Trauma is ranked as one of the foremost public health issues in the United States. Unintentional injury related to trauma is the fifth leading cause of death and the leading cause of death for people ages 1 to 44 years (Barclay, 2009). Whether the injury is a result of a motor vehicle collision, violence, crime, or is a work-related injury, trauma occurs unplanned and without warning. The unpredictable nature of trauma poses a major challenge to the perioperative nurse and the patient care team.

The potential for injury has existed since the beginning of humanity. Many of the major advances in care of critically injured patients have been accomplished through experience in the military. Clearly the shorter the response time, the greater the survival rate for casualties. This was demonstrated by the success of the mobile army surgical hospital (MASH) units during the Korean conflict and again during the Vietnam conflict; MASH brought the necessary supplies, equipment, and personnel closer to the battlefields and consequently improved patient outcomes.

Eventually this concept was applied to the civilian population and is commonly referred to as the “golden hour” of trauma care. More specifically, the golden hour refers to the time immediately after the injury when rapid and definitive interventions can be most effective in the reduction of morbidity and mortality. The golden hour starts at the scene, where prehospital personnel determine the severity of injury, initiate medical treatment, and identify the most appropriate facility to which to transport the patient. Traumatic deaths may occur in three phases, or timeframes. The first occurs immediately after the injury. In this phase, death is usually a result of lacerations to the heart or aorta or brainstem injury. These patients rarely survive transport to the hospital, and die at the scene. The second phase occurs within the first 1 to 2 hours after the injury. These patients have injuries to the spleen, liver, lung, or other organs that result in significant blood loss. This is the group in which definitive trauma care (i.e., appropriate and aggressive resuscitation with adequate volume replacement) may have the most significant effect (the golden hour). The third phase occurs days to weeks after the injury, often during the intensive care phase, and is usually caused by complications or a failure of multiple organ systems.

The wars in Iraq and Afghanistan have resulted in some changes in the way traumatic injuries are managed; the military has not set up convalescence centers as in Vietnam and Desert Storm. Rather, the doctrine of “essential care in theater” is followed. Physicians and nurses have been trained to provide immediate care, keeping in mind the treatment resources that will be available at the next level of care. Soldiers with upper body injuries are surviving because of body armor. However, there is no protection for upper extremities; therefore, many amputations are performed, including above-elbow and shoulder disarticulations. The new philosophy is to stress continuity of care with the goal of returning the soldier to the highest possible level of function.

Time is of the essence in providing definitive care to the critically injured person. A significant number of patient deaths can be prevented if rapid transport is provided from the scene to a facility equipped to provide resuscitation and treatment in an efficient and timely manner. This concept is reflected in the national development of the emergency medical services (EMS) system. Facilities and resources are allocated and coordinated to provide specific interventions for a group of patients. For example, facilities that meet certain criteria to accommodate the specialized needs of the critically injured patient are designated as trauma centers. Communities establish transfer and triage protocols that allow for a trauma patient to reach the appropriate facility with the least out-of-hospital time possible. This may be accomplished by a helicopter with a specially trained flight crew or by the use of ground transport with an advanced life support (ALS) ambulance team (Figure 28-1).

Trauma centers (TCs) are classified based on the scope of available services and resources. A level I TC is capable of providing total care for every type of injury. Accepting this designation commits the TC to providing qualified personnel and equipment necessary for rapid diagnosis and treatment on a 24-hour basis. A level II TC provides comprehensive care for all injuries but lacks some of the specialized clinicians and resources required for the level I designation. A level II facility may provide surgical intervention if the critical nature of the injury dictates immediate intervention before transfer to a level I facility. A level III facility provides prompt evaluation, resuscitation, emergency surgery, and stabilization, as needed, before transfer to a higher-level facility. The American College of Surgeons (ACS) recommends that in level II and III centers, an operating room (OR) team be readily available at all times. Depending on the population served and the volume of urgent cases, this requirement may be met with on-call staff. A level IV trauma center has the ability to provide advanced trauma life support before patient transfer. These facilities may be located in rural areas with limited access and may be a clinic or a hospital.

Although the risk for death is 25% lower for a severe injury treated in a level I TC (Barclay, 2009), not all patients require the services of a level I TC and thus may be transported to the closest emergency department (ED) for care. New guidelines and recommendations for triage, first developed as a position statement by the ACS in 1986, have been published (Barclay, 2009). Known as the Decision Scheme, this algorithm guides EMS personnel through the following four decision points: physiologic parameters, anatomic parameters, mechanism of injury (MOI), and other special considerations. Personnel review physiologic parameters. Patients with a Glasgow Coma Scale (see Table 21-2) score less than 14, systolic blood pressure less than 90 mm Hg, or respiratory rate less
than 10 breaths per minute or greater than 29 breaths per minute should be transported to the highest level facility available. The anatomic parameters include specific types of injuries, such as penetrating injuries of the neck or torso, flail chest, or proximal long bone fracture; these patients are also transported to the highest level facility available. The MOI and other special considerations, such as age or prior medical history, are also reviewed to determine to what level facility the patient is transported.

Trauma patients require immediate access to the OR 24 hours per day, 365 days per year. A sudden influx of a large number of trauma patients to a trauma center may necessitate triage or classification of those less seriously injured as less urgent, allowing immediate access for the critically injured patients. The elective surgery schedule may need to be interrupted to expedite care for the trauma patient or patients. Scheduling policies and procedures are established collaboratively by the departments of surgery, trauma, anesthesia, and perioperative nursing services. Consequently, the perioperative nurse and scrub person (who may be a registered nurse or surgical technologist) need to be familiar with supplies and equipment located in the OR designated for trauma or in the ORs that are used most frequently for these patients.

Perioperative Nursing Considerations

Preliminary Evaluation: Mechanism of Injury

Because of the unpredictable timing of trauma, it is often the on-call perioperative nursing team who cares for injured patients requiring surgical intervention. In contrast to an elective surgical procedure, little information may be known about trauma patients and preparation time is often abbreviated. A working knowledge of the MOI is essential to assist the perioperative nurse in rapid patient assessment.

MOI, or kinematics, involves the action of forces on the human body and their effects. Knowing the forces applied provides valuable information in evaluation of the patient and injuries that may be present. The first EMS team to respond to the scene of an injury must carefully evaluate the patient in relation to the MOI. For example, the position of the victim in a car, whether the person was the driver or a passenger seated in the back seat or front seat, estimated velocity of the vehicle, location of impact, and use of a seat belt or air bag are all pieces of information used to determine the index of suspicion about the probable causes of injuries to the patient. After immediate threats to life are addressed, the MOI can provide valuable clues as to probable cause of injuries. This systematic approach can reduce morbidity and mortality (Table 28-1).

The MOI is a product of the type of injuring force and the resulting tissue response. The velocity of the collision, the shape of the object, and the tissue's flexibility influence the magnitude of the injury sustained. For example, long bone tissue has little or no flexibility. A strong collision involving a long bone most often results in a fracture of some type. In contrast, soft tissue injury from a colliding force may result in a contusion because this tissue has greater flexibility.

Blunt trauma is injury resulting from a combination of forces, such as acceleration, deceleration, shearing, and compression that do not result in a break of the skin. Morbidity and mortality may be greater than with penetrating trauma because identification of injuries is more difficult when injuries are less obvious. Causes of blunt trauma include motor vehicle collisions (MVCs), contact sports injuries, aggravated assault, and falls. Even low-energy trauma, such as that associated with low-level falls, can produce significant injuries.
**BMI and Risk for Upper Body Injury Following an MVC**

Individuals with a high BMI have an increased amount of adipose tissue; the adipose distribution differs between men and women. Obese women tend to have excess fat around the hips, thighs, and buttocks, whereas obese males typically have more adiposity in the upper body. A recent study explored the differences in body shape among obese men and women in relation to the severity of injuries sustained following an MVC.

The study obtained data from the Crashworthiness Data System of the National Automotive Sampling System and computer crash simulation data to examine the injury patterns. The researchers found obese males to be at a higher risk for injuries to the head, face, thorax, abdomen, and spine. Obese females have a decreased risk for injuries to the face and an increased risk of injury to the thorax, abdomen, and lower extremities. Obese males are more vulnerable to serious upper body injuries due to the fat distribution, body shape, and a higher center of gravity.

Studies found obese males to be at a higher risk for injury related to a combination of factors including momentum effects, comorbidities associated with obesity, and the body's response to the crash. Furthermore, the vehicle's cabin is designed for a male with a BMI of 24.3, which is not optimal for an obese male.

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**FIGURE 28-2** The three collisions of a head-on motor vehicle crash: the car hits an object; the occupant's body impacts on some surface within the motor vehicle; and the result is a collision between internal tissues and the rigid body surface structures.

Acceleration and deceleration injuries occur most frequently in blunt trauma. A ruptured thoracic aorta is an example of an injury that occurs as a result of these types of forces. In an MVC, the large vessels are stopped or decelerated rapidly, resulting in vessel damage caused by stretching that exceeds the vessel's elastic ability. This affects the aorta at the ligamentum arteriosum, the anatomic point where it is affixed tightly to the chest wall, just below the origin of the subclavian artery. This shearing below the attachment site causes a rupture as the aorta continues to move in a forward motion after the chest wall motion has stopped.

