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CARDIO VASCULAR SURGERY

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KAROLINUM

CARDIOVASCULAR SURGERY

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VASCULAR SURGERY (*Milan Krajíček, Pavel Šebesta*)

GENERAL INTRODUCTION

During the past fifty years, cardiovascular surgery has become one of the pillars of surgery in general. The search for a more effective treatment of an increasing number of cardiovascular diseases contributed to the relatively rapid development of surgical tactics and techniques, instruments, vascular substitutes and other necessary tools. Its very important role has also been played in the progress of diagnostic procedures, anesthesiology, prevention of infection and other specialties. The substance of cardiovascular surgery was deeply affected during the past twenty years by the development of intraluminal procedures performed mostly by radiologists. However, these two approaches are not antagonistic, but symbiotic.

The trend of the recent past is to direct education to the qualification of the vascular interventionist who will be able to perform surgical as well as intraluminal procedures.

Cardiovascular surgery is an important part of the state examination in surgery.

In Czech universities, a substantial number of foreign students study medicine for which the courses are presented in the English language. However, as far as cardiovascular surgery is concerned, so far, no texts in this language have been available for study. This work deals with all aspects of said field to acquire the necessary level of knowledge for the successful coping with the demand of the state examination in surgery. The concept of this text tries not only to furnish the necessary facts, but also offers an understanding of different facts from the physiological, pathophysiological and anatomical point of view.

The authors wish students to use the text to their benefit, and also wish them good luck.

Last, but not least, the authors warmly thank their friends and backers, who by this or other way, mostly as language consultants, did contribute to the quality of this work.

Milan Krajíček

CARDIAC SURGERY

1 THE FUNDAMENTALS OF CARDIAC SURGERY

1.1 PREOPERATIVE ASSESSMENT

The initial diagnosis of heart disease is usually determined by the cardiologist, and is made by reviewing the medical history, a physical examination and different diagnostic techniques to confirm the diagnosis. This is presented on referral to cardiac surgeons, and further assessment can be proposed about the extent to which cardiac surgery may relieve symptoms. On admission to hospital, the medical history and some degree of physical examination occur in an attempt to gain a baseline on the physical condition of the patient and to determine whether the patient's illness has deteriorated.

1.1.1 Patient History

Dyspnea

This is an abnormal sensation of breathlessness on effort or at rest. With increasing disability, orthopnea and paroxysmal nocturnal dyspnea (PND) occur. A dry nocturnal cough is often a sign of impending PND. In acute pulmonary edema, pink frothy sputum and streaky hemoptysis occur. With poor left ventricular function, Cheyne-Stokes ventilation makes the patient feel dyspneic in the fast cycle phase. Effort tolerance is graded by the New York Heart Association criteria (Table 1).

Table 1. New York Heart Association classification of dyspnea

Class	Classification
1.	Patients with cardiac disease, but without resulting limitations of physical activity. Ordinary physical activity does not cause breathlessness.
2.	Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in dyspnea (e.g., walking up two flights of stairs, carrying a shopping basket, making beds). By limiting physical activity, patients can still lead a normal social life.

3.	Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest, but even mild physical activity causes dyspnea (e.g., walking around the flat). The patient cannot do any shopping or housework.
4.	Patients with cardiac disease who are unable to do any physical activity without symptoms. Dyspnea may be present at rest. They are virtually confined to a bed or chair and are totally incapacitated.

Palpitations

This is the undue awareness of heart action. The heart rate may be normal or increased, and the rhythm regular or irregular. The sensations may be described as a heavy or pounding heartbeat, a fluttering in the chest, a racing heart (regular or irregular), a missed beat; and the heart turning over. The history of palpitations may range from a few hours to decades; palpitations may occur daily or very infrequently, with intervals of months or even years. In most patients, palpitations are not associated with primary heart disease. The patient is aware of a normal heart beat or of simple sinus tachycardia associated with anxiety or extracardiac disease (e.g., infection or thyrotoxicosis).

History of Angina

The degree to which angina is suffered and its effect on the patient as an individual may give an indication of the severity of the disease. The Canadian Cardiovascular Society produced a classification of angina, which is widely used as a measure (Table 2).

