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What's New in ACS Surgery

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THE BEST SURGICAL THINKING

Acute Wound Care

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The goals of acute wound management are a closed, healing wound and the best functional and aesthetic outcome. Although the basic goals and principles of acute wound care remain unchanged, surgeons and scientists continue to investigate new strategies to promote wound healing.

Wound Preparation

Preparation for wound closure includes anesthesia. Adding epinephrine to local anesthetics can produce vasoconstriction. Traditionally, anesthetics with epinephrine have not been used in digits because of the theoretical risk of ischemia. However, these adverse effects have not been documented by prospective studies. If arterial inflow is believed to be compromised after epinephrine injection, infiltration of phentolamine, an alpha-adrenergic blocking agent, reverses epinephrine-induced vasoconstriction.[1]

Normal healing can proceed only if tissues are viable, without foreign bodies, and free of excessive bacterial contamination. Wound irrigation helps accomplish these goals; delivery systems can be divided into high-pressure (> 35 psi) and low-pressure (< 15 psi) systems. To avoid tissue disruption, only low-pressure systems should be

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This Month's Updates

ELEMENTS OF CONTEMPORARY PRACTICE

6 Risk Stratification, Preoperative Testing, and Operative Planning

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Tools for the assessment of surgical risk, identification of factors affecting cardiac risk, optimization of cardiac status, ACC/AHA Task Force Guidelines, identification of factors affecting noncardiac risk, assessment of physical and mental happiness, epidemiology of surgical risk, and changing paradigms of cost-effectiveness are discussed.

Risk Stratification with RCRI

Perhaps the simplest and most cost-effective component of preoperative cardiac risk stratification is identification of clinical risk factors with subsequent optimization of any such factors that are modifiable. Numerous cardiac risk indices have been created over the past three decades. During that period, risk stratification criteria have evolved from the Goldman criteria, which represented the first substantial effort at stratification, to the Revised Cardiac Risk Index (RCRI), which is currently the most widely applied risk stratification system. The RCRI identifies six predictors of major cardiac complications (i.e., myocardial infarction, cardiogenic pulmonary edema, cardiac arrest, and cardiac death); scores range from 0 to 5, and the likelihood of major perioperative complications increases with rising scores [*see Table, page 3, bottom right*]. This index has weaknesses—namely, its exclusion of emergency surgical patients, as well as neurosurgical patients; its overrepresentation of thoracic, vascular, and orthopedic patients; and its simplistic classification of surgical procedures into only two categories, high risk or non–high risk.[1] Despite these weaknesses, however, the predictive accuracy of the RCRI has been validated in large cohorts.[2]

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2. Boersma E, Kertai MD, Schouten O, et al:

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employed. Pulse lavage (6 to 19 psi) is more effective than bulb syringe irrigation at reducing bacterial contamination of complex wounds.[2]

Only nontoxic solutions (e.g., 1% surgical soap, sterile saline, sterile water, and tap water) should be used for wound irrigation. Irrigation with an antibiotic solution appears to offer no advantages, and the antibiotic solution may increase the risk of wound-healing problems.[3] In a randomized controlled trial comparing irrigation using sterile saline with irrigation using tap water in uncomplicated skin lacerations, no difference in infection rates was found.[4]

Wound Closure and Coverage

The majority of acute wounds are closed with suture. Suture is a foreign body and may generate an inflammatory response, interfere with wound healing, and increase the risk of infection. In an effort to reduce infection rates, bioactive sutures coated with antimicrobials have been introduced. Animal studies have shown that polyglactin 910 suture coated with triclosan (Vicryl Plus, Ethicon, Cornelia, Ga.) inhibits bacterial colonization of suture.[5] Although prospective trials in humans are not yet published, antimicrobial coated sutures appear promising.

When a wound such as a burn cannot be simply closed, we must rely on coverage. There has been tremendous effort to develop skin replacement for wound coverage. Culturing keratinocytes with stratified expansion allows for epidermal replacement. However, epidermal replacement alone does not provide the integrity and durability provided by the dermis and basement membrane. The result is an expensive product with high rates of culture loss and infection. Although early reports documented successful coverage of large burns with cultured epidermal autografts, they are now rarely used alone.