MVCs account for a high degree of blunt trauma (Research Highlight). During an MVC, actually three collisions occur (Figure 28-2). The first collision is that of a car into another object. The second collision is the impact of the occupant's body on the vehicle's interior. The third collision occurs when an internal body structure hits a rigid bony surface. A coup-contrecoup injury of the brain, for example, is the result of an acceleration force to one area of the brain and a deceleration force to an opposite area. Front and side air bag deployment along with the use of seat belts can decrease the severity of traumatic injury.

Falls also cause a significant number of traumatic deaths in the United States. Injuries are most commonly associated with children experiencing falls more than twice their height. In adults, falls more than 10 to 15 feet are usually accompanied by significant injury. Deceleration forces in falls produce forces of stretching, shearing, and compression. Consequently, aortic injuries are also suspect in this group of patients. Skeletal injuries occur as well, because of the compressive forces present.

Penetrating trauma is a result of the passage of a foreign object through tissue. The degree or extent of tissue injury is a function of the energy that is dissipated to the tissue and the surrounding areas. The anatomic structures most often injured include the liver, intestines, and vascular system. The extent of the injury relates to the nature of the foreign object (e.g., bullet caliber, knife size), distance from the weapon, structures penetrated, and amount of energy dissipated to the structures.

The velocity of a bullet is responsible for the degree of injury or cavitation to the tissue. A low-velocity bullet is one that travels at a lower speed (1000 feet per second or less) and disrupts only the bullet tract and its immediate surrounding area. A high-velocity weapon, such as used by the military, fires a bullet traveling at a greater speed (3000 feet or more per second) and causes significantly more damage and tissue destruction because the bullet tract involves more extensive surrounding tissue (Figure 28-3). The distance from the weapon also influences the degree of injury because the velocity is greatest when the bullet leaves the weapon and decreases as it travels. In addition, the type of bullet (e.g., shotgun shells with multiple pellets and hollow-point bullets, which mushroom on impact) influences the degree of injury. Commonly the entrance wound is smaller than the exit wound because of the dissipation of energy, but an exit wound may not always be present. If the bullet completely fragments or is lodged in an internal structure, there will not be an exit wound. Depending on the position of the bullet and any injury that could be caused by attempting to remove it, bullets are not always removed.

Stab and impalement wounds are considered to be low-velocity wounds. The associated injuries usually correspond to the path of the penetrating object. Factors such as the object's width and length assist in identifying the possible occurrence of injuries. A single injury site may penetrate several different organs or cavities.
Penetrating injuries located at or below the nipple line may cause both chest and abdominal injuries. This is attributable to the diaphragmatic excursion that occurs with inspiration and expiration. Impaled objects should not be removed at the scene or in the ED. The impaled object provides a tamponade effect to injured blood vessels and is removed only when the ability to control potential bleeding from those vessels is present. Wound debridement may also be necessary. Therefore, these objects are removed in the OR, where the needed supplies and instrumentation are located.

Injuries that result from explosions are related to the effects of the blast. With the threat of domestic terrorism on the rise, the treatment of blast victims may become more frequent in trauma settings. Blast injuries are capable of inflicting a variety of injuries. Primary blast injury is the result of a direct pressure wave on the body, most likely to affect the lungs, gastrointestinal (GI) tract, tympanic membrane, or blood vessels. Secondary blast injuries are often present as penetrating organ injury and result from airborne shrapnel and debris. Tertiary injuries result from the blast wind moving bodies and debris (Kumar, 2010). The type of injury sustained and its intensity are directly related to factors such as the size of the blast and the proximity of the victim or victims. Patients from a blast explosion may present with penetrating injury, contusions, lacerations, amputations, abrasions, avulsions, evisceration, and various degrees of burns (Table 28-2).

Thermal and electrical tissue damage and inhalation injuries may occur from an explosion or as a sole mechanism of injury. These patients are usually resuscitated and require operative intervention for debridement on a nonemergent basis, unless the injury is limb- or life-threatening.

Injuries can be scored objectively according to their severity. This scoring system assists medical personnel in more effective triage and provides a universal method of communication among facilities, departments, and nursing personnel. The ACS guidelines, as published by the National Expert Panel on Field Triage, now recommend the use of the Decision Scheme (Table 28-3).

### Assessment

The resuscitative process begins with arrival of emergency personnel on the scene and ends when the patient has been stabilized, received definitive care, and undergone a complete and thorough physical examination to determine all injuries sustained. When the patient arrives in the ED, the trauma team initiates a primary assessment and secondary assessment. This is a logical, orderly process of patient assessment for potential life threats. These assessment activities are based on established protocols for advanced trauma life support (ATLS). The mnemonic used for the primary assessment is “ABCDE,” representing assessment of the following:

- **Airway** (with cervical spine precautions)
- **Breathing**
- **Circulation**
- **Disability** (brief neurologic examination)
- **Exposure** (to reveal all life-threatening injuries) and environmental control (thermoregulation)

Airway interventions may include manual maneuvers (chin-lift, jaw-thrust), insertion of oral or nasopharyngeal airways, or...
TABLE 28-3
Decision Scheme Recommendations*

<table>
<thead>
<tr>
<th>Steps</th>
<th>Transition</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>1 to 2</td>
<td>Transport to TC for any of the following: GCS &lt;14, systolic BP &lt;90 mm Hg, respiratory rate &lt;10 or &gt;29 breaths/min. These patients have potentially serious injuries and should be transported to the highest level TC available.</td>
</tr>
<tr>
<td>Step 2</td>
<td>2 to 3</td>
<td>Transport to TC for any of the following: penetrating injuries of head, neck, torso, and extremities proximal to elbow and knee; flail chest; 2 or more proximal long bone fractures; crushed, degloved, or mangled extremity; amputation proximal to wrist and ankle; pelvic fracture; open or depressed skull fracture; paraplegia.</td>
</tr>
<tr>
<td>Step 3</td>
<td>3 to 4</td>
<td>If yes to any criteria, transport to the highest level TC available; if patient does not meet step 2 criteria, proceed to step 3.</td>
</tr>
<tr>
<td>Step 4</td>
<td></td>
<td>Consider transport to TC for the following: age &gt;55 or &lt;15, anticoagulation and bleeding disorders, burns, time-sensitive extremity injury, end-stage renal disease requiring dialysis, pregnancy, or provider judgment.</td>
</tr>
</tbody>
</table>

*The Decision Scheme is an essential component of the trauma system, guiding EMS providers in transporting injured patients to the most appropriate facility, ensuring proper treatment, and thus reducing death and disability. 

BP, Blood pressure; GCS, Glasgow Coma Scale; TC, trauma center.


intubation. The trauma team may also perform emergent procedures, such as tracheotomy or needle cricothyrotomy, to secure the patient’s airway. Pulse oximetry and capnography monitoring are used. If cervical spine precautions were not implemented before arrival at the hospital, the team initiates them before performing any other procedures on the patient. A trauma team member can stabilize the head and neck, if necessary, until a cervical collar is used. If cervical spine precautions were not implemented before the patient’s airway. Pulse oximetry and capnography monitoring are used. If cervical spine precautions were not implemented before arrival at the hospital, the team initiates them before performing any other procedures on the patient. A trauma team member can stabilize the head and neck, if necessary, until a cervical collar is placed. Once placed, the team does not remove it until an examination and cervical radiograph confirms there is no neck injury.

During this time, the surgeon or ED physician and trauma team identify and correct life threats that are present before progressing to the next part of the examination. A patient requiring immediate surgery is transported to the OR, undergoes surgical intervention, and then is transferred to the postanesthesia care unit (PACU) or intensive care unit (ICU), depending on his or her condition. On the other hand, a patient may have a penetrating wound with evisceration of abdominal contents. However, correcting the obvious defect, which is currently not life-threatening, is postponed until the trauma team is assured that the patient has a patent airway and an effective breathing pattern and cervical spine precautions have been implemented. An evisceration needs to be corrected, but an inadequate airway is an immediate life threat and assumes priority.

Depending on the patient’s injury, the surgeon may order an arterial blood gas (ABG) measurement. This test provides an accurate assessment of the ventilatory status of the patient and evaluates resuscitative airway and breathing interventions. Metabolic acidosis or a large base deficit (pH <7.35 or >7.45), with all other causes ruled out, may indicate internal bleeding. The surgeon may check for coagulopathy using thromboelastography (TEG). Rapid TEG testing can provide valuable information about the depleted component within the clotting cascade, allowing for direct therapy to correct the coagulopathy (Jeger et al, 2009).

