

Preoperative evaluation and preparation for anesthesia and surgery

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Abstract

The ultimate goals of preoperative medical assessment are to reduce the patient's surgical and anesthetic perioperative morbidity or mortality, and to return him to desirable functioning as quickly as possible. It is imperative to realize that "perioperative" risk is multifactorial and a function of the preoperative medical condition of the patient, the invasiveness of the surgical procedure and the type of anesthetic administered. A history and physical examination, focusing on risk factors for cardiac and pulmonary complications and a determination of the patient's functional capacity, are essential to any preoperative evaluation. Laboratory investigations should be ordered only when indicated by the patient's medical status, drug therapy, or the nature of the proposed procedure and not on a routine basis. Persons without concomitant medical problems may need little more than a quick medical review. Those with comorbidity should be optimized for the procedure. Proper consultations with appropriate medical services should be obtained to improve the patient's health. These consultations should ideally *not* be done in a "last second" fashion. The preoperative preparation involves procedures that are implemented based on the nature of the expected operation as well as the findings of the diagnostic workup and the preoperative evaluation. *Hippokratia* 2007; 10 (1): 13-21

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Surgical procedures and administration of anesthesia are associated with a complex stress response that is proportional to the magnitude of injury, total operating time, amount of intraoperative blood loss and degree of postoperative pain. The adverse metabolic and hemodynamic effects of this stress response can present many problems in the perioperative period. Decreasing the stress response to surgery and trauma is the key factor in improving outcome and lowering the length of hospital stay as well as the total costs of patients care.

It is well recognized that safe and efficient surgical and anesthesia practice requires an *optimized* patient. Several of the large-scale epidemiological studies have indicated that inadequate preoperative preparation of the patient may be a major contributory factor to the primary causes of perioperative mortality¹⁻⁵.

The following primary goals of preoperative evaluation and preparation have been identified^{1, 3}:

1. Documentation of the condition(s) for which surgery is needed.
2. Assessment of the patient's overall health status.
3. Uncovering of hidden conditions that could cause problems both during and after surgery.
4. Perioperative risk determination.
5. Optimization of the patient's medical condition in order to reduce the patient's surgical and anesthetic perioperative morbidity or mortality.
6. Development of an appropriate perioperative care plan.

7. Education of the patient about surgery, anesthesia, intraoperative care and postoperative pain treatments in the hope of reducing anxiety and facilitating recovery.

8. Reduction of costs, shortening of hospital stay, reduction of cancellations and increase of patient satisfaction.

General Health Assessment

The history

The history is the most important component of the preoperative evaluation. The history should include a past and current medical history, a surgical history, a family history, a social history (use of tobacco, alcohol and illegal drugs), a history of allergies, current and recent drug therapy, unusual reactions or responses to drugs and any problems or complications associated with previous anesthetics. A family history of adverse reactions associated with anesthesia should also be obtained. In children, the history should also include birth history, focusing on risk factors such as prematurity at birth, perinatal complications and congenital chromosomal or anatomic malformations and history of recent infections, particularly upper and lower respiratory tract infections.

The history should include a complete review of systems to look for undiagnosed disease or inadequately controlled chronic disease. Diseases of the cardiovascular and respiratory systems are the most relevant in respect of fitness for anesthesia and surgery^{1, 3}.

Physical examination

The physical examination should build on the information gathered during the history. At a minimum, a focused preanesthesia physical examination includes an assessment of the airway, lungs and heart, with documentation of vital signs⁶. Unexpected abnormal findings on the physical examination should be investigated before elective surgery.

Laboratory work up

It is generally accepted that the clinical history and physical examination represent the best method of screening for the presence of disease. Routine laboratory tests in patients who are apparently healthy on clinical examination and history are not beneficial or cost effective. A clinician should consider the risk-benefit ratio of any ordered lab test. When studying a healthy population, 5% of patients will have results which fall outside the normal range. Lab tests should be ordered based on information obtained from the history and physical exam, the age of the patient and the complexity of the surgical procedure⁶⁻⁹ (Table 1).

