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The perioperative period is defined as the time before, during and after the operative procedure. Preoperative testing should include pregnancy testing for the female of childbearing age, assessment of the patients nutritional status, and hemoglobin in all female patients. Other tests should be ordered on the basis of history and the procedure planned. The rest of this paper will concentrate on specific problems in perioperative care.

Preoperative Malnutrition

Patients need to be assessed preoperatively for malnutrition. Mild to moderate malnutrition requires a recent weight loss of 6% to 12% of the normal body weight in the preceding 3-6 months. The serum albumin in these patients should be greater than 3.5 g/dl and serum transferrin should be greater than 200mg/dl. In the majority of mild to moderate malnutrition cases, treatment can be taken care of in the post-operative period by attention to the specific nutritional needs of the patient. Severe malnutrition is defined as weight loss greater than 12% of normal body weight and albumin and transferrin levels below the previously stated levels. These patients need nutritional replacement(usually via an nasogastric tube or total parental nutrition) 7 to 10 days prior to surgery. Nasogastric or nasojejunal feedings are always better for the patient than the intravenous route. However, in the patient who is unable to tolerate feeding via the enteral route, total parental nutrition is an option. Regardless of the route, attention should be given to the protein levels needed. The normal protein requirement is 0.8 g/ kg/day. The critically ill patient requires more protein in the range of 1.2 to 2.0 g/kg/day.

Patients receiving total parental nutrition(TPN) should be monitored rigorously. This includes assessment of vital signs, urine, glucose, acetone concentrations and fluid balance several times a day. Body weight, electrolytes, BUN, blood glucose, and intake of fluid, protein, and calories are monitored daily. Liver function tests, serum magnesium, total protein, albumin, transferrin, and iron levels need to be measured weekly. In planning the patients postoperative nutrition, tube feedings or TPN need to be initiated if adequate oral intake is not attained in 5 to 7 days.

Hematologic Management

Transfusions allow for rapid correction of hematologic deficiencies. Fresh frozen plasma allows for broad coverage of clotting disorders as it contains all the clotting factors. It does not contain platelets and the fibrinogen levels are low. Cryoprecipitate can be used to treat low fibrinogen levels. Autologous

donations can be made prior to surgery with a maximum of 1U donated every 72 hours up to 72 hours prior to surgery as long as the patient maintains a hematocrit of greater than 33%.

Blood product transfusion should not be taken lightly. Patients need to be monitored for hypersensitivity reactions, volume overload, electrolyte and acid/base imbalance, thrombocytopenia, hypothermia. Citrate toxicity can cause low ionized calcium requiring replacement in the symptomatic patient.

Anemia requiring treatment is defined as a hemoglobin level less than 7g/dl in a surgical case with expected moderate blood loss. Patients who are healthy or chronically anemic may be able to undergo surgery safely with a hemoglobin at this level if the expected blood loss is minimal. Sickle cell condition is divided into two categories. Sickle cell trait is the heterozygous condition and is not associated with increased surgical risk. Sickle cell anemia is the homozygous condition and these patients require the level of hemoglobin S reduced to 50% by exchange transfusion prior to surgery. Special attention should be paid to avoid dehydration, hypoxia, and hypernatremia in these patients. Glucose-6-phosphate dehydrogenase deficiency is another condition which should be noted preoperatively. This is seen almost exclusively in men and is genetically transmitted. It causes oxidant damage to hemoglobin which causes hemolysis. Certain medications need to be avoided in the postoperative period to avoid hemolysis in these patients.