Dermal replacement is difficult because of the complex structure, though some products have been developed. Integra (Integra Life Sciences, Plainsboro, N.J.) is made of bovine collagen and chrondroitin-6-sulfate covered by Silastic. The Integra neodermis serves as a scaffold for tissue ingrowth; it vascularizes in 2 to 3 weeks. The Silastic is then removed and replaced with a thin (0.006 in.) split-thickness autograft. Integra has been used for coverage of viable, non-infected wounds, exposed bone, and exposed tendon. Alloderm (LifeCell, Woodlands, Tex.) is another acellular dermal replacement; it is produced from human cadaveric skin. Alloderm can also be used in combination with a thin split-thickness autograft for immediate wound coverage.

Adjunctive Wound Treatment

Significant research efforts have focused on developing topical agents that accelerate wound healing and modulate scarring. Although our understanding of wound pathophysiology has improved, few agents have reached the clinical arena.

Hypertrophic scarring is unsightly, painful, and pruritic. Our ability to prevent or treat hypertrophic scarring is limited, because the biologic and molecular basis is not well understood. The greatest impact a surgeon can have on cosmetic outcome is by providing meticulous care when the wound is initially encountered.

Postoperative wound care measures aimed at optimizing cosmetic outcome include application of ointments and the use of pressure garments and silicone bandages. Some interventions help, but prospective trials are needed. The healing wound is fragile, and the application of ointment to achieve an improvement in scar appearance may actually have the opposite result. For example, vitamin E, which is commonly applied to healing wounds, can induce contact dermatitis, impair collagen formation and wound healing, and cause scars to look worse.[6] A randomized, double-blinded study found that the use of onion extract gel (Mederma; Merz Pharmaceuticals, Greensboro, N.C.) does not improve scar appearance as compared with the use of a petrolatum-based ointment.[7]

AMERICAN COLLEGE OF SURGEONS
ACS SURGERY
Principles & Practice

Published by WebMD Inc.

ACS Surgery: Principles & Practice (ISBN 0-9703902-1-1) (ISSN 1538-3210) is published by B C Decker Inc, P.O. Box 620, L.C.D.1, Hamilton, Ontario L8N 3K7.

Annual subscription rates: print $229, quarterly CD-ROM $329 (individual) and $829 (institutional), and Web site $199 (individual). Institutional Web site license pricing available on request. Please email acssurgery@webmd.net. Separate shipping and handling apply. All prices subject to change without notice and quoted in U.S. dollars.

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Pressure garments are frequently used, though studies have not clearly demonstrated hypertrophic scar prevention. The garment's elastic support can, however, relieve throbbing and pruritis. Silicone gel sheeting is effective in both preventing and treating raised hypertrophic scars.[8]

Good nutritional balance and adequate caloric intake are necessary for normal wound healing. Supplementation with arginine, glutamine, and taurine is essential for anabolic processes and is known to enhance wound healing.[9] Oxandrolone, an oral anabolic steroid, is a supplement employed clinically to treat muscle wasting, improve wound healing, and mitigate the catabolism associated with severe burn injury.[10]

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This Month's Updates

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Perioperative cardiovascular mortality in noncardiac surgery: validation of the Lee cardiac risk index. Am J Med 118:1134, 2005 [PMID 16194645]

Guidelines Are Ignored

Whereas the RCRI documents factors that affect cardiac risk, the updated guidelines developed by the American College of Cardiology (ACC) and the AHA serve as a national quality initiative for utilization of the RCRI and optimization of perioperative risk by either medical or, in rare cases, surgical means. As currently understood, the goal of a cardiac consultation is to determine the most appropriate testing and treatment strategies for optimizing patient care while avoiding unnecessary testing. This understanding represents a definite paradigm shift from the stratification and revascularization strategies employed between the 1970s and the early 1990s.

Unfortunately, the guidelines are not always followed in clinical practice. One survey study found that despite the availability of guidelines, 40% of cardiology consultations resulted in simple recommendations to proceed with surgery, with no modification of perioperative plans or optimization of risk factors.[1] Clinical implementation of ACC/AHA guidelines appears to be poor in Europe as well. In a survey from the Netherlands, only 21% of patients referred for noninvasive cardiac testing actually underwent a study.[2] In addition, patients selected for noninvasive testing appeared to receive more medical therapy (e.g., beta blockers, statins, and platelet inhibitors) than patients not referred for noninvasive testing did.