Table 1. Indications for specific preoperative tests

Complete blood count
Major surgery Chronic cardiovascular, pulmonary, renal, or hepatic disease; or malignancy Known or suspected anemia, bleeding diathesis, or myelosuppression Less than one year of age
International Normalized Ratio (INR), Activated Partial Thromboplastin Time (aPTT)
Anticoagulant therapy Bleeding diathesis Liver disease
Electrolytes & creatinine
Hypertension Renal disease Diabetes Pituitary or adrenal disease Digoxin or diuretic therapy, or other drug therapies affecting electrolytes
Fasting glucose
Diabetes (should be repeated on day of surgery)
Electrocardiograph
Heart disease, hypertension, diabetes Other risk factors for cardiac disease (may include age) Subarachnoid or intracranial hemorrhage, cerebrovascular accident, head trauma
Chest radiograph
Cardiac or pulmonary disease Malignancy

Drug history

A history of medication use should be obtained in all patients. Especially, the geriatric population consumes more systemic medications than any other group. Numerous drug interactions and complications arise in this population and special attention should be paid to them¹⁰.

Generally, administration of most drugs should be continued up to and including the morning of operation, although some adjustment in dosage may be required (e.g. antihypertensives, insulin).

Some drugs should be discontinued preoperatively. The monoamine oxidase inhibitors should be withdrawn 2-3 weeks before surgery because of the risk of interactions with drugs used during anesthesia. The oral con-

traceptive pill should be discontinued at least 6 weeks before elective surgery because of the increased risk of venous thrombosis.

Recently, the American Society of Anesthesiologists (ASA) examined the use of herbal supplements and the potentially harmful drug interactions that may occur with continued use of these products preoperatively¹¹⁻¹³. All patients are requested to discontinue their herbal supplements at least 2 weeks prior to surgery.

The use of medications that potentiate bleeding needs to be evaluated closely, with a risk-benefit analysis for each drug and with a recommended time frame for discontinuation based on drug clearance and half-life characteristics. Aspirin should be discontinued 7-10 days before surgery to avoid excessive bleeding and thienopyridines (such as clopidogrel) for 2 weeks before surgery. Selective cyclooxygenase-2 (COX-2) inhibitors do not potentiate bleeding and may be continued until surgery. Oral anticoagulants should be stopped 4-5 days prior to invasive procedures, allowing INR to reach a level of 1.5 prior to surgery¹⁴.

Perioperative risk assessment

Perioperative risk is a function of the preoperative medical condition of the patient, the invasiveness of the surgical procedure and the type of anesthetic administered.

The *ASA grading system* was introduced originally as a simple description of the physical state of a patient (Table 2). Despite its apparent simplicity, it remains one of the few prospective descriptions of the patient general health which correlates with the risk of anesthesia and surgery¹⁵⁻¹⁶. It is extremely useful and should be applied to all patients who present for surgery. Increasing physical status is associated with increasing mortality. Emergency surgery increases risk dramatically, especially in patients in ASA class 4 and 5.

Surgical complications occur frequently. One large study¹⁷ documented at least one complication in 17% of surgical patients. Surgery-related morbidity and mortality generally fall into one of three categories: cardiac, respiratory and infectious complications¹⁷. The overall risk for *surgery-related complications* depends on individual factors and the type of surgical procedure. For example, advanced age places a patient at increased risk for surgical morbidity and mortality. The reason for an age-related increase in surgical complications appears to correlate with an increased likelihood of underlying disease states in older persons¹⁸. Diseases associated with an increased risk for surgical complications include respiratory and cardiac disease, malnutrition and diabetes mellitus⁷. With respect to the type of surgery, major vascular, intraabdominal and intrathoracic surgical procedures, as well as intracranial neurosurgical procedures are frequently associated with increased perioperative morbidity and mortality¹⁹⁻²⁰. In addition, urgent and emergency procedures constitute higher risk situations than elective, nonurgent surgery and present a limited op-

Table 2. American Society of Anesthesiologists' Classification of Physical Status

Status	Disease State
ASA class 1	No organic, physiologic, biochemical, or psychiatric disturbance
ASA class 2	Mild to moderate systemic disturbance that may or may not be related to the reason for surgery <i>Examples:</i> Heart disease that only slightly limits physical activity, essential hypertension, diabetes mellitus, anemia, extremes of age, morbid obesity, chronic bronchitis
ASA class 3	Severe systemic disturbance that may or may not be related to the reason for surgery, (<i>does limit activity</i>) <i>Examples:</i> Heart disease that limits activity, poorly controlled essential hypertension, diabetes mellitus with vascular complications, chronic pulmonary disease that limits activity, angina pectoris, history of prior myocardial infarction
ASA class 4	Severe systemic disturbance that is life-threatening with or without surgery <i>Examples:</i> Congestive heart failure, persistent angina pectoris, advanced pulmonary, renal, or hepatic dysfunction
ASA class 5	Moribund patient who has little chance of survival but is submitted to surgery as a last resort (resuscitative effort) <i>Examples:</i> Uncontrolled hemorrhage as from a ruptured abdominal aneurysm, cerebral trauma, pulmonary embolus.
ASA class 6	A declared brain-dead patient whose organs are being removed for donor purposes
E	An "E" is added to the status number to designate an emergency operation

portunity for preoperative evaluation and treatment.