After the trauma team completes the primary assessment and corrects any immediate life threats, they perform a secondary assessment. The purpose of the secondary assessment is to identify all injuries present. Sometimes the secondary assessment may be completed by the perioperative nurse, the PACU nurse, or the critical care nurse. The mnemonic used for the secondary assessment is “FGHI,” representing assessment of the following:

- **Full set of vitals/focused adjuncts/facilitate family presence**
- **Give comfort measures**
- **History/head-to-toe assessment**
- **Inspect posterior surfaces**

This assessment begins with a full set of vital signs, including a rectal or tympanic temperature, unless contraindicated, and placement of noninvasive monitoring devices. Often during resuscitation the nurse will insert a Foley catheter to monitor urine output and fluid resuscitation efforts. The nurse should inspect the urinary meatus for the presence of blood before inserting the catheter. If blood is noted, the nurse notifies the surgeon and does not insert the catheter. The patient may have a ruptured bladder or a urethral injury, either of which is commonly associated with a fracture of the pelvis. The surgeon may wish to perform a retrograde urethrogram to examine the bladder and urethra for the presence of tears or disruption. After catheter insertion, urine is obtained for a urinalysis and urine drug screen. The identification of specific drugs in the urine may assist in further diagnosis and treatment. The urine will also be tested to determine the presence of red blood cells (RBCs). Depending on the amount of hematuria present, a renal contusion or other renal injury may be present. In addition, a nasogastric tube may be inserted at this time. The nurse prepares to provide comfort measures by assessing the patient’s pain by using a pain scale (if indicated, orders for pain medication should be obtained).

The history and past medical history begin with information generated from the patient; if the patient is unable to provide the history, the team obtains the information from the family or significant others when possible (Emergency Nurses Association [ENA], 2007). This history is referred to as the “AMPLE” history and may be obtained even after the patient is transferred to the OR by the ED personnel. The history includes the following:

- **Allergies**
- **Medications**
- **Past medical history**
• Last meal, Last menstrual period (if appropriate)
  • Events or Environment leading to the accident or injury

If the history is obtained before the initiation of surgery, it is important to communicate it to the surgeon and the anesthesia providers.

The head-to-toe evaluation of the patient—inspection, palpation, percussion, and auscultation—is used in the complete head-to-toe assessment to reveal any deformities, open injuries, tenderness, or swelling. The assessment begins at the head and face and then moves to the neck (including the spine), the chest, the abdomen, and the pelvis. The four extremities are next; distal pulses, motor function, and sensation are assessed. The final check is the back; the patient is carefully rolled to the side for a full visual and tactile assessment (Evidence for Practice).

**Routine Laboratory Tests.** Laboratory values aid the trauma team in evaluating the patient’s status (see Appendix A). Appropriate laboratory tests include a minimum of a complete blood count (CBC), hemoglobin and hematocrit (H&H) value, blood alcohol level (BAL), and a blood type and screen; other tests may be requested during evaluation. The results of the laboratory studies should be reviewed and communicated as appropriate. An abnormal level of RBCs may signify dehydration, hypovolemia, or fluid overload (dilutional). An elevated white blood cell (WBC) count, indicating the presence of infection, may be related to inflammation, tissue necrosis, or immunocompromise. H&H values also are important to note. Caution is recommended when evaluating an H&H drawn in the ED. The time delay between bleeding and a drop in the H&H value can be significant. It is only after hemodilution occurs (from shock compensation or crystalloid replacement) that hematocrit level drops. Frequently, abnormal values in the patient with blunt trauma alert the team to the possibility of internal bleeding.

BAL also assists the trauma team in their evaluation. If the patient’s level is significantly high, the physical examination and response may be unreliable. In addition, the neurologic status of patients with high BALs is very difficult to assess. Abnormal clotting studies are of obvious significance in trauma patients. These results may be attributable to anticoagulant medication the patient is taking or the effects of profound hypothermia. Clotting times may also be prolonged in the presence of excessive alcohol ingestion or the use of anabolic steroids. Clotting times may decrease with the use of antihistamines and diuretics.

A blood type and screen shortens the time needed by the blood bank to obtain a crossmatch, if needed later. Most trauma centers have several units of type O-negative blood (universal donor) available in the event that a blood transfusion is required before a type and crossmatch (T&C) can be performed. Because of regional shortages of O-negative blood, O-positive blood can be used in male patients and adult female patients of non-childbearing age. Initially, trauma patients are fluid-resuscitated with warmed crystalloid solutions, such as lactated Ringer’s solution or normal saline solution. If the patient’s blood pressure responds, the diagnostic examination continues. However, if the hypotension returns, blood transfusions may be initiated and the patient may be transported immediately to the OR for exploratory surgery.

Many trauma centers are implementing massive transfusion policies for the clinical management of patients experiencing massive hemorrhage and to coordinate interdisciplinary and interdepartmental resources. Massive transfusion is defined as the replacement of one or more blood volumes within a 24-hour period.

### EVIDENCE FOR PRACTICE

#### Assessing Neurovascular Status in Patients with Musculoskeletal Trauma

Trauma patients frequently present to the OR with fractures or other musculoskeletal injuries. A thorough assessment of the patient’s neurovascular status is imperative to establish a baseline for nursing and surgical interventions.

<table>
<thead>
<tr>
<th>Assessment Technique</th>
<th>Normal Findings</th>
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<tbody>
<tr>
<td><strong>Skin Color</strong></td>
<td></td>
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<tr>
<td>Inspect the skin distal to the injury.</td>
<td>There is no change in pigmentation compared with other parts of the body.</td>
</tr>
<tr>
<td><strong>Skin Temperature</strong></td>
<td></td>
</tr>
<tr>
<td>Palpate the area distal to the injury (the dorsum of the hands is the most sensitive to temperature).</td>
<td>The skin is warm.</td>
</tr>
<tr>
<td><strong>Movement</strong></td>
<td></td>
</tr>
<tr>
<td>Ask the patient to move the affected area or the area distal to the injury (active motion).</td>
<td>The patient can move without discomfort.</td>
</tr>
<tr>
<td>Move the area distal to the injury (passive motion).</td>
<td>There is no difference in comfort compared with active movement.</td>
</tr>
<tr>
<td><strong>Sensation</strong></td>
<td></td>
</tr>
<tr>
<td>Ask the patient if numbness or tingling is present (paresthesia).</td>
<td>There is no numbness or tingling.</td>
</tr>
<tr>
<td>Palpate with a paper clip (especially in the web space between the first and second toes or the web space between the thumb and forefinger).</td>
<td>There is no difference in sensation in the affected and unaffected extremities. (Loss of sensation in these areas indicates perineal nerve or median nerve damage.)</td>
</tr>
<tr>
<td><strong>Pulses</strong></td>
<td></td>
</tr>
<tr>
<td>Palpate the pulses distal to the injury.</td>
<td>Pulses are strong and easily palpated; there is no difference between the affected and unaffected extremities.</td>
</tr>
<tr>
<td><strong>Capillary Refill (Least Reliable)</strong></td>
<td>Blood return (to usual color) is within 3 seconds (5 seconds for older people).</td>
</tr>
<tr>
<td>Press the nailbeds distal to the injury until blanching occurs (or the skin near the nail if nails are thick and brittle).</td>
<td></td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
</tr>
<tr>
<td>Ask the patient about the location, nature, and frequency of the pain.</td>
<td>Pain is usually localized and is often described as stabbing or throbbing. (Pain out of proportion to the injury and unrelied by analgesics may indicate compartment syndrome.)</td>
</tr>
</tbody>
</table>

Modified from Ignatavicius DD: Care of patients with musculoskeletal trauma. In Ignatavicius DD, Workman ML, editors: Medical-surgical nursing: patient-centered collaborative care, ed 7, St Louis, 2013, Saunders.
or 50% of estimated blood volume in 3 hours or less (Nessen et al, 2008). This volume is approximately equal to the transfusion of 10 units of RBCs. Transfusion guidelines recommend a balanced administration of blood products. Replacing a patient’s circulating volume with packed RBC/plasma/platelet ratios of 1 : 1 : 1 improves outcomes by preventing and treating coagulopathy due to massive hemorrhage (Johansson et al, 2012). This simple ratio not only is easy to use but also has the benefit of administration of higher plasma and platelet volumes.

**Diagnostic Procedures**

**Radiology.** Depending on the trauma center protocol, a blunt trauma radiographic series may be ordered during the resuscitative phase. The series minimally includes a lateral view of the cervical spine and an anteroposterior (AP) view of the chest. In addition, the patient also undergoes lateral thoracic and lumbar spine films and an AP view of the pelvis. Any area with deformity, swelling, or pain may also be examined by x-ray. Trauma patients are always treated as if they have a cervical spine injury until proven otherwise. When reviewing the cervical spine films for cervical spine injury clearance, the clinician should consider any existing factors that place the patient at high risk for spine injury. These include age older than 65 years, a dangerous MOI, and paresthesias in the extremities. Patients with penetrating trauma injuries usually are transferred immediately to the OR for exploratory laparotomy.

If the resources are available, the trauma center protocol may also include a computed tomography (CT) scan as a diagnostic or screening tool. Depending on the MOI, such as a fall, CT scans of the head and abdomen may be performed. Because injuries in blunt trauma are very difficult to diagnose, the CT scan is frequently done before patient transfer to the OR. A high index of suspicion is maintained for other injuries until proven otherwise. Bowel injuries may be missed during initial scanning. A CT scan of the brain revealing an injury incompatible with life may alter the course of definitive treatment for a patient.