Table 2. Canadian classification of angina

Grade	Characteristics
I.	Ordinary exercise does not cause angina (strenuous activity provokes angina)
II.	Slight limitation of ordinary physical activity (climbing more than one flight of stairs and walking uphill)
III.	Marked limitation of ordinary physical activity (walking on the level or climbing one flight of stairs provokes angina)
IV.	Inability to carry on any physical activity/angina may be present at rest

Syncope

This is the brief loss of consciousness as a result of inadequate blood supply to the brain. The immediate cause is reduced cerebral artery perfusion pressure, which may be the consequence of a fall in cardiac output, peripheral vascular resistance or both. Syncope can occur for a variety of reasons as highlighted in Table 3.

Table 3. Causes of syncope

Cause	Contributing factors
Inappropriate vasodilatation	Simple vasovagal faint
	Malignant vasovagal syndrome
	Hypersensitive carotid sinus syndrome
	Micturition syncope
	Orthostatic hypotension (diabetes / Parkinson's disease, age)
	Hypotensive drugs
Impaired cardiac function	Extreme bradycardia (heart block, sinoatrial disorder)
	Paroxysmal tachycardia
	Myocardial ischemia
Obstruction to ventricular emptying	Aortic stenosis
	Hypertrophic obstructive cardiomyopathy
	Pulmonary stenosis
	Pulmonary hypertension
Reduced ventricular filling	Cough syncope
Micturition syncope	Atrial myxoma
	Ball-valve thrombus of atrium
	Pulmonary embolism
Hypovolemia	Excessive diuretic therapy
	Hemorrhage

Physical examination between attacks may reveal evidence of significant valvular heart disease or cardiac arrhythmia, which gives a clue to the mechanism of syncope. The lying and standing blood pressure should be checked as a matter of course, but the absence of a falling blood pressure upon standing does not rule out the presence of orthostatic hypotension.

Cyanosis

Central cyanosis should be detectable when arterial saturation is less than 85% and when there is more than 5g of reduced hemoglobin present. It is more difficult to detect if the patient is anemic. Cardiac cyanosis is the result of an inadequate uptake of oxygen in the lungs secondary to pulmonary disease, or of right-to-left shunting, which results in deoxygenated blood bypassing the lungs and passing directly into systemic circulation. It is characterized by cyanosis, which affects the mouth and tongue as well as the extremities – these are warm to the touch. Peripheral cyanosis in the absence of central cyanosis may be caused by peripheral vasoconstriction and stagnation of the blood in the capillaries. It is best seen in the extremities and the lips, and is often associated with coldness of the part. It may occur in heart failure or be the result of local causes.

Embolism

Both systemic and pulmonary embolisms are common in cardiac disease. The following are some of the common factors: atrial fibrillation, aortic stenosis, mitral stenosis, infective endocarditis, and left atrial myxoma.

Edema

Factors important in cardiac disease are elevated venous pressure (congestive cardiac failure, pericardial constriction), increased extracellular volume (salt and water retention), secondary hyperaldosteronism, hypoalbuminemia (liver congestion, anorexia and poor diet), venous disease and secondary renal failure. Acute edema and ascites may develop in pericardial constriction. Protein-losing enteropathy can occur with a prolonged high venous pressure exacerbating edema. Patients presenting with pulmonary edema in the preoperative period could be commenced on a short course of diuretics, but the identification of pulmonary edema immediately preoperatively does not exclude the patient from surgery.

1.1.2 Physical Examination

The physical examination should start with the hands, because they can indicate the extent of the disease as well as the type of disease. Coldness of the extremities is the result of vasoconstriction or obstruction of the superficial blood vessels, so that the blood supply to the skin is reduced. In heart disease, it is often caused by peripheral vasoconstriction that follows a fall in cardiac output. In conditions with a high cardiac output, the peripheral vessels are dilated and the skin is very warm.

Facial and General Appearance

- Down's syndrome: an atrioventricular canal defect
- Elf-like faces: supravalvular aortic stenosis
- Turner's syndrome: coarctation, aortic stenosis
- Moon-like plump faces: pulmonary stenosis
- Noonan's syndrome: pulmonary stenosis, peripheral pulmonary artery stenosis
- Mitral facies with pulmonary hypertension
- Central cyanosis
- Differential cyanosis in patent ductus arteriosus (PDA) with pulmonary hypertension or interrupted aortic arch
- Xanthelasma

Teeth must be checked as part of the general cardiovascular examination. The condition of the mouth and teeth is particularly important in patients prone to bacterial endocarditis and under review for valvular surgery. In most cases, valve surgery will not occur until the patient has undergone a full dental screening for tooth decay. In many cases, this results in patients having a dental extraction before surgery. It is also important to note the presence of dentures, caps and crowns. Although this has no impact on surgery, it is important for anesthesia and placement of the endotracheal tube.