When one looks at strictly *anesthetic problems* that lead to morbidity and mortality, airway problems and failure to provide adequate ventilation leading to hypoxia become important. Fortunately the number of critical incidents involving anaesthetics alone appear to be decreasing in recent years¹⁵.

Assessing cardiovascular risk

The American College of Cardiology (ACC) and the American Heart Association (AHA) published a task force report on Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery¹⁹. The purpose is to provide a framework for considering cardiac risk of noncardiac surgery in a variety of patients and operative situations.

The factors which guide decision making include the patient's cardiovascular risk and functional capacity and the surgery specific risk (Tables 3-5).

Patients' risk factors are usually subdivided into three categories: major, intermediate and minor (Table 3). A 6-week period is necessary for the myocardium to heal after an infarction and for the thrombosis to resolve. Patients with coronary revascularization done within the preceding 40 days should also be classified as high-risk patients. Because of sympathetic stimulation and hypercoagulability during and after surgery, *patients with major predictors have a five times greater perioperative risk*. Only vital or emergency surgical procedures should therefore be considered for these patients. All elective operations should be postponed and the patients properly investigated and treated.

Table 3. Patient-Related Predictors for Risk of Perioperative Cardiac Complications

<p>Major clinical predictors (markers of unstable coronary artery disease)</p> <ul style="list-style-type: none"> Myocardial infarction <6 weeks Unstable or severe angina (class III-IV) Decompensated congestive heart failure Significant arrhythmias (e.g., causing hemodynamic instability) Severe valvular disease (e.g., aortic or mitral stenosis with valve area <1.0 cm²) CABG or PTCA <6 weeks
<p>Intermediate clinical predictors (markers of stable coronary artery disease)</p> <ul style="list-style-type: none"> Previous myocardial infarction >6 weeks and <3 months (>3 months if complicated) based on the history or the presence of pathologic Q waves Mild angina (class I-II) Silent ischemia (Holter monitoring) Compensated congestive heart failure, ejection fraction <0.35 Post CABG or PTCA >6 weeks and <3 months, or >6 yr, or with anti-anginal therapy Diabetes mellitus Renal insufficiency
<p>Minor clinical predictors (increased probability of coronary artery disease)</p> <ul style="list-style-type: none"> Familial history of coronary artery disease Age >70 yr ECG abnormalities (arrhythmia, LVH, left bundle branch block) Low functional capacity History of stroke Uncontrolled systemic hypertension Hypercholesterolemia Smoking Post infarction (>3 months), asymptomatic without treatment Post CABG or PTCA >3 months and <6 yr, and no symptoms of angina nor anti-anginal therapy
<p>CABG= coronary artery bypass grafting, PTCA= percutaneous transluminal coronary angioplasty, LVH=left ventricular hypertrophy</p>

Intermediate-risk factors are proof of well established but controlled coronary artery disease. Diabetes mellitus is included in this category because it is frequently associated with silent ischemia and represents an independent risk factor for perioperative mortality.

Minor risk factors are markers of an increased probability of coronary artery disease, but not of an increased perioperative risk (Table 3).

Exercise tolerance is a major determinant of perioperative risk. It is usually evaluated by the estimated energy requirement for various activities and graded in metabolic equivalents (MET) on a scale defined by the Duke Activity Status Index (Table 4). One MET represents the oxygen consumption of a resting adult (3.5 ml/kg/min).

Table 4. Examples of Functional Capacity

1-4 METs	Standard light home activities Walk around the house Walk 1-2 blocks on level ground at 3-5 km/h
5-9 METs	Climb a flight of stairs, walk up a hill Walk on level ground at >6 km/h Run a short distance Moderate activities (golf, dancing, mountain walk)
≥10 METs	Strenuous sports (swimming, tennis, bicycle) Heavy professional work
METs=metabolic equivalents of oxygen consumption	

Surgical procedures can be stratified into three categories, according to their level of perioperative physiological stress (Table 5).