A CT-angiogram may be indicated in diagnosis of vascular injuries. If the patient is hemodynamically stable, this test is of great value in determining the extent of the injury. It is particularly beneficial in the diagnosis of a ruptured thoracic aorta, in which extravasation of the dye at the area of aortic fixation to the chest wall is noted. Other uses include evaluation of penetrating wounds, especially in the extremity. Vessel injury can be noted and the need for surgical intervention determined.

**Other Diagnostic Tests.** Cardiac monitoring is another component of the initial phase of trauma care and is particularly important in blunt trauma. Early detection of ventricular dysrhythmias may indicate a myocardial contusion, or bruising of the heart. An electrocardiogram (ECG) is obtained when indicated by the mechanism of injury or the patient’s symptoms. Undiagnosed heart disease, as evidenced by an abnormal ECG, is noteworthy in a patient requiring operative intervention.

Focused assessment with sonography in trauma (FAST) may assist with diagnosis in difficult situations. FAST is a portable, noninvasive scan that can determine the presence of free fluid in the chest or abdomen. The typical FAST scan consists of chest, pelvic, and four abdominal scans. The chest scan examines right and left chest views and can determine the presence of pericardial fluid. The upper right abdominal scan evaluates the hepatorenal area, the first area that shows the presence of air. The left upper scan examines the splenorenal area. The left and right paracolic gutters are also scanned. The pelvic scan assesses for free fluid near the bladder.

**FAST is also used in pregnant patients with blunt abdominal trauma; it is both faster and safer than a CT scan, which is contraindicated in the pregnant patient because of the use of iodinated contrast medium and ionizing radiation (Cunningham, 2008).**

Although FAST is useful in diagnosing free fluid, it cannot determine damage to solid organs; therefore, it complements rather than replaces other imaging scans. Diagnostic peritoneal lavage (DPL) may be performed to determine the presence of abdominal injury. This tool is of particular benefit when evaluation of the abdomen is difficult, such as when the patient is intoxicated, unconscious, or hemodynamically unstable. DPL can be performed in the ED, OR, PACU, or ICU. Nonetheless, retroperitoneal blood may be missed with a DPL, whereas the FAST approach may be quicker and visualize more structures, even pericardium; it is also less expensive and noninvasive. Thus FAST may be used with patients who are unstable and need a quick approach without the risk of a false-positive tap (Table 28-4).

Internal compartment pressures may be measured with an injury to the extremity as well as to the abdomen. Swelling of the muscles below the fascia covering may compromise circulation and result in the eventual loss of the extremity because of tissue necrosis. This is known as compartment syndrome. There are multiple compartments in the lower extremity that may be affected (Figure 28-4). Surgeons may measure compartment pressures with a manometer/stopcock/syringe or a commercial compartment pressure–measuring device. Normal compartmental pressures are less than 20 mm Hg. Pressures more than 30 mm Hg require a fasciotomy. Symptoms include severe pain, paresthesia, and a decrease in motor movement in the involved extremity, especially on passive movement (Table 28-5).

Massive intestinal edema may occur with trauma patients, causing compromise to internal organs and development of a different type of compartment syndrome. Abdominal compartment syndrome, also called abdominal hypertension, is characterized by increased intra-abdominal pressure (IAP). An increase in IAP can have a negative effect on the respiratory, splanchnic, and cerebral pressure.

### **TABLE 28-4**

<table>
<thead>
<tr>
<th>Comparison of DPL, FAST, and CT Scans</th>
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<tbody>
<tr>
<td><strong>Diagnostic Peritoneal Lavage (DPL) Documents Bleeding</strong></td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
</tr>
<tr>
<td>Early diagnosis</td>
</tr>
<tr>
<td>Performed rapidly</td>
</tr>
<tr>
<td>98% sensitive</td>
</tr>
<tr>
<td>Detects bowel injury</td>
</tr>
<tr>
<td>Repeatable</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>Invasive</td>
</tr>
<tr>
<td>Low specificity</td>
</tr>
<tr>
<td>Misses diaphragmatic and retroperitoneal injuries</td>
</tr>
</tbody>
</table>

Management involves a decompressive laparotomy. After a decompression the greatest nursing priority is wound management. The swelling may render the abdomen difficult or impossible to close. If the abdomen is closed, IAP may rise to a level greater than 25 cm of H₂O, at which point it may lead to significant organ dysfunction (Kulaylat and Dayton, 2012). IAP monitoring is accomplished with the use of a nasogastric tube in the stomach or a Foley catheter in the bladder. Simple water-column manometry is done at 2- to 4-hour intervals, although it is possible to connect a pressure transducer to a Foley catheter by way of the sampling port (Figure 28-5). By establishing a water column of urine in the Foley catheter with a clamp distal to the port, a pressure gradient is established. After zero-balancing the transducer, an 18-gauge needle is placed on the end of the pressure tubing and inserted into the sampling port. Using the pressure tubing and a 60-mL syringe, 50 to 60 mL of normal saline is then instilled into the Foley.

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functions. It contributes to sepsis or multiple organ failure seen in many trauma patients. Normal IAP is approximately 5 to 7 mm Hg; elevation to 25 mm Hg is often seen in patients with septic shock and correlates with high mortality (Vegar-Brozovic et al, 2008). IAP is graded from I to IV based on a 12 to more than 25 mm Hg scale. Adverse effects on organ function may manifest as decreased cardiac output, oliguria, and hypoxia. Elevated intrathoracic pressure reduces left ventricular compliance, causing limitations in effective ventilation, often requiring ventilator support. Elevated IAP may cause an increase in intracranial pressure related to obstruction of cerebral venous blood outflow and increased intrathoracic and central venous pressure. Delay in treatment of IAP may lead to brain deterioration and damage.

**TABLE 28-5**

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Location of Sensory Changes</th>
<th>Movement Weakened</th>
<th>Painful Passive Movement</th>
<th>Location of Pain or Tenseness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower Leg</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>First web space</td>
<td>Toe extension</td>
<td>Toe flexion</td>
<td>Along lateral side of anterior tibia</td>
</tr>
<tr>
<td>Lateral</td>
<td>Dorsum (top) of foot</td>
<td>Foot eversion</td>
<td>Foot inversion</td>
<td>Lateral lower leg</td>
</tr>
<tr>
<td>Superficial posterior</td>
<td>None</td>
<td>Foot plantar flexion</td>
<td>Foot dorsiflexion</td>
<td>Calf</td>
</tr>
<tr>
<td>Deep posterior</td>
<td>Sole of foot</td>
<td>Toe flexion</td>
<td>Toe extension</td>
<td>Deep calf—palpable between Achilles tendon and medial malleoli</td>
</tr>
<tr>
<td><strong>Forearm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volar</td>
<td>Volar (palmar) aspect of fingers</td>
<td>Wrist and finger flexion</td>
<td>Wrist and finger extension</td>
<td>Volar forearm</td>
</tr>
<tr>
<td>Dorsal</td>
<td>None</td>
<td>Wrist and finger extension</td>
<td>Wrist and finger flexion</td>
<td>Dorsal forearm</td>
</tr>
<tr>
<td><strong>Hand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intraosseous</td>
<td>None</td>
<td>Finger adduction and abduction</td>
<td>Finger adduction and abduction</td>
<td>Between metacarpals on dorsum of hand</td>
</tr>
</tbody>
</table>

instillation of the saline, the waveform on the monitor is correlated to the existing bladder pressure. Normal IAP is zero, or subatmospheric. A pressure of more than 25 cm of H2O is considered diagnostic of abdominal compartment syndrome (Kulaylat and Dayton, 2012). Postoperatively these patients are susceptible to fluid and heat loss. Continuous hemodynamic monitoring is essential in the critical care phase of treatment.

**Admission Assessment.** The perioperative nurse may not obtain information concerning the trauma patient until the patient arrives in the OR for surgical intervention. If the patient's condition permits, the perioperative nurse should obtain a brief, precise report from the ED nurse that contains the following information: MOI, an AMPLE history (if available), condition on arrival (e.g., level of consciousness), availability of and prior administration of blood or blood products, spine clearance, injuries present, and any other pertinent information (e.g., family present, completion of secondary assessment). If the injury is life- or limb-threatening, implied surgical consent is assumed (i.e., if the patient were able, consent would be given).

Additional data are collected as the perioperative nurse accompanies the patient to the OR. The status of the airway, as well as breathing patterns and circulatory condition, can be observed. The ED record also provides information concerning amount and type of intravenous (IV) fluid received, vital signs, core temperature, and laboratory and other diagnostic examinations performed. A quick visual and physical survey of the patient when the perioperative nurse is preparing the patient for the procedure enables identification of other sites of injury that might require attention.

The patient's psychologic status also can be assessed. If the patient is conscious, the perioperative nurse is challenged to allay fear and anxiety. The trauma patient has endured a very frightening experience and is in need of support. The perioperative nurse is often the best member of the surgical team to communicate with the patient and explain the interventions occurring before anesthesia induction. A touch or handhold is an important aspect of this communication process, demonstrating the nurse's caring behaviors and offering comfort.