The Pulse

The pulse rate and rhythm should be determined by feeling the radial pulse, and certain characteristics of the pulse may be indicative of heart disease. The pulse volume is dependent on the pulse pressure. A small pulse volume indicates a small stroke volume, and is often associated with peripheral vasoconstriction or severe heart disease. A large pulse volume is associated with a large stroke volume and a low peripheral resistance. The pulse wave, felt at the carotid artery, is also helpful in diagnosis. The collapsing pulse (water-hammer pulse) is associated most strongly with aortic incompetence, but it may also be present in PDA or a rigid atherosclerotic aorta. A plateau pulse is found in severe aortic stenosis. Pulsus bisferiens is found in patients with a combined aortic stenosis and regurgitation or in pure aortic regurgitation. Pulsus alternans is found in left ventricular failure and pulsus paradoxus in constrictive pericarditis and pericardial effusions. The neck veins should be examined in the recumbent patient with the head and shoulders raised 30° from the horizontal. At this angle, the column of blood in the jugular system should reach the level of the clavicle. Raised jugular pressure is found in heart failure and in certain conditions associated with a high cardiac output. Blood pressure measurements are important in relation to determining hypertension. Subclavian artery stenosis, which may be identified by differential arm blood pressure between the two arms, i.e. the differing blood pressure of each arm, could be a contraindication to the use of pedicled internal mammary grafts.

Percussion of the Heart

This percussion may provide a crude estimate of heart size, but a radiograph is much more accurate. It may have a place in the diagnosis of pericardial effusion when the area of cardiac dullness is extended to the right of the sternum and to the second intercostal space.

Auscultation

Vibrations within the heart are of sufficient volume to be heard through a stethoscope. If the noise is brief, it is a heart sound. A more prolonged sound is a murmur. The presence of a heart murmur may warrant preoperative echocardiography if a non-valvular abnormality has been identified at cardiac catheterization. The new onset of ischemic mitral regurgitation or unsuspected aortic valve disease may occasionally be detected.

1.1.3 Investigations

Many investigations are available to aid in the diagnosis of cardiac disease and will allow the severity of the disease to be risk stratified, i.e. determination of the risk to the patient of further acute episodes without medically or surgically invasive intervention. These investigations may be invasive or non-invasive and available at either every hospital or a few specialized centers.

Electrocardiography

The electrocardiography (ECG) is the most widely used method of cardiac assessment. A resting 12-lead ECG provides baseline information about the electrical activity of the heart. It can detect abnormal cardiac rhythms, conduction defects, and signs of ischemia (ST segment changes) or infarction (Q waves); it also provides information about the position of the heart and the size of the cardiac chambers. Results of the ECG are correlated to clinical data obtained from the history and physical examination. The ECG may be normal at rest in the presence of coronary artery disease, with abnormal changes becoming apparent only with exercise. These patients may undergo continuous ECG with a Holter monitor.

Exercise ECG

After myocardial infarction (MI), the prognosis of the patient is very dependent on left ventricular function, which is reflected in an exercise test using workload and blood pressure. Exercise ECG can predict the risk of a future serious cardiac event, including non-fatal MI and cardiac death. This is important in deciding who should have coronary angiography and, subsequently, who should be considered for revascularization. Patients walk on a gradually inclining treadmill until they reach a target heart rate or demonstrate symptoms of hypertension, ventricular dysrhythmias, ST segment changes or chest pain.

Exercise testing has two main aims:

1. To provoke a symptom (usually chest pain or dyspnea) or a specific ECG abnormality (usually ST-segment depression) by increasing cardiac work.
2. To determine the workload achieved at the time of the response or maximum effort.

A crude method of calculating the prognosis for coronary artery disease is based on ST depression and exercise time, which allows for half of all patients to be classified as high or low risk. The results also provide some indication of the patient's functional status. As waiting lists for surgery continue to lengthen, exercise tests can be a useful aid in determining urgency, but current resources prevent it from being used routinely for this purpose.