Table 5. Surgery-Related Predictors for Risk of Perioperative Cardiac Complications

High risk procedures (cardiac complication rate >5%) Emergency surgery Aortic and major vascular surgery Prolonged surgical procedures with large fluid shifts or blood loss Unstable hemodynamic situations
Intermediate risk procedures (cardiac complication rate 1-5%) Abdominal or thoracic surgery Neurosurgery ENT procedures Minor vascular surgery, including carotid endarterectomy Orthopedic surgery Prostatectomy
Low risk procedures (cardiac complication rate <1%) Breast surgery Superficial surgery Eye surgery Endoscopic procedures Plastic and reconstructive surgery Ambulatory surgery

Previous MI

Till recently it was accepted generally that a MI within 6 months of proposed surgery is a contraindication to elective anesthesia and surgery. It appears now that the risk after a previous infarction is related less to the age of the infarction than to the functional status of the ventricles and to the amount of myocardium at risk from further ischemia. A small infarction without residual angina in the context of a good functional status allows

essential non-cardiac surgery as soon as 6 weeks after the ischemic episode. On the contrary, a patient with a large infarct, residual symptoms and ejection fraction <0.35 has a high probability of a further cardiac event, even 6 months after the infarction. Usual 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. The period from 6 weeks to 3 months is of intermediate risk; this period is extended beyond 3 months in cases with complications such as arrhythmias, ventricular dysfunction or continued medical therapy. In uncomplicated cases, no benefit can be demonstrated for delaying surgery more than 3 months after an ischemic accident¹⁹.

Recent data have shown that any event in the coronary circulation, (ischemia, infarction, or revascularization), induces a high-risk period of 6 weeks and an intermediate-risk period of 3 months. A 3-month minimum delay is therefore indicated before performing non-cardiac surgery after myocardial infarction or revascularization. However, this delay may be too long if an urgent surgical procedure is requested, as for instance with rapidly spreading tumors, impending aneurysm rupture, infections requiring drainage, or bone fractures. In these situations, recent studies, have demonstrated a marked benefit of operating under the protection of β_1 -adrenergic antagonism, which reduces the cardiac complication rate in such patients. When possible, beta-blockers should be started days or weeks before elective surgery, with a target heart rate between 50 and 60 beats per minute²⁰.

What are defined as perioperative cardiac complications?

Myocardial infarction, pulmonary edema, ventricular fibrillation, primary cardiac arrest, or complete heart block are defined as major perioperative cardiac complications. *Perioperative MI*: usually presents atypically (without chest pain), occurs within the first 2 days of surgery and carries a high mortality. The rate of post-operative myocardial infarction is 0.7% after general surgery in a male population over 50 yr old, but increases to 3.1% after vascular surgery where the prevalence of asymptomatic coronary artery disease is particularly high^{17,21}. Should a MI occur, the mortality rate remains at 40% to 70%²¹. The ACC/AHA Guidelines for Perioperative Cardiovascular Evaluation for Non-cardiac Surgery offer recommendations for a patient suffering a perioperative MI. These include consideration for prompt angioplasty, aspirin, beta-blockade and possible angiotensin converting enzyme inhibitor therapy¹⁹.

Management recommendations

Given an *acute surgical emergency*, preoperative evaluation might have to be limited to simple and critical tests such as a rapid assessment of cardiovascular vital signs, volume status, hematocrit, electrolytes, renal function, urine analysis and ECG. Only the most essential

tests and interventions are appropriate until the acute surgical emergency is resolved. A more thorough evaluation can be conducted after surgery.

The decision to proceed with *elective* surgery begins with an assessment of risk. The clinician should assess the patient's preoperative risk factors and the risks associated with the planned surgery. It is often helpful to give an estimate of the percentage risk of cardiac complications (see above, by risk class) so that the surgeon can make the most educated decision regarding whether or not to proceed with surgery.

The decision to undergo further testing depends upon the interaction of the patient's risk factors, surgery-specific risk and functional capacity.

If a major risk predictor is present, nonemergency surgery should be delayed for medical management, risk factor modification and possible coronary angiography. For patients at intermediate clinical risk, both the exercise tolerance and the extent of the surgery are taken into account with regard to the need for further testing.