Thrombocytopenia is defined as platelet count less than 140,000/microliter. Counts less than 50,000/mL can cause bleeding problems during surgery and up to 3 to 4 day postoperatively. In correcting thrombocytopenia, it is important to know that each unit of platelets will raise the count 5,000 to 10,000/mL and the platelet half-life is 2 to 3 days. The differential diagnosis of thrombocytopenia in the postoperative period includes massive transfusion, sepsis, disseminated intraavascular coagulation, and drug induced thrombocytopenia. Qualitative platelet disorders can exist with a normal platelet count and should be suspected in patients with a history of uremia, liver disease, or previous bleeding problems. In addition, drugs such as aspirin and other NSAIDS can cause platelet dysfunction. These disorders can be treated by correcting the underlying condition, platelet transfusion, or giving desmopressin acetate.

Patients who are on anticoagulant therapy deserve special attention preoperatively. It is important to discuss the patient's specific case with his/her internist. The following guidelines apply. Patients who are low risk for developing deep vein thrombosis(DVT) can have their warfarin discontinued 1 to 2 days before and restarted about 5 days after surgery. These patients include those who have an aortic prosthetic valve, atrial fibrillation, or a previous resolved DVT. High risk patients(those with mitral valve problems or history of cardiac emboli) need their warfarin discontinued and heparin begun. In emergency situations, FFP can be given to correct warfarin induced coagulopathy and protamine sulfate to antagonize heparin.

Thromboembolic Diseases

The major risk factors for DVT include immobilization, oral contraceptive use, age greater than 40 years old, hypercoagulable states, and prior history of DVT. Protein C, Protein S and deficiency of antithrombin III can cause a decrease lysis of clots. Preventative measures include use of elastic stockings and pneumatic compression devices, and early mobilization. Suspicion of a DVT is raised when a patient has a positive Homan's sign, unexplained fever, edema, pain, and a palpable cord or discoloration over a leg vein. Diagnosis should be made with use of duplex ultrasound. It should be noted this is less sensitive for calf thrombosis than femoral or iliac thrombosis.

Pulmonary embolism should be suspected in patients with sudden onset tachypnea, dyspnea, chest pain, hemoptysis, hypoxia or arrhythmias. A ventilation/perfusion scan should be ordered. A normal result means there is little chance of a embolus. An abnormal result may necessitate the use of pulmonary angiography depending on the risk of embolus. Therapy for DVT and/or pulmonary embolus is with heparin followed by oral anticoagulants.

Endocrine Abnormalities

Some authors advocate a fasting blood glucose as a routine test because the frequency of diabetes is approximately 1% and rises to 5% of the population aged over 40 years. When a diabetic patient is required

to fast after midnight, the morning dose of insulin or oral agent is withheld. The blood glucose level is measured before the procedure and every two hours thereafter. Short-acting insulin is given on a sliding scale basis as needed. A poorly controlled diabetic patient should be in good control before surgery (e.g. levels 120 to 250 mg/dl). In ketoacidosis, an IV bolus of 12 to 20 U of regular insulin with a constant infusion of 5 to 10 U per hour. Hyperosmolar nonketotic hyperglycemia requires lower insulin doses (0.05–0.10 U/kg hourly). In both conditions, fluid replacement with normal saline at 1 L per hour is started and adjusted accordingly. Potassium replacement is necessary and guided by serum potassium levels. In the later postoperative period, the patient should be continued on a modified insulin dose and i.v. glucose until regular diet and activity is resumed. One half to two thirds of the patient's usual daily dose of intermediate-acting insulin is given each morning, and blood sugar is measured every 6 hours.