Radiography

Posteroanterior (PA) and lateral chest radiographs provide important information about the size of the heart, thoracic aorta and pulmonary vasculature, including signs of pulmonary artery or pulmonary venous hypertension. Signs of pulmonary disease, including chronic obstructive pulmonary disease (COPD), effusions or cancerous lesions, may change the timing of surgery. If tumors or other mediastinal masses are identified, they should be investigated before cardiac procedures are performed. Cardiac size in adults is determined by assessing the cardiothoracic ratio. The cardiac diameter is normally 50% or less of the thoracic diameter. A ratio greater than 50% indicates cardiac enlargement. Films may also show the presence of calcium in the cardiac valves, coronary arteries and aorta. The most recent, as well as the previously taken, chest radiographs should be available at the time of surgery. For patients who have required previous sternal operations, the lateral radiograph demonstrates the chest wires, the proximity of the heart to the sternum and the possible extent of pericardial adhesions. Rib notching may be evident on the left side of the thorax because of the tortuous path of hypertrophic intercostal arteries in patients with coarctation of aorta.

Echocardiography and Doppler Ultrasonography

Being non-invasive and not requiring the use of ionizing radiation, echocardiography is ideal for the evaluation of seriously ill adults. Echocardiography is an integral part of cardiological diagnosis and should be carried out in all patients in whom a new diagnosis of heart failure is made. It can be used to identify any acute, but treatable, primary cause of heart failure.

Transesophageal echocardiography (TEE) uses miniaturized transducers incorporated into adapted endoscopes. This allows the heart and great vessels to be studied from within the gastric fundus. It is used to evaluate the cardiac valves and to assess the need to repair versus replacement of a valve at operation. Intraoperative TEE is used to test repairs of congenital defects as well as regurgitant valves, and to assess ventricular function. Echocardiograms of moving blood (Doppler techniques) are advantageous when studying the blood flow within the heart and great vessels.

Diagnosis of Abnormal Wall Motion

When new ischemia occurs, the contractile function of the myocardium becomes impaired before the ECG becomes abnormal and before the patient develops symptoms. New abnormalities of wall motion are sensitive indicators of ischemia or developing infarction.

Complications of Myocardial Infarction

It is invaluable for the prompt diagnosis of the cause relating to sudden hemodynamic collapse in a patient with acute MI. It distinguishes cardiogenic shock from severe left ventricular damage, right ventricular infarction and cardiac rupture with tamponade. It is the best technique for differentiating between acute mitral regurgitation and ventricular septal rupture.

Valvular Assessment

Valvular disease is diagnosed with great accuracy. Obstruction and regurgitation are detected, and their consequences on ventricular dimensions and function are observed. In most patients with valvular heart disease, cardiac catheterization is required only for coronary arteriography to identify coronary arteries that may be demonstrating significant ischemia.

Dynamic Electrocardiography (Holter Monitoring)

From its initiation as a research tool in the 1970s, dynamic electrocardiography or Holter monitoring, has developed from a fragile research tool to becoming a standard and widely available cardiac investigation. It is used for:

- Diagnosis of arrhythmias
- Assessment of antiarrhythmic drugs
- Assessment of pacemaker or implanted cardioverter defibrillator (ICD) function
- Detection of ischemia
- Monitoring of blood pressure
- Determination of prognosis

Coronary Angiography

Coronary angiography (cardiac catheterization) is a diagnostic test performed by a cardiologist within the operating room environment of a cardiac catheterization laboratory; it was developed in 1959. It is the ultimate cardiology test because it allows the cardiologist to observe the left and right coronary arteries for any blockages or narrowings, to assess the function of the heart valves and the left ventricle, and to measure the pressures within the heart – normal pressures are shown in Table 4.

Table 4. Normal cardiovascular pressures

Chamber		**Mean (mmHg)**	**Range (mmHg)**
Right atrium	Mean	4	0–8
Right ventricle	Systolic	25	15–30
	End-diastolic	4	0–8
Pulmonary artery	Systolic	25	15–30
	Diastolic	10	5–15
	Mean	15	10–20
Pulmonary artery wedge	Mean	10	5–14
Left atrium	Mean	7	4–12
Left ventricle	Systolic	120	90–140
	End-diastolic	7	4–12
Aorta	Systolic	120	90–140
	Diastolic	70	60–90
	Mean	85	70–105

Cardiac catheterization is usually performed via the femoral artery, but increasingly it is performed using the brachial or radial artery. The procedure takes about 30 minutes on a day-case admission, but a lengthened procedure is required if previously grafted arteries are to be investigated. A provisional diagnosis may be provided on the day of the test, and a number of options may be available, including remaining on the same treatment, increasing medication, proceeding to angioplasty or referral for cardiac surgery.