Patients with poor functional status should undergo noninvasive cardiac testing unless low-risk surgery is planned. Patients with good or excellent functional status require noninvasive testing only if they are having high-risk surgery. Finally, patients with minor risk predictors or no risk predictors should have noninvasive testing if they have poor functional status and are about to undergo high-risk surgery. *Importantly, no preoperative cardiovascular testing should be performed if the results will not change perioperative management.*

The results of noninvasive testing can then be used to determine further perioperative management. Such management may include intensified medical therapy or cardiac catheterization, which may lead to coronary revascularization or potentially to cancellation or delay of the elective noncardiac operation. Alternatively, results of the noninvasive test may lead to a recommendation to proceed directly with surgery. In some patients, the risk of coronary angioplasty or corrective cardiac surgery may approach or even exceed the risk of the proposed noncardiac surgery. In some instances, this approach may be appropriate, however, if it also significantly improves the patient's long-term prognosis.

Assessing pulmonary risk

A careful history taking and physical examination are the most important parts of preoperative pulmonary risk assessment. The role for preoperative pulmonary function testing remains uncertain. No data suggest that spirometry identifies a high-risk group that would not otherwise be predicted by the history and physical examination. Spirometry may be useful when there is uncertainty about the presence of lung impairment. It should be used *selectively* when the information it provides will change management or improve risk stratification.

Postoperative pulmonary complications (PPCs) such as pneumonia, atelectasis, bronchitis, bronchospasm,

hypoxemia, respiratory failure with prolonged mechanical ventilation or exacerbation of underlying chronic lung disease, increase patient morbidity and mortality and prolong the length of hospital stay after surgery²³. PPCs occur in approximately 20-30% of patients undergoing major, non thoracic surgery.

The *risk factors for PPCs* include the following²⁴:

Procedure-related risk factors: primarily based on how close the surgery is to the diaphragm (*i.e.* upper abdominal and thoracic surgery are the highest risk procedures).

Length of surgery (> 3 hours) and general anesthesia (vs. epidural or spinal).

Emergency surgery.

Underlying chronic pulmonary disease or symptoms of respiratory infection.

Smoking.

Age >60 years.

Obesity.

Presence of obstructive sleep apnea.

Poor exercise tolerance or poor general health status.

The most significant of these risk factors is the *site of surgery*, with abdominal and thoracic surgery having pulmonary complication rates ranging from 10 to 40 percent²⁵. As a rule, the closer the surgery is to the diaphragm, the higher the risk of pulmonary complications. The most important modifiable risk factor is *smoking*. The relative risk of pulmonary complications among smokers as compared with nonsmokers ranges from 1.4 to 4.3. Unfortunately, the risk declines only after eight weeks of preoperative cessation²⁶. This interval allows the mucociliary transport mechanism to recover, the secretions to decrease and the carbon monoxide levels in the blood to drop.

The presence of either *obstructive or restrictive pulmonary disease* places the patient at increased risk of developing perioperative respiratory complications. If significant pulmonary disease is suspected by history or physical examination, determination of functional capacity, response to bronchodilators and/or evaluation for the presence of carbon dioxide retention through arterial blood gas analysis may be justified.

For elective anesthesia and surgery in a patient with a history of *asthma*, the asthmatic condition should be under control and the patient should be free of wheezing, with a peak flow greater than 80% of predicted. If necessary, the patient should receive a short course of steroids (60 mg of prednisone daily or the equivalent) prior to surgery to achieve this goal²⁷⁻²⁸. If the patient takes drugs regularly, treatment must not be discontinued. Any patient who has previously been admitted to hospital for an asthmatic attack should be carefully assessed, because airway reactivity persists for several weeks after an asthmatic episode.

The increased frequency of PPCs in patients with chronic obstructive pulmonary disease (COPD) may be

explained by co-morbidities (e.g. cardiovascular disease) rather than by airway obstruction. Patients with COPD may have chronically fatigued respiratory muscles. Impaired nutrition, electrolyte and endocrine disorders can contribute to respiratory muscle weakness and should be corrected before surgery. Patients with COPD should be examined for unrecognized cor pulmonale; if present, it should be treated before surgery²⁹⁻³⁰.

Generally, all patients with COPD / asthma who require home oxygen therapy or have required hospitalization for respiratory problems in the past 6 months are assumed to be at greater risk.