For elective surgery in the hypothyroid patient, gradual replacement of hormone is better than rapid replacement due to the risk of relative adrenal insufficiency and angina in patients with coronary insufficiency. Synthetic levothyroxine (T_4) is given with the normal daily dose of 0.1 to 0.2 mg. In severe myxedema, hydrocortisone is also administered because adrenocorticotropic (ACTH) pituitary responsiveness to stress may be decreased. In thyrotoxicosis, thyrotoxic crisis (i.e., thyroid storm) is to be avoided. Elective surgery in hyperthyroid patients should be rescheduled when the patient reaches a euthyroid state. The thyrotoxic patient in the emergent setting may require treatment with iodines, propranolol, and antithyroid drugs, such as propylthiouracil or methimazole. Propylthiouracil blocks thyroid hormone production, inhibits the conversion of T_4 to triiodothyronine (T_3). Iodides inhibit thyroid hormone production and release from the gland and decrease vascularity of the gland, which lasts 10 to 14 days. Palpitations, tachycardia, and tremor can be controlled with propranolol. Hydrocortisone should be given to treat relative adrenal insufficiency. Thyrotoxic crisis is a severe form of thyrotoxicosis and may develop intraoperatively or postoperatively. The patient may have fever, sweating, tachycardia, vomiting, abdominal pain, and delirium. Treatment for thyrotoxicosis is begun as well as supportive therapy including temperature control with acetaminophen or a cooling blanket. Sedation and oxygen therapy may be needed, and adequate intravenous fluids administered.

There is a risk of hypocalcemia in any thyroid or parathyroid surgery. After surgery, serum calcium levels should be obtained every 12 hours for the first few days until stabilized. If the calcium level falls below 8.0 mg/dL, signs or symptoms of hypocalcemia should be sought. A positive Chvostek's or Trousseau's sign, hyperreflexia, numbness or tingling in the extremities, or circumoral paresthesias are indications to begin calcium replacement. Laryngeal stridor or overt tetany require prompt treatment with intravenous calcium. Magnesium, sodium, and albumin levels should be monitored. Patients with prolonged hypocalcemia may require oral calcium replacement and vitamin D replacement.

Adrenal insufficiency in otolaryngology patients is usually due to long-term steroid use with suppression of the hypothalamic-pituitary-adrenal axis. During the stress of surgery, this can cause loss of vascular tone with hypotension that is refractory to fluids or pressor agents. Patients who have been on more than 5 mg of prednisone each day for 3 weeks in the past year are considered to have suppressed production of cortisol and should receive supplemental steroids for surgery. Patients who are currently on steroids, those with known adrenal insufficiencies, and even patients with Cushing's syndrome also should be covered with supplemental steroids.

Diabetes insipidus is caused by a decreased level of antidiuretic hormone (ADH), which decreases free-water reabsorption. This leads to large volumes of dilute urine and hyperosmolarity of the serum. A diagnosis of diabetes insipidus is made when urinary outputs are greater than 200 mL per hour with associated hypernatremia, serum hyperosmolarity, low urinary specific gravity, osmolarity, and sodium. Urine osmolarity is less than 200 mOsm and urine specific gravity less than 1.005. The patient's intake and output, body weights, urine-specific gravity, and serum sodium osmolarity should be monitored. In mild cases, increasing oral intake of water may provide adequate fluids. In more severe cases, i.v. 5% dextrose in water with the minimum required sodium is given. The volume should equal the urinary loss plus insensible losses. For high urinary volumes (i.e., more than 4 L daily), pharmacologic treatment should be

considered. Desmopressin acetate (dDAVP) is a long-acting vasopressin analog given intranasally. It must be used with caution in patients with coronary artery disease. The syndrome of inappropriate ADH secretion is associated with hyponatremia with a urine osmolality that is inappropriately concentrated compared with serum osmolality. Because surgery and trauma cause ADH release, excessive administration of hypotonic i.v. solutions should be avoided. Treatment usually is accomplished by fluid restriction or use of demeclocycline, which inhibits the action of ADH on the kidney.

Cardiovascular Considerations

In asymptomatic patients, a routine electrocardiogram (ECG) is recommended for men aged over 40 and women aged over 55 years. A full cardiac evaluation should be done before surgery for patients with cardiovascular disease signs or symptoms. If the patient is taking cardiac medications (e.g., digitalis), serum levels should be obtained preoperatively. Antihypertensive and cardiac medications should be administered the morning of surgery and resumed immediately postoperatively. Monoamine oxidase inhibitors and guanethidine should be discontinued 2 weeks before surgery because of the possibility of drug interactions or inhibition of circulatory reflexes. All anesthetic agents are vasodilators and negative inotropes. Once anesthesia is discontinued, sympathetic tone returns to the vessels and this can raise the blood pressure. In postoperative hypertension, it is extremely important to understand the cause. The differential diagnosis includes hypervolemia, ventilatory or respiratory failure, pain, residual effects of anesthesia or intraoperative pressor agents, anesthetic-induced hypothermia and shivering, distended stomach or bladder, or manifestations of preexisting hypertension. Treatment is based on correcting the underlying condition. In urgent situations, nitroprusside is given.