**Nursing Diagnosis**

Nursing diagnoses related to the care of trauma patients undergoing operative intervention might include the following:

- Anxiety and Fear (patient and family) related to unpredictable nature of condition
- Deficient Fluid Volume related to hemorrhage, fluid shifts, alteration in capillary permeability, alteration in vascular tone, or myocardial compromise
- Hypothermia related to rapid infusion of IV fluids, decreased tissue perfusion, and exposure
- Acute Pain related to effects of trauma/injury agents, experience during invasive procedures or diagnostic tests
- Risk for Aspiration related to reduced level of consciousness secondary to injury or concomitant substance abuse; impaired cough and gag reflex; trauma to head, face, or neck; and secretions and debris in airway

**Outcome Identification**

Outcomes identified for the selected nursing diagnoses could be stated as follows:

- The patient and family will experience decreasing anxiety and fear, as evidenced by orientation to surroundings, ability to verbalize concerns and ask questions of the healthcare team, decreased fear-related behaviors (e.g., crying, agitation), and use of effective coping skills.
- The patient will have an effective circulating volume as evidenced by strong, palpable peripheral pulses; warm, dry skin of normal color; stable vital signs appropriate for age; maintenance of hematocrit level of 30 mL/dL or hemoglobin level of 12 to 14 g/dL or greater; and control of external hemorrhage.
- The patient will maintain a normal core body temperature, as evidenced by a core temperature measurement of 98° to 99.5°F (36.6° to 37.5°C) and warm, dry skin of normal color.
- The patient will experience relief of pain, as evidenced by diminishing or absent level of pain through his or her self-report, absence of physiologic indicators of pain (e.g., tachypnea, pallor, diaphoretic skin, increasing blood pressure), and ability to cooperate with care as appropriate.
- The patient will not experience aspiration, as evidenced by a patent airway; clear and equal bilateral breath sounds; regular rate, depth, and pattern of breathing; clear chest radiograph without evidence of infiltrates; and ability to handle secretions independently.

**Planning**

Because of the unexpected nature of trauma, planning perioperative care is of the utmost importance. Equipment, instruments, and supplies that have a high probability of use must be immediately available. Autologous blood salvage units should also be considered during patient care preparation, because blood salvage will be done if not contraindicated by the nature of the injury. (A Sample Plan of Care for a trauma patient is shown on page 1113.)

**Implementation**

**Multiple Operative Procedures.** Depending on the severity of the injuries, the multiple trauma patient may require many surgical interventions. Some of these procedures may be performed simultaneously. This is determined through a collaborative effort among the surgeons, anesthesia provider, and perioperative nurse. If a patient has sustained severe head and abdominal trauma, a surgeon will need to place an intracranial pressure (ICP) monitoring device (Surgical Pharmacology). However, the abdominal exploration is also emergently indicated. Consequently, the severe condition of the patient may require performance of both of these procedures at the same time.

Multiple procedures, either simultaneously or in succession, require a great deal of preparation by the perioperative nurse, scrub person, and the trauma team. The order of procedures is determined by the presence or absence of life threats. The usual order of priority is chest, abdomen, head, and extremities. However, this priority is determined for each patient's situation and adjusted accordingly. Performance of simultaneous procedures is preferable when physically possible. Anesthesia time is decreased for the critically ill patient, and definitive surgical interventions are accomplished more rapidly.

**Increased Risk for Infection.** Many trauma patients have wounds that are contaminated with roadside debris, dirt, grass, or automobile parts. Others have a perforated full stomach, and food particles are released into the peritoneum, increasing the risk of peritonitis. Consequently many patients are at high risk for infection. Sterile technique may be compromised secondary only to immediate life threat. Pouring an antimicrobial solution across the surgical site...
SAMPLE PLAN OF CARE

Nursing Diagnosis
Anxiety and Fear (patient and family) related to unpredictable nature of condition

Outcome
The patient and family will experience decreasing anxiety and fear, as evidenced by orientation to surroundings; ability to verbalize concerns and ask questions to healthcare team; decreased fear-related behaviors (e.g., crying, agitation); and use of effective coping skills.

Interventions
- Monitor the patient’s level of anxiety by assessing the state of alertness, ability to comprehend, and ability to comply with requests.
- Facilitate the family’s presence.
- Assist the family in identifying coping mechanisms; facilitate and support their use.
- Reassure the patient and family during interactions by touch (when welcomed) and empathic verbal and nonverbal communication.
- Explain the perioperative environment to patient and what to expect to assist in reduction of anxiety.
- Discuss the patient’s postoperative appearance (i.e., drains, tubes, equipment) with the patient and family.

Nursing Diagnosis
Deficient Fluid Volume related to hemorrhage, fluid shifts, alteration in capillary permeability, alteration in vascular tone, or myocardial compromise.

Outcome
The patient will have an effective circulating volume as evidenced by strong, palpable peripheral pulses; warm, dry skin of normal color; stable vital signs appropriate for age; maintenance of hematocrit level of 30 mL/dL or hemoglobin level of 12 to 14 g/dL or higher; and control of external hemorrhage.

Interventions
- Manage any uncontrolled bleeding by doing the following:
  - Applying direct pressure over bleeding site
  - Elevating extremities
  - Applying pressure over arterial pressure sites
- Ensure trauma profile laboratory work is complete.
- Verify that requested blood and blood replacement components are available in the OR.
- Prepare laboratory request slips as required; document time and type of analysis requested.
- Collaborate with anesthesia provider in monitoring cardiovascular changes suggestive of hypovolemia.
- Assist in accurate monitoring of intake and output during the surgical procedure.
- Administer blood and blood components as indicated.

Nursing Diagnosis
Hypothermia related to rapid infusion of intravenous (IV) fluids, decreased tissue perfusion, exposure

Outcome
The patient will maintain a normal core body temperature, as evidenced by a core temperature measurement of 96.8° to 99.5°F (36° to 37.5°C) and warm, dry skin of normal color.

Interventions
- Warm IV solutions and blood products using approved warming devices.
- Minimize body exposure during all phases of perioperative care.
- Use forced-air warming units and warm blankets to facilitate normothermia.
- Ensure irrigant solutions are warm.
- Monitor body temperature for signs of hypothermia, and report to anesthesia provider.

Nursing Diagnosis
Acute Pain related to effects of trauma/injury agents, experience during invasive procedures or diagnostic tests

Outcome
The patient will experience relief of pain, as evidenced by diminishing or absent level of pain through self-report, absence of physiologic indicators of pain (e.g., tachypnea, pallor, diaphoretic skin, increasing blood pressure), and ability to cooperate with care as appropriate.

Interventions
- Collaborate with anesthesia provider and surgeon regarding pain management therapy to increase the patient’s level of comfort if condition permits.
- Assess nonverbal cues regarding level of pain and discomfort.
- Assume that pain is present or that procedures will cause pain if the patient is unable to provide verbal or nonverbal cues.
- Use a visual or numeric pain scale to assess pain levels and change in comfort if the patient is conscious and able to respond.

Nursing Diagnosis
Risk for Aspiration related to reduced level of consciousness secondary to injury or concomitant substance abuse; impaired cough and gag reflex; trauma to head, face, or neck; and secretions and debris in airway

Outcome
The patient will not experience aspiration, as evidenced by a patent airway; clear and equal bilateral breath sounds; regular rate, depth, and pattern of breathing; clear chest radiograph without evidence of infiltrates; and ability to handle secretions independently.

Interventions
- Ensure operation of suction apparatus preoperatively, and maintain one open suction line solely for use by the anesthesia provider.
- Provide assistance with cricoid pressure under the direction of the anesthesia provider.
- Assist with placement of nasogastric or orogastric tube to evacuate stomach contents.

may be the only surgical skin prep undertaken when an immediate life threat exists. The use of antimicrobial prophylaxis shortly before skin incision has become the standard of care for surgical procedures. Perioperative nurses are in a position to ensure the timely administration of antibiotics.