Patients with obstructive sleep apnea (OSA) are prone to postoperative hypoxemia quickly after emergence from general anesthesia. The sedative and respiratory depressant effects of general anesthesia place the patient with OSA at significantly increased risk of airway obstruction and respiratory compromise in the perioperative period. It is prudent to diagnose OSA preoperatively so special treatments applied appropriately³¹.

Diabetes mellitus

Perioperative morbidity and mortality are greater in diabetic than in non-diabetic patients. When a diabetic patient needs surgery, *it is important to remember that he or she is more likely to be harmed by neglect of the long term complications of diabetes than from the short term control of blood glucose levels.* The majority of long-standing diabetics develop compromise in one or more organs. The diabetic patient who needs elective surgery should be carefully assessed preoperatively for symptoms and signs of peripheral vascular, cerebrovascular and coronary disease. Co-existing pathologies must be identified and carefully managed perioperatively.

Diabetics have a higher incidence of death after MI than non-diabetics. Myocardial ischemia or infarction may be clinically "silent" if the diabetic has autonomic neuropathy. Therefore, a high index of suspicion for myocardial ischemia or infarction should be maintained throughout the perioperative period if unexplained hypotension, dysrhythmias, hypoxemia or ECG changes develop. Eight to 31% of type 2 diabetics are reported to have asymptomatic coronary artery disease on stress testing. Administration of perioperative beta-blockers should be considered in diabetic patients with coronary artery disease to limit perioperative ischemia. Despite prior controversy regarding the use of beta blockade in diabetics (due to concerns of worsened glucose intolerance and masking symptoms of hypoglycemia), it is emphasized that diabetics benefit as much or more than the non-diabetic population from post-MI beta blockade³²⁻³³.

Adequate control of blood glucose concentration (< 180 mg/dL) must be established preoperatively and maintained until oral feeding is resumed after operation. Oral hypoglycemic agents are withheld the day of surgery for an agent with a short half-life and up to 48 h

preoperatively for a long acting agent such as chlorpromamide. A combination of glucose and insulin is the most satisfactory method of overcoming the deleterious metabolic consequences of starvation and surgical stress in the diabetic patient. Generally, there is no need for insulin infusion in diabetics who are diet-controlled regardless of type of surgery, or in diabetics who are on oral agents only and are undergoing minor surgeries.

Complications of perioperative *hyperglycemia* include dehydration, impaired wound healing, inhibition of white blood cell chemotaxis and function (associated with an increased risk of infection), worsened CNS and spinal cord injury under ischemic or hypoxic conditions and hyperosmolarity leading to hyperviscosity and thrombogenesis. A glucose level > 180 mg/dL (10 mmol/L) results in osmotic diuresis; glycosuria may lead to dehydration and increases the risk of urinary tract infection. As a general rule in a 70 kg patient, 1 unit/h of regular insulin lowers the glucose by approximately 25-30 mg/dL (1.5 mmol/L).

Hypoglycemia [a glucose < 50 mg/dL (2.8 mmol/L) in adults and < 40 mg/dL (2.2 mmol/L) in children] may develop postoperatively due to residual effects of long-acting oral hypoglycemic agents or insulin preparations given preoperatively, in addition to perioperative fasting. Recognition of hypoglycemia in the perioperative period may be delayed because anesthetics, analgesics, sedatives and sympatholytics agents alter the usual presenting symptoms of hypoglycemia. In addition, diabetics with autonomic neuropathy have blunting of the adrenergic symptoms associated with hypoglycemia. These symptoms generally begin with confusion, irritability, fatigue, headache and somnolence and may progress to seizures, focal neurologic deficits, coma and death³².

Perioperative management of Anticoagulation Surgery in the anticoagulated patient

In performing noncardiac surgery on patients on long-term oral anticoagulation, the major concern is when it is safe to perform surgery without increasing the risk of hemorrhage or increasing the risk of thromboembolism (venous, arterial) after discontinuing oral anticoagulation therapy. There is no consensus as to how perioperative anticoagulation should be managed. Listed below are some helpful recommendations that can be used along with clinical judgment in order to come up with a solution for the individual patient³⁴⁻³⁷:

1. Most patients can undergo dental extractions, arthrocentesis, biopsies, ophthalmic operations and diagnostic endoscopy without alteration of their regimen. For other invasive and surgical procedures, oral anticoagulation needs to be withheld and the decision whether to pursue an aggressive strategy of perioperative administration of intravenous (IV) heparin or subcutaneous (SC) low-molecular-weight heparin (LMWH) should be individualized.

