. The risk of conduction defects increases with the use of certain drugs (Table 2.5). However, currently no data exists on outpatient anesthesia for these patients. Until such evidence is available, these patients should undergo preoperative evaluation by their cardiologist, and their recommendations should guide the anesthesia plan. In addition, according to the current AHA guidelines, patients with unrepaired congenital heart diseases require endocarditis prophylaxis.

2.9 Anticoagulation

Various antiplatelet or anticoagulant drugs are available to reduce the risk of thrombus formation (Table 2.6). Cardiac conditions such as IHD, valvular heart disease, and cardiac arrythmias are indications for anticoagulant therapy. Surgical procedures of the oral cavity have an increased risk of bleeding. In the past interruption of anticoagulation therapy was commonly done to reduce the risk of oral bleeding. However, this

Table 2.5 Drugs that affect cardiac repolarization and prolong the QT interval, with documented cases of torsades de pointes

Class of drugs	Drug name
Class Ia antiarrhythmics	Quinidine, disopyramide, procainamide
Class Ic antiarrhythmics	Flecainide
Class III antiarrhythmics	Sotalol, amiodarone
Antipsychotics	Droperidol, haloperidol, phenothiazine, thioridazine, quetiapine, risperidone, zotepine
Serotonin reuptake inhibitors	Fluoxetine, paroxetine, sertraline
Macrolide antibiotics	Erythromycin, azithromycin, clarithromycin
5-HT1 agonists	Zolmitriptan, naratriptan
Antimalarial agents	Halofantrine
Antihistamines	Terfenadine
Prokinetic agents	Cisapride

Table 2.6 Various anticoagulant agents and their mechanism of action

Drug name	Mechanism of action
Aspirin	Inhibition of platelet aggregation
Clopidogrel	Inhibition of platelet aggregation
Coumadin	Inhibits vitamin K-dependent coagulation factors (II, VII, IX, X, protein C, and protein S)
Prasugrel	Inhibition of platelet aggregation
Ticagrelor	Inhibition of platelet aggregation
Apixaban	Selective coagulation factor Xa inhibitor
Dabigatran	Reversible direct thrombin inhibitor
Rivaroxaban	Selective coagulation factor Xa inhibitor
Edoxaban	Selective coagulation factor Xa inhibitor
Betrixaban	Selective coagulation factor Xa inhibitor
Vorapaxar	Inhibition of platelet aggregation
Dipyridamole	Decreases platelet aggregation
Cilostazol	Phosphodiesterase III inhibitor and reduces platelet aggregation

inherently increased the risk of ischemic stroke or myocardial infarction.

Atrial fibrillation is the one of the most common cardiac arrhythmic conditions that may require anticoagulation. Several risk factors were identified in these patients to reduce the risk of thromboembolism (Table 2.7). A score of greater than 2 requires managing these patients with anticoagulant therapy [37]. In addition, those with bioprosthetic valves and valve repair are considered increased risk and should be anticoagulated regardless of score.

The risk of perioperative stent thrombosis in cardiac patients is increased by noncardiac surgical procedure, when surgery is performed early after stent implantation and if dual antiplatelet therapy is discontinued [38]. Dual platelet therapy is known to cause more bleeding than single drug. Despite this, interruption of antiplatelet therapy is not indicated for routine oral surgical procedures [39]. In patients who are anticoagulated with warfarin, oral surgical procedures can be safely performed with therapeutic levels of anticoagulation up to INR 4.0 [40]. However, the type of surgery, including the number of extractions, and the technique, such as staged extractions or quadrant procedures, are critical to perioperative success. A meta-analysis study involving aspirin (ASA) and a control group showed longer bleeding time in the aspirin group. However, this increase is not shown to be statistically significant compared to the control group. Hence disruption of antiplatelets therapy was not indicated [41]. Several studies have overwhelmingly concluded against the interruption of antiplatelet therapies prior to oral and maxillofacial surgery although some authors have recommended the use of local hemostatic agents [42, 43]. Further, evidence suggests an approximately 5% stroke risk with cessation of anticoagulation medications in patients on such medications for atrial fibrillation [44].

In order to obtain local hemostasis, it is advisable to take into account all the hemostatic agents known. The local hemostatic measures include the use of hemostatic gauze with regenerated oxidized cellulose, gelfoam consisting of animal origin gelatin, topical thrombin, fibrin sealants, bone wax, sutures, electrocautery, and the use of tranexamic acid. In addition, recently, the US Food and Drug Administration approved idarucizumab, a monoclonal antibody fragment, for the treatment of patients taking dabigatran when

Table 2.7 Risk factors development of stroke in patient with atrial fibrillation: the CHA2DS2-VASc score [36]

Abbreviation	Risk factors	Points
C	Congestive heart failure/left ventricular dysfunction	1
H	Hypertension	1
A2	Age >75 years	1
D	Diabetes mellitus	1
S2	h/o CVA/TIA/thromboembolism	2
V	Vascular disease (MI, PVD)	1
A	Age 65–74 years	1
Sc	Gender; female	1

reversal of the anticoagulant effects of dabigatran is needed for emergency surgery/urgent procedures or in life-threatening or uncontrolled bleeding.