Wounds may need to be grossly decontaminated before the surgical skin prep. Sterile scrub brushes or a mechanical irrigation-under-pressure device may be used preoperatively and intraoperatively. Care must be exercised to remove as much contamination as possible, without creating further damage to the wound or body part. Perioperative personnel must wear personal protective equipment (PPE) during irrigation under pressure to prevent splashes and contamination from the lavage system. Traffic in the OR should be limited to essential personnel. Increased traffic...
SURGICAL PHARMACOLOGY

Commonly Used Medications by the Anesthesia Provider to Decrease ICP

<table>
<thead>
<tr>
<th>Medication/Category</th>
<th>Dosage/Route</th>
<th>Purpose/Action</th>
<th>Adverse Reactions</th>
<th>Nursing Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiopental (Pentothal)</td>
<td>Adults: 1.5-3.5 mg/kg IV bolus</td>
<td>Reduce intraoperative elevations of intracranial pressure</td>
<td>Respiratory depression, hypotension, bronchospasm, and cardiac arrhythmias</td>
<td>Monitor for hypotension, ECG.</td>
</tr>
<tr>
<td>Pharmacotherapeutic: Barbiturate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propofol (Diprivan)</td>
<td>Adults: Induction 20-40 mg every 10 sec until induction onset Children 3-16 yr: Induction 2.5-3.5 mg/kg over 20-30 sec</td>
<td>For general anesthesia induction, reduce cerebral blood flow and the cerebral metabolic rate for oxygen</td>
<td>Respiratory depression, apnea, hypotension, and sinus bradycardia</td>
<td>Monitor respiratory rate, BP, heart rate, O₂ saturation, ABGs.</td>
</tr>
<tr>
<td>Pharmacotherapeutic: General anesthetics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esmolol (Brevibloc)</td>
<td>Adults: Initially give a loading dose of 250-500 mcg/kg IV over 1 min, then begin a maintenance infusion of 50-100 mcg/min IV for 4 min</td>
<td>Blunt systemic hypertension caused by laryngoscopy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacotherapeutic: Beta-blocker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mannitol (Osmitrol)</td>
<td>Adults: Initial dose 0.5-1 g/kg IV, then maintenance dose 0.25-0.5 g/kg IV q4-6 hr Children: Initial dose 0.25-1 g/kg IV, then maintenance dose 0.25-0.5 g/kg IV q4-6 hr</td>
<td>Elevates osmotic pressure of glomerular filtrate, inhibiting tubular reabsorption of water and electrolytes, resulting in increased flow of water into interstitial fluid/plasma</td>
<td>Pulmonary edema, CHF, excessive diuresis may produce hypokalemia, hyponatremia</td>
<td>Monitor urinary output to determine therapeutic response. Monitor serum electrolytes, BUN, renal/hepatic function tests, assess vital signs.</td>
</tr>
<tr>
<td>Pharmacotherapeutic: Osmotic diuretic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furosemide (Lasix)</td>
<td>Adults: 20-40 mg IV; may increase by 20 mg/dose q1-2 hr; maximum single dose 160-200 mg Children: 1-2 mg/kg IV q6-12 hr; maximum single dose 6 mg/kg</td>
<td>Excretion of sodium, chloride, potassium by direct action at ascending limb of loop of Henle; produces diuresis; lowers BP, ICP</td>
<td>Hypokalemia, hyponatremia, dehydration, sudden volume depletion may result in increased risk of thrombosis, circulatory collapse, sudden death</td>
<td>Check vital signs, BP, pulse; assess baseline serum electrolytes, especially for hypokalemia.</td>
</tr>
<tr>
<td>Pharmacotherapeutic: Diuretic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ABGs, Arterial blood gases; BP, blood pressure; BUN, blood urea nitrogen; CHF, congestive heart failure; ECG, electrocardiogram; ICP, intracranial pressure; IV, intravenous.


in the room increases chances for contamination in an already compromised patient, as well as potentially interferes with the delivery of expedient care.

Procedure Preparation. Most level I trauma centers have a designated trauma OR that contains all equipment and supplies potentially needed for trauma patients. Many hospitals maintain an emergency abdominal procedure set, craniotomy procedure set, and chest procedure set either obtainable in the OR’s sterile supply area or immediately available in the central supply department. This streamlines preparation for the surgical procedure and allows for rapid preparation in those instances in which the patient bypasses the ED on arrival and is transported directly to the OR.

After the perioperative nurse is notified of the surgical procedure, OR determination is made in consultation with the anesthesia provider and surgeon. Considerations include the following:

- Equipment required by the surgeon or surgeons to perform the surgical procedure
- Room availability
- Room size (to accommodate equipment, staff, and multiple procedures)
- Need for additional staff
- Capability for autologous blood salvage
- Availability of emergency procedure supplies (including power equipment)
- Selection of OR bed

Additional diagnostic procedures are often required during multiple trauma procedures. A fluoroscopic electric OR bed provides increased flexibility in patient management. The bed can be rotated on its base to facilitate two teams operating at once. The fluoroscopic capabilities allow for additional radiographs and arteriograms as needed. The bed should easily accommodate different positions, such as lithotomy or lateral rotation. If a fluoroscopic bed is not available, arrangements must be made in advance to perform diagnostic radiologic procedures intraoperatively.

Before transfer of the patient to the OR bed, the perioperative nurse must ascertain if the spinal column has been cleared by the surgeon or attending physician as free from injury. If the spine has...
not been cleared, the surgeon must be consulted before removal of the patient from the backboard. Safe transfer of the patient from the transport vehicle to the OR bed can be accomplished using the log-rolling technique.

Positioning the patient is based on the surgical approach. Ascertaining the type and location of the wound (anterior or posterior) and type of operative procedure dictates the patient’s position. For example, an aortic injury may be approached through a thoracotomy or a median sternotomy incision. The thoracotomy requires lateral positioning devices, and the sternotomy necessitates a supine position.

If several procedures are being performed, positioning may change intraoperatively. Changing the anesthetized patient’s position is accomplished under the supervision of the anesthesia provider, with particular attention to maintain the airway. The patient is moved slowly, allowing for assessment of vital sign changes in response to the position movement. All precautions regarding positioning are re-executed, with special attention given to the electro-surgical grounding pad. This pad may loosen during patient repositioning and require replacement to ensure adequate pad contact.

When the trauma patient is transferred to the OR, the extent of injury is not always known. The perioperative nurse should prep the patient from the suprasternal notch to the midthigh. This allows for rapid access to the chest to clamp the aorta should massive hemorrhage control be indicated; it also allows for exposure of the femoral arteries for potential cannulation and access to the thigh for harvesting a saphenous vein.

Established policies for counting soft goods, instruments, and sharps should address surgical procedures of an emergent nature within the institution. Every attempt is made to verify appropriate numbers of counted items without compromising the timeliness of intervention in a life-threatening situation. If a preprocedural count is not performed, the perioperative nurse must document the occurrence and rationale used in accordance with established hospital policies and procedures. Some institutions require an x-ray examination postoperatively to examine the patient for the presence of a retained object. If counted soft goods are intentionally left in the patient (e.g., in a damage control procedure at a level II, III, or IV center before transfer to a level I facility), the number and type of soft goods left in the wound should be documented on the perioperative nursing record and communicated when there is a transfer in patient care (Association of periOperative Registered Nurses [AORN], 2013). The operative dictation by the surgeon should also verify the presence of retained soft goods, their type, and their number. This allows for accurate counts in subsequent procedures and prevents the potential for inadvertently retained soft goods.

In the presence of clotting difficulties or specific types of organ injuries with continuous oozing of blood, the surgeon may elect to pack the surgical site with soft goods and close the site as a temporary measure. After a period of 24 to 48 hours, the patient returns to the OR for removal of the soft goods and primary closure if possible. In such instances the perioperative nurse must document and record accurately the number of soft goods used for packing, as noted. When the soft goods are removed, the exact number is verified and they are isolated and contained in accordance with established hospital policy and procedure.

**Autotransfusion.** Considering the high blood loss associated with traumatic injuries, autotransfusion has become a vital asset in trauma care. Preoperative blood loss that is associated with an isolated hemothorax is collected in a designated chest-drainage device for reinfusion within 4 hours to avoid bacterial contamination. Intraoperative blood loss is collected, filtered, and rein infused to the patient. This provides immediate volume replacement, decreases the amount of bank blood used, and reduces the possibility of transfusion reactions or risk of transfusion with bloodborne pathogens.

The autologous blood salvage unit requires specialized training for operation. Institutional policies vary regarding appropriate personnel designated for operation of the equipment. Capabilities for autotransfusion should be considered during procedure preparation because additional qualified personnel may be required.

During autologous blood salvage the scrub person squeezes out additional blood and fluid from saturated soft goods before discarding them from the surgical field. The blood salvage suction is used whenever possible to maximize the amount of blood salvaged. However, care must be taken to ensure that the blood collected in the salvage unit is free from contamination. For example, if the abdomen is contaminated with free food particles or colonic perforation is present, the blood cannot be used. Similarly, once antibiotic irrigation is initiated, the blood salvage unit is not used.

**Evidence Preservation.** If the injury to the patient is a result of a violent crime, the team must give special attention to preservation of evidence during the course of patient care. Physical evidence (e.g., bullets, bags of powder, weapons, pills, and other foreign objects), trace evidence (e.g., hair and fibers), biologic evidence (e.g., body fluids and blood), and clothing are types of evidence to be preserved. Specific procedures on handling of evidence may differ by institution and law enforcement agencies.

Clothing must be handled properly. When clothing is removed from the patient, the person removing it should cut along the seams or around the bullet or stab wound holes. The shape of the hole may help identify the weapon used. Clothing is placed in paper bags, labeled appropriately, and given to law enforcement personnel. Plastic bags trap moisture and may facilitate growth of mold, which could destroy evidence. The transport vehicle sheet should also be handled in a similar manner because evidence may be present. The nurse must ensure that descriptions of wound appearances, body markings consistent with gang or cult activity, and statements from the patient are accurately recorded.

The chain of custody for all evidence, including clothing, is followed. This process allows for identification of all people handling the evidence. Documentation must verify that the evidence has been in secure possession at all times. Records should be kept of all evidence discovered, including its site of origin and when and to whom the evidence was given. A system of documentation using receipts or a specific form should be established to ensure appropriate compliance.