2. Invasive surgery is generally safe (from major hemorrhagic complication) when the INR ~1.5.

3. It takes approximately 4 days for the INR to reach 1.5 once oral anticoagulant is stopped preoperatively.

4. It takes approximately 3 days for the INR to reach 2.0 once oral anticoagulant is restarted postoperatively.

5. If oral anticoagulant is held 4 days pre-op and started immediately post-op, the patient is, in the mean time, without anticoagulation for 2 days (24 hours pre-op and 24 hours post-op).

Management recommendations:

1. If INR pre-op is 2-3, stop oral anticoagulant 4 days prior to surgery (or longer if INR > 3.0).

2. Measure INR one day prior to surgery: if it is ≥ 1.7 , give 1 mg vitamin K SC.

3. If on the day of surgery the INR is 1.3-1.7, administer 1 unit of fresh frozen plasma and administer 2 units if the INR is 1.7-2.0.

4. The following approaches can be used: administer full-dose anticoagulation with IV unfractionated heparin (UFH); administer full-dose anticoagulation with LMWH; or administer prophylactic doses of UFH or LMWH.

Regional anesthesia in the anticoagulated patient

Regional anesthesia has become the anesthetic technique of choice for many surgical procedures³⁸. However, the enthusiasm for selecting regional anesthesia is tampered by the fear of a spinal or epidural hematoma. This fear arises because patients who present for procedures where a regional technique would be of benefit often have some impairment of their hemostatic system (e.g., a pregnant patient with preeclampsia and thrombocytopenia, an orthopedic patient receiving thromboprophylaxis, or vascular surgery patients who are often completely anticoagulated intraoperatively).

Regional anesthesia can be safely performed in patients receiving anticoagulant or antiplatelet therapy provided that *patient management is based on appropriate timing of needle placement and catheter removal relative to the timing of anticoagulant drug administration*. The patient's coagulation status should be optimized at the time of spinal or epidural needle/catheter placement and the level of anticoagulation must be carefully monitored during the period of epidural catheterization. Indwelling catheters should not be removed in the presence of therapeutic anticoagulation, as this appears to significantly increase the risk of spinal hematoma. Vigilance in monitoring is critical to allow early evaluation of neurologic dysfunction and prompt intervention³⁹⁻⁴⁰.

Patient Receiving Thrombolytic Therapy

Patients receiving fibrinolytic/thrombolytic medications are at risk of serious hemorrhagic events:

1. Thrombolytic drugs should be avoided for 10 days following lumbar puncture, spinal or epidural anesthesia, or epidural steroid injection.

2. Spinal or epidural anesthesia are contraindicated

in patients receiving fibrinolytic and thrombolytic drugs. Data are not available to clearly outline the length of time neuraxial puncture should be avoided after discontinuation of these drugs.

Patient Receiving Unfractionated Heparin

Monitoring of the therapeutic anticoagulation of patients receiving UFH is achieved via the activated partial thromboplastin time (aPTT). Normal values of the aPTT range from 24 to 35 s.

1. During subcutaneous mini-dose prophylaxis (5,000 units 2 h before surgery) there is no contraindication to the use of spinal/epidural anesthesia.

2. When intraoperative anticoagulation with heparin during vascular surgery is combined with a neuraxial technique the following cautions are essential:

a) The technique should be avoided in patients with other coagulopathies.

b) Heparin administration should be delayed for 1 h after needle placement.

c) Epidural catheters should be removed 2-4 h after the last heparin dose, while re-heparinization should occur 1 h after catheter removal.

3. The concurrent use of medications that affect other components of the clotting mechanisms (antiplatelet medications, LMWH and oral anticoagulants) may increase the risk of bleeding complications for patients receiving standard heparin.

Patient Receiving Low Molecular Weight Heparin (LMWH)

In the United States (US) the usual dosing regimen for postsurgical deep vein thrombosis (DVT) prophylaxis with enoxaparin is 30 mg SC, every 12 h, with the initial dose administered 12-24 h postoperatively. The European enoxaparin dosing protocol consists of 40 mg SC/day. However, the European regimen is associated with a much lower incidence of epidural hematoma formation.

1. LMWH prophylaxis with European regimens (e.g. 40 mg enoxaparin daily) does not seem to increase the risk of spinal bleeding, providing that *a minimum interval of 10-12 h has elapsed between administration and puncture*.