1. Katz RI, Cimino L, Vitkun SA, et al: Preoperative medical consultations: impact on perioperative management and surgical outcome.

Revised Cardiac Risk Index[21]

Six clinical risk factors:

1. High-risk surgery
2. Ischemic heart disease (MI, positive treadmill test, use of nitroglycerin, current chest pain, pathologic Q waves on ECG)
3. Congestive heart failure (documented history, pulmonary edema, paroxysmal nocturnal dyspnea, peripheral edema, S3, or chest x-ray with pulmonary vascular redistribution)
4. Cerebrovascular disease (TIA or CVA)
5. Insulin-dependent diabetes mellitus
6. Renal failure (preoperative serum creatinine > 2.0 mg/dl)

No. of Risk Factors	Risk of Major Cardiac Complication (%)
0	0.4
1	0.9
2	7.0
3+	11.0

CVA—cerebrovascular accident MI—myocardial infarction
TIA—transient ischemic attack

Can J Anaesth 52:697, 2005 [PMID 16103381]

2. Hoeks SE, Scholte Op Reimer WJ, Lenzen MJ, et al: Guidelines for cardiac management in non-cardiac surgery are poorly implemented in clinical practive: results from a peripheral vascular survey in the Netherlands. Anesthesiology 107:537, 2007 [PMID 17893448]

Reducing Cardiac Risk Perioperatively

Over the past decade, the scope of perioperative efforts to reduce cardiac risk with cardioprotective therapy has changed. At present, the emphasis is on plaque stabilization, reduction of myocardial oxygen demand (e.g., reduction of delivery-consumption mismatch) and myocardial protection, with revascularization reserved for a discrete subset of patients who would almost require cardiac intervention regardless of any elective preoperative evaluation. It is hypothesized that the likelihood of coronary artery plaque rupture may be increased by perioperative stressors such as amplified sympathetic activation, vasospasm, disruption of coagulation homeostasis, and oxygen supply-demand mismatch.[1]

Although there remains some controversy regarding the appropriate management of patients identified preoperatively as having significant but stable coronary artery disease, current data supporting the use of medical therapy have led to reductions in the extent of preoperative cardiac assessment, thereby decreasing the time from surgical diagnosis to surgical therapy. Documented coronary stenoses account for only 50% of perioperative myocardial infarctions; the remaining 50% occur in vascular distributions unrelated to documented coronary stenoses. The presence of severe stenosis is more a marker of disease (and thus a subset of patients at risk) than a finite predictor of endangered myocardial territory. In part, preoperative cardiac stress testing identifies this at-risk subset, even though the stenotic lesion may not be the cause of the postoperative ischemic event. The inability to assess the propensity for coronary plaque rupture proves to be the main challenge in both risk stratification and risk factor modification.

Whereas the data on risk stratification approaches are relatively plentiful, the data on risk modification strategies are still evolving, and in some ways controversial. In what follows, we summarize the current data on beta blockade and statin therapy. Antiplatelet therapy, calcium channel blockade, and the use of angiotensin-converting enzyme inhibitors are discussed in greater detail in the ACC/AHA guidelines.[2]

1. Schouten O, Poldermans D: Cardiac risk in non-cardiac surgery. Br J Surg 94:1185, 2007 [PMID 17874426]

2. Fleisher LA, Beckman JA, Brown KA, et al: ACC/AHA 2007 Guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac surgery). Circulation 116:e418, 2007 [PMID 17901357]

Preoperative Counseling for Smokers

Cigarette smoking is the leading cause of preventable death in the United States. According to the American Heart Association (AHA), smokers made up a 40% smaller percentage of the U.S. population in 2003 than they did in 1965.[1] Nevertheless, approximately one third of surgical patients are still smokers. Smoking is clearly a risk factor for perioperative complications, including pulmonary complications, circulatory complications, and an increased incidence of surgical site infection. Numerous mechanisms contribute to the deleterious effects of smoking: smoking inhibits clearance of pulmonary secretions, adversely affects the immune system and collagen production, and contributes to wound hypoxia (thereby increasing susceptibility to infection). Some studies have suggested that even passive smoking can reduce blood flow velocity in the coronary arteries of healthy young adults.[2]