CT and MRI of the Heart

Both modalities give the surgeon valuable pre- and postoperative information. While the modality best suited for specific clinical indications evolves with the technology, at present, certain generalizations can be made. Cardiac CT is invaluable in reoperative cardiac surgery because it offers higher-quality noninvasive angiography of native coronary arteries and bypass grafts. Since 3D volume rendering with CT has a higher quality and better spatial resolution, it is preferred for preoperative planning for reoperative coronary artery bypass grafting or minimally invasive cardiac surgery. All calcification is poorly seen with MRI and superbly seen with CT, and thus CT is far superior in demonstrating coronary, myocardial, pericardial, and valvular calcification. The same is true for mechanical valve prostheses; because of large areas of artifact on

MRI images, functional evaluation is possible only with CT. **Finally, all patients with a surgical problem of the aorta require evaluation with CT.** Cardiac MRI is invaluable in assessing myocardial function, contractility, and actual tissue perfusion and viability. For these reasons, MRI remains the „gold standard“ to assess biventricular volumes and function and myocardial mass. A number of MRI pulse sequences can delineate areas of chronic myocardial infarction accurately, identify certain specific cardiomyopathies, and confirm the presence of neoplasm. One distinct advantage of MRI over CT is that MRI delivers no patient radiation.

1.2 PATIENT PREPARATION

Preoperative assessment is performed within a specified period before surgery to ensure that each patient arrives in the operating room in the optimal condition to cope with the physiological changes and stressors associated with surgery, and that patients are less likely to develop perioperative complications. After screening for the initial diagnosis or at the assessment before admission for surgery, the value of impending surgery may be deemed minimal, (e.g., coexisting severe non-cardiac conditions with a poor prognosis, such as extreme debility, mental and emotional deterioration and multiple system disease) and may contraindicate elective cardiac surgery procedure.

1.2.1 Preoperative Blood Tests

Bloods need to be taken for routine screening and a crossmatch. A full blood count is required, including the international normalized ratio (INR), the activated partial thromboplastin time (APPT), and the platelet count. If any abnormality is detected, this should be addressed before surgery. Electrolyte, urea, creatinine and glucose levels should ideally be within normal limits, but an elevated creatinine may require investigation and treatment before surgery. Liver function tests, including bilirubin, alkaline phosphatase, alanine transaminase, aspartate transaminase, albumin and serum amylase, are all useful markers. Elevated levels may be suggestive of hepatitis or cirrhosis and may warrant investigation before surgery. Although the indications for blood transfusion may have been modified as a result of blood-borne disease, blood transfusions can be a lifesaving measure for patients with reduced oxygen-carrying capacity, coagulopathies or hypovolemia. Blood availability is very necessary and at least 4 units of packed red blood cells and 2 units of fresh frozen plasma are generally ordered for cardiac surgical patients. This blood should be in the operating room for the start of surgery.

1.2.2 Assessment of Risks

Assessment of Respiratory Risk

The greatest cause of perioperative morbidity is pulmonary complication, and preoperative assessment is aimed at identifying those at risk and decreasing the risk as far as possible. Underlying respiratory disease, smoking and obesity have all been shown to be important.

Patients should have already been encouraged to stop smoking when the initial cardiac disorder was diagnosed, but cessation of smoking at least 30 days before surgery reduces the risk of both respiratory and wound infections. The presence of a recent-onset upper respiratory tract infection is associated with increased airway reactivity, mucous plugging, atelectasis, bronchospasm and pneumonia. Patients who have had a recent infection (within 3–4 weeks preceding surgery) but are asymptomatic pose the greatest risk. All patients with known chronic chest problems should be questioned about the severity of symptoms, whether they have had a recent chest infection and about the current medication. Pulmonary function tests should be carried out on patients with a chronic disease. These tests include FEV1/FVC ratio (ratio of the forced expiratory volume in the first one second to the forced vital capacity of the lungs) and peak expiratory flow rate, in addition to arterial blood gases. They are valuable in identifying respiratory diseases, which may be improved preoperatively. Severe reduction in FEV1/FVC is associated with the need for prolonged intubation; this necessitates a longer stay in intensive care and may expose the patient to increased pulmonary complications. Patients with COPD, including those with asthma, generally have more complications than patients with restrictive conditions, e.g., kyphoscoliosis. If it appears that asthma or COPD could be improved preoperatively, this could necessitate a longer preoperative stay for physiotherapy or systemic steroids. Evidence of severe pulmonary dysfunction does not contraindicate surgery because it may reflect reversible changes associated with cardiac disease, and it is therefore difficult to define a value below which surgical risk is prohibitive. However, generally an elevated PCO_2 (partial pressure of carbon dioxide) has been identified as a marker of postoperative pulmonary morbidity and mortality.