2. The next dose of LMWH should not be given less than 4 h after puncture.

3. Epidural or spinal catheters should not be removed until *at least 12 h after the last dose of LMWH*. Subsequent LMWH dosing should occur at least 2 h after catheter removal.

4. Antiplatelet or oral anticoagulant medications administered in combination with LMWH and interactions of LMWH with dextrans may increase the risks of spinal hematoma formation.

5. In patients scheduled for spinal or epidural block, *thromboembolic prophylaxis with LMWH should be started on the evening before surgery and continued on the evening of the day of surgery*. This dosage has a similar thromboembolic efficacy as that starting on the morning of surgery.

6. If one elects to use twice-daily dosing as per the US protocol (30 mg q12h), the first dose of LMWH should be administered no earlier than 24 h postoperatively, regardless of anesthetic technique and only in the presence of adequate hemostasis.

Patients receiving Fondaparinux

Fondaparinux (FONDA) is a pentasaccharide with antithrombotic effects. It is a selective factor Xa inhibitor with no known effects upon platelet function. However, thrombocytopenia can occur with the administration of FONDA and platelet counts should be closely monitored. The daily dose of FONDA is 2.5 mg SC, with the first dose given six to eight hours after the completion of surgery. The second and all subsequent doses, should be administered at 24 h intervals. Until further clinical experience is available, performance of neuraxial techniques is *not* recommended given the sustained antithrombotic effect, early postoperative dosing and irreversibility of this agent.

Patients receiving oral anticoagulants (vitamin K antagonists)

1. The spinal or epidural block is contraindicated in the patient who is fully anticoagulated with a vitamin K antagonist such as warfarin or acenocumarol (Sintrom).

2. If the surgery is emergent, the anticoagulation can rapidly be reversed through the administration of fresh frozen plasma, vitamin K, or prothrombin complex concentrate and the INR value should be ~ 1.5 prior to neuraxial block or surgery.

3. If the surgery is elective, the anticoagulant therapy must be stopped 4-5 days prior to the planned procedure, allowing INR to reach a level of 1.5.

4. Epidural catheters should be removed when the INR is <1.5.

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs), antiplatelet medications and spinal axis anesthesia:

Many individuals, in particular the elderly (who more often suffer from osteoarthritis and rheumatoid diseases), use cyclooxygenase-1&2 inhibitors (COX-1 & COX-2) NSAIDs on a regular basis. The elderly are also more likely to have had cardiac stent placements or coronary angioplasties performed and may be taking antiplatelet medications such as the thienopyridines (ticlopidine and clopidogrel) or the newer platelet glycoprotein (GP) IIb/IIIa antagonists such as abciximab, eptifibatide and tirofiban. All of these agents alter platelet function and may increase the risk of spinal/epidural hematoma formation if spinal axis anesthesia is utilized without following proper precautions.

Patients receiving aspirin or a NSAID:

1. The American Society of Regional Anesthesia (ASRA) suggests that the use of COX-1 or COX-2 NSAIDs alone does not create a level of risk that will interfere with the performance of neuraxial blocks.

2. Two European Societies (German and Spanish) believe that there is a risk of hematoma formation when these agents are used in the perioperative period and

they mandate at least a 3-day interval without aspirin or aspirin containing medications before neuraxial blocks are performed or epidural catheters are removed. In addition, they mandate a 1-2 day drug free interval for all other COX-1 NSAIDs.

Patients receiving antiplatelet drugs:

ASRA guidelines are the following:

1. Ticlopidine (Ticlid) should be discontinued 14 days prior to surgery.

2. It is recommended that clopidogrel (Plavix) be stopped 7 days prior to surgery.

Patients receiving platelet Glycoprotein IIb/IIIa Antagonists:

ASRA guidelines are the following:

1. Abciximab (Reo Pro) should be discontinued 48 h prior to surgery.

2. It is recommended that eptifibatide and tirofiban be stopped 8 h prior to surgery.

What are the presenting signs and symptoms of a spinal/epidural hematoma and how does one manage this potentially catastrophic event?

Prompt recognition and treatment of this condition is essential for optimizing recovery of neurologic function in these patients. An immediate MRI study should be obtained in every patient who develops new onset neurologic deficits following the placement of a neuraxial block or removal of an epidural catheter. If the MRI study identifies the presence of a neuraxial hematoma, immediate surgical decompression is the treatment of choice.

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