The differential diagnosis of hypotension includes hypovolemia, anesthetic agents and medications, pain, sepsis, cardiac dysfunction (e.g., arrhythmias, infarction, failure), pulmonary problems (e.g., inadequate ventilation, emboli, pneumothorax), and electrolyte abnormalities. If a central venous line is not available to monitor intravascular volume, a fluid challenge consisting of 500 mL of normal saline can be given over 10 minutes. If no improvement is evident, a complete cardiac and pulmonary evaluation is necessary. The patient should have a chest radiograph, ECG, arterial blood gas sample, blood cultures if febrile, and insertion of monitoring catheters (e.g., central venous, arterial, and pulmonary artery lines). Vasopressor medication is indicated if significant hypotension is present (i.e., systolic pressure <100 mm Hg) and the patient manifests symptoms of decreased perfusion.

Common causes of arrhythmias include acute cardiac disease, hypoxia, hypotension, acid-base abnormalities, hypokalemia, and central venous or pulmonary artery catheter stimulation of the heart. Supraventricular tachyarrhythmias may be treated with i.v. adenosine, verapamil, propranolol, esmolol, or diltiazem. Intravenous digoxin may be used to control atrial fibrillation or flutter. Ventricular tachycardia is treated with lidocaine. In all cases of tachyarrhythmias, direct current (DC) cardioversion may be necessary if severe hypotension, cardiac ischemia, or congestive heart failure and pulmonary edema develop. Simple bradyarrhythmias (e.g., sinus bradycardia) can be treated with atropine. More significant bradyarrhythmias (e.g., sick sinus syndrome) need cardiac pacing. Any significant cardiac arrhythmia requires a cardiology consult.

Pulmonary Considerations

Mechanical ventilation can result in alveolar hypoventilation with ventilation-perfusion abnormalities. This may become significant depending on the preoperative status of the patient's lung function. Again, a thorough history and physical exam is important paying attention to findings such as dyspnea on exertion, cough, sputum production, and a history of cigarette smoking. A preoperative chest radiograph in asymptomatic patients is suggested by the American College of Surgeons for known pulmonary or cardiac disease, age greater than 40 years, high risk for postoperative pulmonary complications, and a positive

tuberculin test or high risk for unsuspected tuberculosis. If indicated, formal pulmonary function tests can be carried out. The choice of anesthesia is also important. Endotracheal anesthesia with frequent sustained inflation to 20 mL per kilogram or to an airway pressure of 30 cm H₂O should be performed to prevent alveolar collapse. Intravenous crystalloid solutions should be given only as necessary to prevent fluid overload. Postoperatively, treatment with deep-breathing exercises and incentive spirometry is used. If the patient is unable deep breath or use incentive spirometry, continuous positive airway pressure or intermittent positive pressure breathing may help to preventing atelectasis.

Patients who have problems maintaining their oxygen saturations postoperatively require immediate attention. Supplemental oxygen should be administered at 10 liters per minute while a history, physical examination, arterial blood gases, and a chest radiograph are obtained. Treatment of atelectasis involves reexpanding the collapsed segment. Deep-breathing exercises, incentive spirometry, continuous positive airway pressure, and intermittent positive pressure breathing have all been used successfully. Reactive airway disease usually responds to nebulizer treatment. In the case of a mucous plug, bronchoscopy allows direct visualization of the bronchial tree, removal of debris, and culture. If adequate ventilation cannot be obtained, endotracheal intubation and mechanical ventilation are indicated.