A 2002 trial demonstrated that preoperative smoking cessation reduced the incidence of postoperative complications from 52% to 18%.[3] A 2003 study reported similar results: patients who stopped smoking 4 weeks before operation had significantly lower postoperative wound infection rates than patients who continued to smoke up to the time of operation.[4] Ideally, cessation of smoking at least 4 to 6 weeks before operation is recommended. Preoperative counseling of patients on smoking cessation not only can reduce postoperative complications but also can serve as the impetus for permanent smoking cessation and consequent improvement in overall long-term health status.[5,6]

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Preoperative Tests That Count

It was once generally agreed that surgical patients should undergo a series of routine screening tests before operation. This approach has proved not only unhelpful but also confusing and expensive. Perhaps predictably, it has been observed that the more tests are ordered, the more abnormal values are obtained. On the reasonable assumption that a test performed in a healthy person will yield an abnormal result 5% of the time, when 10 such tests are ordered, there is a 50% probability of an abnormal test result. When an SMA-20 is ordered, the probability of an abnormal test result is quite high. Moreover, although these abnormalities are reported, they rarely alter the physician's behavior or result in cancellation or postponement of the operation. Accordingly, current practice is to a take a much more selective approach to preoperative laboratory evaluation. Preoperative testing can provide predictive data when judiciously employed. Serum creatinine, glucose, and glycosylated hemoglobin levels[1] are strong predictors of perioperative cardiac events. There are some data suggesting that high concentrations of plasma N-terminal pro–brain natriuretic peptide (NT-proBNP) predict adverse postoperative cardiac outcome as well.[2]

1. Noordzij PG, Boersma E, Schreiner F, et al: Increased preoperative glucose levels are associated with perioperative mortality in patients undergoing

noncardiac, nonvascular surgery. Eur J Endocrinol 156:137, 2007 [PMID 17218737]
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8 Critical Care

11 Coma, Cognitive Impairment, and Seizures

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Classification of levels of consciousness, initial stabilization, clinical evaluation, management, vegetative state, and prognosis are described.

Treating GCSE

The first-line treatment of generalized convulsive status epilepticus (GCSE) consists of administration of lorazepam [*see this month's Algorithm, page 7*]. Although there is no significant difference between the benzodiazepines with respect to rapidity of seizure control, lorazepam is thought to bind more tightly to brain receptors and thus is believed to have a longer duration of action. Lorazepam is given in 2 mg increments 3 minutes apart to a maximum dose of 8 mg before another agent is tried [*see Table, below*]. Diazepam may be employed as an alternative. The second-line agent is fosphenytoin, 20 mg/kg at up to 150 mg/min I.V.; phenytoin may be given as an alternative. If the patient does not respond to either lorazepam or fosphenytoin, a third-line agent—pentobarbital, midazolam, or propofol—should be given in a continuous infusion. Of the three third-line choices, midazolam may be the most effective, and it certainly has the lowest side effect profile. Levetiracetam has also been successfully employed to treat some refractory cases of GCSE.[1,2]

1. Knake S, Gruener J, Hattemer K, et al: Intravenous levetiracetam in the treatment of benzodiazepine-refractory status epilepticus. J Neurol Neurosurg Psychiatry, Sep 26, 2007 [PMID 17898030] [Epub ahead of print]
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The AAA of Consciousness

A patient's level of consciousness can usefully be described in terms of the three As of consciousness: Awake, Alert, and Aware. To be awake means to be fully roused and thus not asleep. To be alert means to be able to pay attention to one's environment or to an examiner. Finally, to be aware means to have an understanding of oneself and one's environment. Being oriented is a manifestation of being aware of one's environment.

A person who is awake, alert, and aware may be said to be fully conscious. One who is awake and alert but has lost awareness is severely demented. Someone who is merely awake and not alert or aware is delirious. A delirious patient's level of wakefulness may wax and wane. A person who is not awake, alert, or aware either is asleep (in which case he or she can be rendered awake—i.e., is arousable) or is somewhere along the so-called spectrum of coma.