2.10 Perioperative Cardiac Risk Assessment and Testing

The aims of cardiac risk stratification are to:

1. Identify potentially life-threatening cardiac conditions
2. Consider appropriate preoperative testing in high-risk patients
3. Implement optimal perioperative management strategies to reduce the risk of cardiac morbidity and mortality

The risk of perioperative cardiac complications is the summation of the individual patient's risk and cardiac stress related to the surgical procedure. The first step in cardiac risk stratification is to identify patients at risk for perioperative cardiac events. Historically, several indices have been described towards risk assessment in a surgical patient [45–47]. Recent studies have indicated the Goldman index may actually overestimate risk for today's ambulatory surgical patient [48]. However, these indices are outdated due to significant advances in surgical and medical management of patients with cardiac disease. In addition, these indices were used to assess the cardiac risk in patients undergoing major noncardiac surgeries and do not provide optimal data to assess the risk in outpatient oral and maxillofacial surgery. Major noncardiac surgery patients who undergo general anesthesia may experience the risk of significant hemodynamic changes, renal dysfunction, pulmonary failure, and hypermetabolic states. However, such conditions are extremely rarely encountered in the oral surgical patient. Within the oral and maxillofacial surgical procedures, majority of the procedures are considered low risk for cardiac mortality and morbidity. Perhaps, the head and neck reconstructive procedures are considered as intermediate risk. Although not evaluated, patients with severe obstructive sleep apnea (pulmonary hypertension, uncontrolled HTN, diabetes, and renal failure) undergoing a combination of maxillomandibular advancement and soft tissue airway surgery could be classified as intermediate risk.

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) risk calculator (https://riskcalculator.facs.org/RiskCalculator/PatientInfo.jsp) is a more comprehensive online tool and procedure specific [49]. Another simple yet valuable risk assessment tool is the myocardial infarction or cardiac arrest (MICA) calculator (https://www.mdcalc.com/gupta-perioperative-risk-myocardial-infarction-cardiac-arrest-mica) [50]. Recent studies have shown the MICA calculator outperformed several indicators. Preoperative functional status is another predictor of perioperative outcome. Studies in the past have shown that low exercise tolerance is associated with poor perioperative outcome [51, 52]. The Duke Activity Status Index (DASI) is based on a questionnaire and grades exercise ability related to physical activity such as:

- Can take care of self, such as eat, dress, or use the toilet (1 MET)
- Can walk up a flight of steps or a hill or walk on level ground at 3–4 mph (4 METs)
- Can do heavy work around the house, such as scrubbing floors or lifting or moving heavy furniture, or climb two flights of stairs (between 4 and 10 METs)
- Can participate in strenuous sports such as swimming, singles tennis, football, basketball, and skiing (>10 METs)

One metabolic equivalent of task (MET) is defined as 3.5 mL of oxygen consumed per kilogram body mass per minute. A cardiac patient with a functional capacity of more than 4 METs is considered low risk. However, the inability to climb a flight of stairs (4 METs) is significant because it is associated with cardiac events during major noncardiac surgery. At this time, it is unknown if this data can be extrapolated to oral surgical procedures considered as low risk. A recent study however concluded that subjectively assessed preoperative functional capacity did not accurately identify patients with poor cardiopulmonary status or predict postoperative morbidity or mortality in major noncardiac surgery [53]. A surgical classification system that identifies risk based on blood loss can be a valuable tool in risk stratification (Table 2.8).

Despite evidence that routine preoperative testing before elective, low-risk ambulatory surgery is not indicated, studies have shown that more than 60% of all patients underwent at least one laboratory test during their preoperative evaluation [55]. A systematic review of the current literature found that the incidence of abnormal test results that changed perioperative management ranged from less than 0.1% (CBC) to 2.6% (renal function tests) [56]. Inappropriate and unnecessary preoperative testing can lead to significant financial burden on the patient but may also lead to morbidity and mortality as a result of the testing [57]. According to the ACC/AHA perioperative guidelines, if the patient has had a cardiovascular evaluation in the previous 2 years and has not experienced new or worsening symptoms, further testing is usually unnecessary. If there has been no diagnostic workup, or if new or worsening cardiopulmonary symptoms are present, then additional testing may be indicated. Also, asymptomatic, functionally active patients with previous successful coronary revascularization within the last 6 years are in a low-risk category and should not be investigated further for a noncardiac operation [58].

Table 2.8 Surgical classification system [54]

Category 1	Minimal risk to patients independent of anesthesia Minimally invasive procedures with little or no blood loss Operation done in an office setting
Category 2	Minimal to moderately invasive procedures Blood loss <500 mL Mild risk to patients independent of anesthesia
Category 3	Moderately to significantly invasive procedure Blood loss 500–1000 mL Moderate risk to patients independent of anesthesia
Category 4	Highly invasive procedure Blood loss >1500 mL Major risk to patients independent of anesthesia

In summary, perioperative cardiac management of the patient should be based on the best available scientific evidence, individual patient's risk stratification, and cost-effectiveness. The focus should be on appropriate medical interview of the patient and determining their functional status, rather than burdening the already strained health care systems with unnecessary testing. Discussion with primary care providers or other consultants should focus less on preoperative "clearance" and more on determining if the patient is optimized. In addition, conditions like stress, anxiety, and fear of oral surgical procedures can cause endogenous release of catecholamines, particularly norepinephrine, which in turn can precipitate autonomic responses leading to conditions like hypertension and arrhythmias. Hence, control of anxiety and pain plays a major role in reducing complications related to cardiovascular disease.

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