Assessment of Renal Disease

A history of renal disease requires close attention to blood urea and electrolyte estimations. Any significant abnormality, such as high or low sodium and potassium values, pH abnormalities or a high creatinine, should be corrected to decrease the risk of interactions with anesthesia and surgery, which can result in dysrhythmias, cardiac arrest, fits or cerebral depression. An opinion about management from a nephrology consultant may be invaluable in the preparation of patients for surgery. On occasion, 24-hour urine collection for urea and creatinine clearance may be requested.

Assessment of Diabetes

A diabetic assessment should be carried out before surgery because people with diabetes undergoing surgery are always a high-risk group. This assessment should involve reviewing current anti-diabetic treatments, previous glycemic control, known relevant diabetic complications and whether problems have arisen during previous operations. It is important that the patients have good metabolic control, from before induction of anesthesia until they have recovered completely from the operation. Insulin sensitivity and requirements are altered by the metabolic response to surgery. Operations should not be cancelled on the basis of one random elevated blood glucose, if glycemic control is normally satisfactory. Where possible, an operation involving patients with diabetes, especially those with type 1 diabetes (insulin-dependent diabetes mellitus), should be the first procedure on the morning operation list. This helps to shorten the preoperative fast for these patients.

Assessment of Neurological Risk

As a result of the risk of neurological injury caused by a disruption of aortic plaque, preoperative screening of the carotid arteries is sometimes invaluable. Such screening could reduce the prevalence of postoperative stroke. Screening may indicate patients with carotid artery disease who should be monitored for the development of a cerebrovascular accident (CVA). Stenosis of the internal carotid artery is often found in asymptomatic patients. The potential for a CVA after cardiac surgery increases to 9.9% in the presence of proven stenosis (> 75%) of the carotid artery. Detection of a carotid bruit should prompt examination with duplex sonography. If severe (> 70%) stenosis of the carotid artery is detected, clinical judgment is required in relation to the need for carotid endarterectomy and debate continues over the timing of this. The risk of perioperative stroke is also increased in patients with atrial rhythm disorders, left ventricular thrombi and severe aortic atheroma. Patients requiring cardiac surgery as a result of coronary atherosclerosis will also invariably demonstrate atherosclerotic changes elsewhere. This may be most notable in the legs and, therefore, patients should be assessed for peripheral vascular disease that can be superficially achieved by assessing the presence of femoral, post-popliteal and post-tibial pulses. Absence of these pulses by palpitation may prompt a Doppler test, but it does not necessarily denote a contraindication for surgery. However, the use of the saphenous vein for bypass grafts in these patients may result in delayed healing. It is also relevant in the postoperative period for all patients, particularly those requiring intra-aortic balloon counterpulsation or antiembolism stockings, both of which are contraindicated in the presence of peripheral vascular disease. If the patient requires coronary artery bypass grafts, the legs should be assessed for varicose veins or previous surgery. Their presence may prevent the use of the saphenous vein from the affected limb(s). The suitability of the radial and ulnar artery as a conduit should be assessed by an Allen's test. Any delay in the resolution of the blanching could prevent the use of the radial artery. Further investigation by Doppler ultrasonography will provide a more accurate report on the patency of vessels. A patient with a history of alcoholism or alcohol abuse has an increased risk of intraoperative bleeding, in addition to postoperative hepatic dysfunction or delirium. It may also affect the type of surgery performed and subsequent treatment (e.g., the use of a metal or tissue valve prosthesis).

Outcomes and Risk Stratification

There are at least four clinical outcomes of interest to surgeons dealing with cardiac surgical patients: **mortality**, **serious nonfatal morbidity**, **resource utilization**, and **patient satisfaction**. In an effort to predict the postoperative morbidity and mortality, classification systems have evolved, the most common being the American Society of Anesthesiologists (ASA) physical status classification (Table 5). This simple system assigns a number to different degrees of morbidity and it correlates with pre- and postoperative mortality.

Cardiac surgery continues to be a difficult area for outcome prediction, but much effort has gone into predicting operative risk based on general preoperative conditions and perioperative risk. Two widely used, simple and fairly reliable systems are the **Parsonnet Score** and the **EuroScore** (European System for Cardiac Operative Risk). By adding the number allocated to the factor, the risk of mortality can be calculated. Assessment of risk is important on two counts. The mortality rates of surgeons are under scrutiny from outside sources, and patients