Admittedly, describing patients simply in terms of awakeness, alertness, and awareness omits many important nuances; nevertheless, it is an excellent and easily reproducible way of assess-

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Drugs Used to Treat Status Epilepticus

Drug	Priority of Use	Dosing	Potential Adverse Effect
Lorazepam	First-line agent	2 mg increments I.V. 3 min apart to maximum of 8 mg	Respiratory depression Hypotension
Diazepam	Alternative first-line agent	10 mg I.V., 1 or 2 doses	Respiratory depression Hypotension
Fosphenytoin	Second-line agent	20 mg/kg, 150 mg/min	Dysrhythmia Hypotension
Phenytoin	Alternative second-line agent	20 mg/kg, 50 mg/min	Dysrhythmia Hypotension (Risk is lower than with fosphenytoin)
Pentobarbital	Third-line agent	5–12 mg/kg, 1–10 mg/kg/hr	Poor WBC chemotaxis Paralysis of respiratory cilia Poikilothermia
Midazolam	Third-line agent	0.1–0.3 mg/kg, 0.05–2.0 mg/kg/hr	Tachyphylaxis Death (mortality lower than with propofol)
Propofol	Third-line agent	3–5 mg/kg, 1–15 mg/kg/hr	Recurrent seizures after abrupt discontinuance Hypotension Hypertriglyceridemia Anemia Death (mortality higher than with midazolam)

WBC—white blood cell

ing level of consciousness.

What It Means to Be Unresponsive

The term unresponsive is used frequently, but often in a vague manner that does not yield a clear meaning. Fortunately, in the setting of coma management, there are only three possible meanings that need be considered.

First, the term unresponsive may be applied to a patient who is actually fully conscious but is unable or unwilling to respond verbally. For example, a patient with aphasia (a common manifestation of stroke) may be awake, alert, and aware, yet unable to speak. As another example, a patient who is in a locked-in state (either from a brain stem injury or from generalized muscle paralysis) is fully conscious but cannot speak and cannot communicate except through subtle eye movements. Finally, patients with a psychiatric disorder may present with a so-called functional coma while remaining fully conscious; simple examination techniques quickly reveal that they are completely awake.

Second, the term unresponsive may be applied to a patient who has a waxing-and-waning level of wakefulness. This fluctuation between wakefulness and coma is what defines delirium, and it is invariably caused by infection, metabolic disturbances, or alcohol withdrawal.

Third, the term unresponsive may be applied to a patient who truly is not even awake. In this sense, the term could of course be applied to a person who is simply asleep, but for the purposes of this chapter, it should be understood as referring to a patient who is comatose.

Neurologic Examination in Coma

There are two good reasons for performing a neurologic examination on a coma patient. First, such an examination allows the physician to assign the patient a Glasgow Coma Scale (GCS) score, which may be used in making decisions about the necessity for intubation and which provides an objective means of following (at least superficially) the patient's neurologic status. Second, the neurologic examination may quickly yield important diagnostic information.

A complete and exhaustive neurologic examination is totally unnecessary. For the purposes of evaluating coma, a focused neurologic examination is preferable, being both valuable and rapid (~ 60 seconds). If intubation is indicated, the coma examination should be performed quickly before sedative and paralytic agents are given. This examination addresses a number of key findings, but in general, it may be thought of as assessing four neurologic variables: (1) spontaneous movements (~ 15 seconds), (2) pupillary response (~ 15 seconds), (3) ocular motility (~ 15 seconds), and (4) motor response (~ 15 seconds). A reflex hammer is not needed.

Spontaneous movements should be observed over a period of 10 to 20 seconds. Generalized seizures may present as tonic or tonic-clonic movements of one or both sides. Tonic seizures are characterized by sustained contractions with upper-extremity flexion and lower-extremity extension. Tonic-clonic seizures are characterized by tonic contractures alternating with periods of muscle atonia, resulting in rhythmic contractions. Myoclonus consists of motor jerks that are sudden, brief, shocklike, and randomly distributed; it may be seen in patients with hypoxic-ischemic encephalopathy (e.g., after cardiac arrest) or other metabolic disturbances. Other findings (e.g., a flaccid arm that hangs down the side of the stretcher or a leg that is extorted) may be indicative of hemiparesis. The motor response to pain can be tested and assigned a GCS score. Asymmetry should be noted.