Gunpowder residues, tissue, hair, or other valuable information may be present on the hands of a trauma patient. This evidence can be preserved by placing the patient’s hands in a paper bag and securing it with tape. Washing the hands should be avoided until evidence is collected, or until directed to do so by the police.

Bullets and retained implements offer valuable evidence and may assist in identifying the assailant. The weapon firing the bullet and the bullet itself can be matched by the specific grooves and markings placed on the bullet when the gun was fired. Most bullets are composed of soft lead, and handling with metal instruments can interfere with the markings. Therefore, the surgeon should avoid using metal instruments to handle bullets. Some of the newer exploring
types of bullets can present a risk to perioperative team members during wound exploration. Care should be exercised to avoid sterile glove tears because these types of bullets are extremely sharp. Once a bullet is removed, the scrub person should place it in dry, clean gauze in a plastic specimen container and pass it off the sterile field to the perioperative nurse. Using the chain-of-custody procedures, the perioperative nurse should label the container appropriately and dispose of the bullet according to established institutional policies.

Deep Vein Thrombosis Prophylaxis. Because of the prolonged immobilization anticipated for the trauma patient, along with the frequency of orthopedic or lower extremity surgery, trauma patients are at high risk for developing venous thromboembolic events (VTE). Placement of a intermittent pneumatic compression device preoperatively is ideal. These pneumatic compression devices assist in decreasing the possibility of deep vein thrombosis (DVT), and their effect is optimized when applied before surgical intervention. Preoperative placement is subject to the physician’s preference; clinical research regarding similar devices and demonstrated product effectiveness is ongoing. The incidence of DVT and pulmonary embolism (PE) in trauma patients varies widely. In the approximately 235,000 cases of traumatic brain injury (TBI) that occur every year, up to 54% who do not receive any intervention will develop DVT or PE (Phelan, 2012).

Currently, in patients with traumatic brain injury, the only recommended prophylaxis is the use of an intermittent pneumatic compression device because of concerns with the use of heparin leading to bleeding complications. Subsequently, an inferior vena cava filter (VCF) may be inserted in high-risk patients to prevent pulmonary embolus. Risk factors for PE include prolonged immobility, multiple pelvic and lower extremity fractures, previous history of PE, severe head trauma, and incomplete spinal cord injury with paralysis. However, the placement of a VCF is associated with inferior vena cava obstruction and recurrent DVT. Contraindication to pharmacologic prophylaxis is generally limited to a short period after the initial trauma, and long-term vena cava filtration is rarely necessary.

Anesthesia Implications. Depending on institutional protocol, the anesthesia team may be directly involved in resuscitation of the trauma patient immediately after arrival at the ED. The anesthesia provider maintains the airway and intubates the patient if necessary. A critically injured patient may be transferred directly to the OR, whereas some interventions may be performed in the ED of a trauma center. These interventions vary from insertion of an ICP monitor to an emergent exploratory thoracotomy.

However, if diagnostic evaluation can be accomplished without intubation and sedation, the patient may be conscious on arrival in the OR. A trauma patient is assumed to have a full stomach; thus these patients are at high risk for aspiration and resultant pneumonia. Under the direction of the anesthesia provider, the perioperative nurse applies cricoid pressure (Sellick maneuver) (see Figure 5–4). This pressure is maintained over the cricoid area until the cuff on the endotracheal (ET) tube is inflated and tube placement verified by the anesthesia provider. This type of intubation is often referred to as a “crash intubation.”

In addition, the patient may require intubation for protection of the airway before radiologic examination of the cervical spine. If the cervical spine is not cleared or if the radiographic screening examination is not performed before intubation, ET intubation is done while cervical spine precautions (i.e., in-line intubation) are maintained. The anesthesia provider may decide to use rapid-sequence intubation (RSI), which involves administering 100% oxygen, an analgesic, and a neuromuscular relaxant; applying cricoid pressure; and inserting a cuff ed ET tube. Etomidate (Amidate) is the most commonly used induction agent (ENA, 2007). It acts in about 1 minute and lasts about 5 minutes and is often used in trauma patients because it does not cause an increase in ICP or worsening of hypotension. Succinylcholine (Anectine) is the most frequently used neuromuscular relaxant. The perioperative nurse can facilitate RSI by ensuring availability of all intubation and resuscitation equipment, assisting with monitoring devices, and confirming correct ET-tube placement (Box 28-1).

Injuries of the face where midface fractures are present, nasal intubation and nasogastric tube placement are avoided. Tube placement in the brain through a fracture of the cribriform plate is a well-known complication. To avoid this, oral ET intubation is the technique of choice. The anesthesia provider places an oral gastric tube to achieve stomach decompression. An oral intubation on a conscious patient is often necessary because anesthetics and muscle relaxants can result in the loss of any remaining airway in the presence of facial trauma.

Large-bore IV access used with rapid-infusion fluid warmers may be used in the ED. These fluid warmers can deliver high volumes of crystalloid solution at body temperature. Use of the fluid warmer may continue during the intraoperative phase to facilitate volume replacement and help maintain normothermia. A number of factors may influence a trauma patient’s response to fluid loss. These factors include age, severity of injury, type and location of injury, time lapse from injury to treatment, prehospital fluid therapy, prehospital use of a pneumatic antishock garment (PASG), and medications taken for chronic conditions. Fluid resuscitation should be initiated when early signs of blood loss are suspected. A classification system can be useful in determining the needs of the patient (Table 28-6).

**BOX 28-1**

Rapid-Sequence Intubation Steps

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation</td>
<td>Assist anesthesia care provider as needed. Ensure all equipment is available.</td>
</tr>
<tr>
<td>Preoxygenation</td>
<td>Administer 100% oxygen.</td>
</tr>
<tr>
<td>Pretreatment</td>
<td>Assist anesthesia provider in medication administration, as indicated (atropine, lidocaine, etomidate).</td>
</tr>
<tr>
<td>Paralysis with induction</td>
<td>Stand by while anesthesia is induced (midazolam, fentanyl), provide support while patient loses consciousness and neuromuscular agent is administered (succinylcholine).</td>
</tr>
<tr>
<td>Protection and positioning</td>
<td>Use Sellick maneuver to provide cricoid pressure. Prepare to apply pressure continuously and until anesthesia provider asks to have pressure released to avoid aspiration.</td>
</tr>
<tr>
<td>Placement with proof</td>
<td>Inflate cuff; check placement with exhaled carbon dioxide detector and by listening to lungs with stethoscope.</td>
</tr>
<tr>
<td>Postintubation management</td>
<td>Secure tube, verify ventilator settings, and monitor per routine.</td>
</tr>
</tbody>
</table>

into the peritoneal cavity, increasing the risk for injury. Furthermore, intra-abdominal organs change position as pregnancy progresses, increasing the risk for GI injury when the MOI is a stabbing or gunshot wound (Reddy et al, 2012).

It is also important to note that the pregnant trauma patient has a much larger circulatory volume (Table 28-7). The cardiac output may be increased by as much as 40%. Oxygen requirements are increased. Heart rate increases over the prepregnant state. The usual clinical indicators of hypovolemic shock are unreliable in the pregnancy.

| TABLE 28-6 |
| Estimated Fluid and Blood Losses Based on Patient's Initial Presentation* |

<table>
<thead>
<tr>
<th>System</th>
<th>Alteration</th>
<th>Clinical Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>↑ Oxygen consumption</td>
<td>↑ Risk of acidosis</td>
</tr>
<tr>
<td></td>
<td>↑ Tidal volume</td>
<td>↑ Risk of respiratory mismanagement</td>
</tr>
<tr>
<td></td>
<td>↓ Functional residual capacity</td>
<td>↓ Blood-buffering capacity</td>
</tr>
<tr>
<td></td>
<td>Chronic compensated alkalosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>↓ PaCO₂</td>
<td>Can lose 1000 mL of blood</td>
</tr>
<tr>
<td></td>
<td>↓ Serum bicarbonate</td>
<td>No signs of shock until blood loss &gt;30% of total volume</td>
</tr>
<tr>
<td></td>
<td>Circulating volume, 1600 mL</td>
<td>↓ Placental perfusion in supine position</td>
</tr>
<tr>
<td></td>
<td>↑ Cardiac output</td>
<td>Point of maximal impulse, fourth intercostal space</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>↑ Heart rate</td>
<td>Heart displaced upward to left</td>
</tr>
<tr>
<td></td>
<td>↓ Systemic vascular resistance (SVR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>↓ Arterial blood pressure</td>
<td></td>
</tr>
<tr>
<td>Renal</td>
<td>↑ Renal plasma flow</td>
<td>↑ Risk of stasis, infection</td>
</tr>
<tr>
<td></td>
<td>Dilatation of ureters and urethra</td>
<td>↑ Risk of bladder rupture</td>
</tr>
<tr>
<td></td>
<td>Bladder displaced forward</td>
<td>↑ Risk of aspiration</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>↓ Gastric motility</td>
<td>Passive regurgitation of stomach acids if head lower than stomach</td>
</tr>
<tr>
<td></td>
<td>↑ Hydrochloric acid production</td>
<td></td>
</tr>
<tr>
<td></td>
<td>↓ Competency of gastroesophageal sphincter</td>
<td></td>
</tr>
<tr>
<td>Reproductive</td>
<td>↑ Blood flow to organs</td>
<td>Source of ↑ blood loss</td>
</tr>
<tr>
<td></td>
<td>Uterine enlargement</td>
<td>Vena caval compression in supine position</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>Displacement of abdominal viscera</td>
<td>↑ Risk of injury, altered rebound response; altered pain referral</td>
</tr>
<tr>
<td></td>
<td>Pelvic venous congestion</td>
<td>↑ Risk of pelvic fracture</td>
</tr>
<tr>
<td></td>
<td>Cartilage softened</td>
<td>Center of gravity changed</td>
</tr>
<tr>
<td>Hematologic</td>
<td>↑ Clotting factors</td>
<td>↑ Risk of fetal injury</td>
</tr>
<tr>
<td></td>
<td>↓ Fibrinolytic activity</td>
<td>↑ Risk of thrombus formation</td>
</tr>
</tbody>
</table>