Cardiogenic pulmonary edema is usually associated with a pulmonary artery wedge pressure (PAWP) greater than 25 mm Hg. Treatment is usually fluid restriction with the use of diuretics. In patients with cardiopulmonary or renal disease, dobutamine, dopamine, or both may be needed for low cardiac output and to increase renal perfusion. Adult respiratory distress syndrome (ARDS) is associated with pulmonary edema in the presence of normal PAWP. It presents as severe hypoxemia and decreased lung compliance, and on x-ray is evident by diffuse bilateral pulmonary infiltrates. Treatment is by targeting the underlying cause while providing supportive measures.

Gastrointestinal

Prevention of stress ulcers is by reducing gastric acidity (above pH of 4–5), which is best accomplished by use of antacids or histamine-receptor blockers. For massive bleeding, a large-bore nasogastric tube is used to evacuate the blood and a stat GI consult is made. Intravenous cimetidine or ranitidine is given. Angiography with selective injection of vasopressin can be considered as well as arterial embolization or cauterization.

Intestinal motility should be assessed prior to beginning postoperative feeding. Adynamic ileus should be considered in any patient with constipation, prolonged vomiting, abdominal pain and distention, or an absence of bowel sounds. Abdominal radiographs should be obtained and will show a diffuse gas pattern and distended loops of bowel in the case of an ileus. The most common cause is the perioperative administration of pharmacologic agents. The patient usually responds to supportive measures of NPO status, administration of i.v. fluids, and nasogastric suction.

The most significant perioperative diarrhea is antibiotic-associated diarrhea and colitis. The severity of antibiotic-related diarrhea varies from mild diarrhea to pseudomembranous colitis with severe systemic manifestations. Clindamycin and ampicillin are the most common causes, but cephalosporins, erythromycin, penicillin, and trimethoprim-sulfamethoxazole also have been suspected. The stool should be evaluated for bacteria, intestinal parasites, and *Clostridium difficile*. Management is both supportive with fluid management and specific with Vancomycin (125–500 mg orally four times daily) or metronidazole (250 mg orally three times daily) are given for 7 to 14 days for patients who tolerate oral intake.

Renal

Dialysis must be continued before and after surgery to minimize uremic complications such as acid-base, fluid, and electrolyte imbalances. For elective procedures, the patient is dialyzed on the day before and the day after surgery. Platelet dysfunction, low hematocrit, hypertensiton and electrolyte abnormalities can all occur and should be treated accordingly. Special effort to maintain a special renal diet (low protein) and adjustment of medications should be made based on effective renal clearance.

The most common postoperative intrinsic renal cause of acute renal failure is acute tubular necrosis. This can be due to ischemia or nephrotoxicity. Urinalysis will show a hypoosmolar urine with a high sodium content and a low urinary-to-plasma creatinine ratio and the urine will have casts in it. Baseline weight, blood pressure, chemistry and hematologic profile, urinary chemistry and sediment examination should be obtained. Early nephrology consultation should be made.

Neuropsychiatric

Metabolic imbalances may cause seizures. Head trauma, stroke, subarachnoid hemorrhage, central nervous system infections, drug and alcohol withdrawal, cardiac arrhythmias, hypotension, and certain drugs and toxins can also precipitate a seizure. Overdosage of cocaine and local anesthetics may be the cause. Complete physical examinations should be performed. Characteristics of the seizure also should be obtained. An search for underlying causes is important, but the primary goals are to stop the seizure, maintain the airway and ventilation. Serum anticonvulsant drug levels and arterial blood gases also should be obtained. Pharmacologic treatment is obtained with benzodiazepines, phenytoin, and barbiturates.