Pupillary responses are important

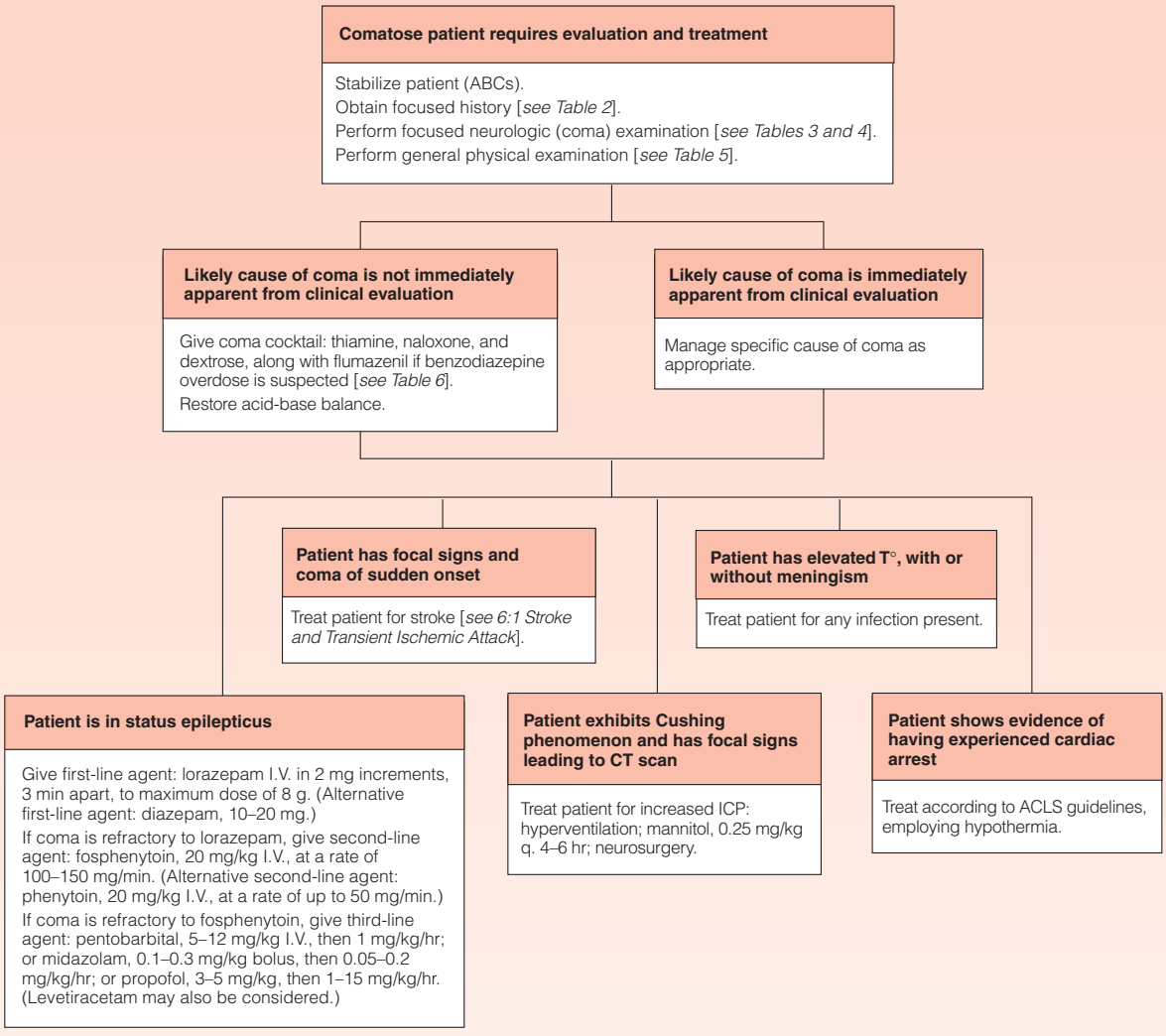
Coma Cocktail

Drug	Indications	Dosing (Adults)	Potential Adverse Effects
Thiamine	Wernicke-Korsakoff syndrome Ethylene glycol ingestion	100 mg I.V. over 5 min	Anaphylactoid reaction Hypotension Angioedema
Dextrose	Symptomatic hypoglycemia Altered mental status without ability to rapidly obtain serum glucose level	50–100 ml of 50% dextrose I.V. Alternatively, 250 ml of 10% dextrose (to prevent the phlebitis that frequently occurs with administration of 50% dextrose)	Phlebitis Cellulitis
Naloxone	Reversal of CNS depression and respiratory depression caused by overdose of opioid medication	0.1 mg I.V. initially (I.V. route is more effective than subcutaneous or endotracheal), aimed at producing subtle improvement in ventilation Repeat doses given in 2–3 min intervals, increased very slowly each time If no response after total dose of 10 mg, opioid toxicity ruled out	Hypersensitivity reaction Precipitation of sudden narcotic withdrawal sync (If heroin has been tainted with scopolamine, wit opioid can precipitate anticholinergic crisis) Lung injury, hypertension, and cardiac dysrhythn reported)
Flumazenil	Benzodiazepine overdose	0.2 mg I.V. over 30 sec If no response, 0.3 mg I.V. over 30 sec If still no response, 0.5 mg I.V. every 30 sec to maximum dose of 3 mg	Contraindicated in patient experiencing seizure Benzodiazepine withdrawal, which may cause s autonomic dysfunction

This Month's Algorithm

Common Causes of Acute Coma

Coma is the neurologist's favorite consultation: the history is usually straightforward, the neurologic examination is focused, and the differential diagnosis is limited. A good neurologic examination, in combination with a thoughtful battery of tests, will invariably achieve the correct diagnosis. It is vital for the intensivist to become equally comfortable with the rapid assessment of coma. As the patient is being stabilized, evaluation should be initiated. A witness or someone else capable of providing a history should be sought. The differential diagnosis of coma is wide but limited. Clues from the history, the focused neurologic examination, and the general physical examination are often helpful and sometimes diagnostic.