Multiple factors can contribute to increased muscular weakness in patients who have myasthenia gravis in the perioperative period. Anticholinesterase preparations like pyridostigmine or neostigmine should be maintained preoperatively and reinstated on the first postoperative day. Medications such as quinidine, curare, lithium, β -adrenergic blockers, phenytoin, and aminoglycoside antibiotics should be avoided. Cognitive impairment after surgery can be difficult to deal with. Delirium needs to be differentiated from dementia, depression, mania, and other organic brain disease. Dementia is a clinical syndrome that has a long course and is characterized by loss of cognitive abilities, personality disorganization, and decreased ability to perform daily activities without disturbance of consciousness. Delirium is a transient organic mental disorder characterized by global impairment of cognitive functions and resulting from diffuse brain cell metabolic dysfunction. It is usually preceded by a lucid period of a few days after surgery prior to the onset of symptoms. Restlessness, insomnia, irritability, frightening dreams, difficulty in thinking, disturbed consciousness, urinary incontinence, focal neurological signs, nystagmus, and loss of motor coordination can all be present in delirium. The differential diagnosis of delirium includes drug intoxication, drug withdrawal, metabolic disturbances, acute cerebral disorders, infections, hemodynamic disturbance, respiratory disorders, nutritional and vitamin deficiencies, and trauma. Psychiatric consultation is recommended.

General

Evaluation of the postoperative fever should include a complete history and physical examination. The following procedures should be done if no obvious site is found: a leukocyte count and urinalysis; gram stain of sputum, urine, and wound exudate; cultures of sputum, urine, wound, and blood; chest radiograph; and removal and culture of intravenous catheters. Depending on the clinical picture, consideration should be given to examination and culture of spinal fluid. Treatment should be directed at the cause. If no obvious cause is apparent, treatment is directed toward lowering body temperature by giving antipyretics (e.g., aspirin, acetaminophen, ibuprofen). Other adjunctive measures such as removing bed covers, cool or ice-water sponge baths, decreasing room temperature, or increasing air flow over the patient can be considered. In life-threatening elevations of body temperature ($\geq 40^{\circ}\text{C}$ or 104°F), pharmacologic cardiac support and intubation should be considered. Rapid cooling of the patient can be achieved administering an ice bath or initiating partial cardiopulmonary bypass with a heat exchanger.

Malignant hyperthermia occurs in anesthetized patients and is can be lethal. Because there is a genetic predisposition, all preoperative patients should be screened. In malignant hyperthermia, intracellular levels of calcium are increased in the skeletal muscle, causing a sustained contraction which increases oxygen consumption and heat production. Patients with the condition should avoid inhalation agents such as halothane and the muscle relaxant succinylcholine chloride. Signs occur briefly after the onset of anesthesia. Treatment is with dantrolene sodium, which inhibits the release of the calcium. Marked hyperkalemia from potassium released from muscle cells may require treatment.

Postoperative pain is often inadequately treated as a result of a variety of factors which include fear of side effects (e.g., respiratory depression, nausea), fear of addiction, or failure to give medicine as prescribed. Pharmacologic treatment of postoperative pain usually requires the use of systemic opioids. Patient-

controlled analgesia is an increasingly popular method of pain control. Morphine remains the drug of choice. The principal side effect is respiratory depression, and it may be worse in elderly patients. Respiratory depression can be treated with 0.4 mg of naloxone given intravenously. The nonsteroidal antiinflammatory drugs (NSAIDs) can play an important adjunctive role. NSAIDs are antiinflammatory, antipyretic, and decrease platelet adhesion. The side effect of gastrointestinal bleeding is uncommon but should be kept in mind.

Hemostasis in the alcoholic patient can be a significant problem and should be addressed as suggested in the hematologic section of this paper. Hypoglycemia and deficiencies in thiamine, folate, and vitamin B₁₂, phosphate and magnesium should be evaluated and treated. In the case of other substance abuse, the mainstay is to avoid withdrawal in the immediate postoperative period. A special anesthesiology consult(e.g. to the pain service) may be warranted.

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