in that their presence or absence distinguishes structural from metabolic coma (because the pupils are generally resistant to metabolic insult); they also indicate the integrity of the brain stem. The origin of the reticular activating system (RAS), the so-called on switch of consciousness, may be physically located adjacent to the brain stem nuclei that control pupillary response.

The pathways that control ocular motility also lie adjacent to the RAS. Roving eye movements usually indicate that the brain stem is intact and that a metabolic problem is affecting the brain. Minimal or absent eye movement in conjunction with reactive pupils also typically signifies a metabolic process. Gaze deviation may indicate a stroke: a cortical stroke will cause the eyes to look toward the damaged side of the brain, whereas a pontine stroke will cause the eyes to look away from the damaged side of the pons. Gaze deviation may also signify an ongoing seizure: the eyes look away from the hemisphere in which the seizure is occurring or, after the seizure is over, toward the postictal hemisphere. Vertical disconjugation of the eyes (skew deviation) is indicative of brain stem disease and frequently occurs during basilar artery thrombosis. Ocular bobbing (rapid downward movements with a slow drift back to the original position) is occasionally seen in the setting of extensive pontine damage.

The Coma Cocktail in Patient Management

As emergency management is being provided, laboratory studies should be obtained, including serum electrolyte, calcium, magnesium, phosphorus, blood urea nitrogen, and creatinine levels, as well as liver function tests. A complete blood count, a urinalysis, and a urine toxicity screen should also be obtained. A lumbar puncture should be performed only if meningitis is suspected on the basis of clinical examination.

The so-called coma cocktail—consisting of dextrose, naloxone, and thiamine—is administered if the cause of coma is not immediately apparent from the brief history and physical examination; the addition of flumazenil is considered if benzodiazepine overdose is suspected [*see Table, page 6*]. It should be kept in mind that administering dextrose to a thiamine-depleted patient (especially one who is malnourished or alcoholic) may precipitate the Wernicke-Korsakoff syndrome. As a rule, therefore, thiamine should always be given before dextrose.