*The guidelines are for a 70-kg man. They are based on the 3:1 rule. This rule derives from the empiric observation that most patients in hemorrhagic shock require as much as 300 mL of electrolyte solution for each 100 mL of blood loss. Applied blindly, these guidelines can result in excessive or inadequate fluid administration. For example, a patient with a crush injury to the extremity may have hypotension out of proportion to his or her blood loss and require fluids in excess of the 3:1 guidelines. In contrast, a patient whose ongoing blood loss is being replaced by blood transfusion requires less than 3:1. The use of bolus therapy with careful monitoring of the patient’s response can moderate these extremes.


| TABLE 28-7 |
| Maternal Adaptation During Pregnancy and Relation to Trauma |

<table>
<thead>
<tr>
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<th>Alteration</th>
<th>Clinical Responses</th>
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</tr>
</tbody>
</table>

Coma Scale for children.

UNIT III  Special Considerations

Pediatric Trauma Patients. Special considerations related to the care of infants and children who have sustained a trauma are described in Chapter 26. Table 26-7 details a modified Glasgow Coma Scale for children.

TABLE 28-8

Signs of Hypovolemic Shock in Pregnancy

<table>
<thead>
<tr>
<th>Circulating Blood Volume Deficit</th>
<th>Early (20%)</th>
<th>Late (25%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse rate</td>
<td>&lt;100 beats/min</td>
<td>&gt;100 beats/min</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>12-20 breaths/min</td>
<td>&gt;20 breaths/min</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Normal</td>
<td>Hypotensive</td>
</tr>
<tr>
<td>Skin perfusion</td>
<td>Warm, dry skin</td>
<td>Cool, ashen skin</td>
</tr>
<tr>
<td>Capillary refill time</td>
<td>&lt;2 seconds</td>
<td>&gt;2 seconds</td>
</tr>
<tr>
<td>Level of consciousness</td>
<td>Alert</td>
<td>Agitated, lethargic</td>
</tr>
<tr>
<td>Urine output</td>
<td>&gt;30-50 mL/hr</td>
<td>&lt;30-50 mL/hr</td>
</tr>
<tr>
<td>Fetal heart rate (normally)</td>
<td>High, low, late</td>
<td>High, low, absent, late decelerations</td>
</tr>
<tr>
<td></td>
<td>120-160 beats/min</td>
<td></td>
</tr>
</tbody>
</table>

Early (20%) Late (25%)

Invasive Emergency Department Interventions. If a patient has shown a very recent deterioration of vital signs, either en route to the hospital or on arrival at the ED, the surgeon may elect to perform an emergency thoracotomy in the ED. A left-sided approach is usually performed because this allows rapid access to the heart for external cardiac massage and exposure of the great vessels for clamping in the event of severe blood loss (Figure 28-6). The incision can be extended to the right side by cutting across the sternum; this approach is commonly referred to as the clam shell thoracotomy. This procedure can be used to gain control in hemorrhage of the great vessels, to access the heart, or, in a grave situation, as a final effort to save a life. The procedure is used more often in penetrating injuries in which a laceration to a ventricle or other potentially treatable, life-threatening injury may be present.

Because of the perioperative nurse’s knowledge of surgical instrumentation and procedures, his or her assistance in this procedure in the ED is often required. Rapid access to the heart and great vessels is the goal. The patient is then transported to the OR for additional interventions once hemorrhage is controlled.

In a similar fashion, an exploratory laparotomy can be initiated in the ED to control abdominal hemorrhage, especially when a splenic rupture is suspected and the patient is severely compromised.

If all other techniques of airway access are unsuccessful, the surgeon performs a cricothyotomy. The surgeon makes a vertical incision through the skin, and incises the cricothyroid membrane. An ET or tracheostomy tube can be inserted through the membrane to create an airway. In the event a tube is not immediately available, a large-bore needle can be inserted into the membrane and the catheter left in place. This provides a temporary airway access.

Bariatric Trauma Patients. There has been a notable increase in admissions of bariatric patients in all healthcare facilities. Bariatric medicine is defined as the care of the extremely obese patient, as measured by body mass index (BMI). The World Health Organization (WHO) defines obese as a BMI greater than 30 and severely obese as a BMI greater than 40 (Muir and Archer-Heese, 2009). The obese patient often has several comorbid conditions, including cardiac disease, hypertension, respiratory disease, diabetes, osteoarthritis, and stress incontinence. Because of their size and their decreased self-esteem, the needs of bariatric patients are different from those of other patients. Societal prejudice against obesity is well established. Studies show that nurses are often less attentive to the needs of the obese patient and are often worried about the possibility of personal injury related to positioning the patient (Patient Safety). Furthermore, the patient’s BMI may prohibit CT and MRI scans due to the limitations of the equipment (Sherwood et al, 2009).

Elderly Trauma Patients. As the number of adults older than 65 years continues to grow, so does the number of elderly patients requiring surgical intervention related to trauma. The physiologic effects of aging combined with the preinjury health status of many elderly patients significantly affect their ability to respond to initial treatment for traumatic injuries and subsequent surgical intervention. Consequently the mortality for elderly trauma patients is significantly higher than that in younger patients with the same level of injury. Preexisting medical conditions, medication use, decreased physiologic reserves, and the physical and psychologic stress experienced during surgical interventions place elderly trauma victims at increased risk for perioperative complications (Plummer, 2009). (See Chapter 27 for the physical and psychologic changes that occur in elderly patients.)

Pregnant Trauma Patients. The team must assume that the pregnant trauma victim is in shock until proven otherwise. Early aggressive treatment is essential. The uterus is enlarged and no longer a pelvic organ, and it elevates the bladder out of the pelvis as well. Supine position for the pregnant patient can result in a decrease in cardiac output as a result of compression of the inferior vena cava. If the patient is close to term, cardiac output can be decreased by as much as 30% as a result of compression on the inferior vena cava. If the patient is close to term, cardiac output can be reduced by as much as 30% as a result of compression on the inferior vena cava. Consequently, patients who are 20 weeks or more into their pregnancy should be placed in the left lateral decubitus position to avoid a hypotensive episode and maintain blood flow to the uterus and placenta. If this is not possible, manual displacement of the uterus by lateral abdominal pressure should be attempted. As a result of the physiologic changes just described, the pregnant patient is at risk for aspiration. Rapid-sequence induction, along with the Sellick maneuver, is the preferred method for intubation.

Ultrasound studies are conducted to determine viability of the fetus when possible. In the event of a ruptured uterus, a cesarean delivery and hysterectomy may be required if the fetus is viable. Neonatal resuscitation is of the utmost importance immediately on delivery of the fetus.

Pregnant patients requiring surgery also need fetal assessment performed intraoperatively. Any fetal movement should be noted. In addition, fetal monitoring is continuous. This includes fetal heart rate and uterine contractions. Fetal monitoring provides information on the condition of the fetus and the response to uterine contractions, if present. Fetal heart rate can usually be obtained after 10 weeks of gestation. Abnormalities in fetal heart rate can be an early sign of maternal compromise because the pregnant uterus is viewed as a nonessential peripheral organ in states of hypovolemic shock. Personnel qualified in the interpretation of fetal heart rate patterns must be present. This expertise may be provided by the obstetric nursing staff.

Perimortem (postmortem) cesarean delivery may be performed in the event of the sudden death of the mother and the presence of a viable fetus.

Invasive Emergency Department Interventions. If a patient has shown a very recent deterioration of vital signs, either en route to the hospital or on arrival at the ED, the surgeon may elect to perform an emergency thoracotomy in the ED. A left-sided approach is usually performed because this allows rapid access to the heart for external cardiac massage and exposure of the great vessels for clamping in the event of severe blood loss (Figure 28-6). The incision can be extended to the right side by cutting across the sternum; this approach is commonly referred to as the clam shell thoracotomy. This procedure can be used to gain control in hemorrhage of the great vessels, to access the heart, or, in a grave situation, as a final effort to save a life. The procedure is used more often in penetrating injuries in which a laceration to a ventricle or other potentially treatable, life-threatening injury may be present.

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PATIENT SAFETY

The Bariatric Trauma Patient

Patient safety in the trauma OR is important for all patient populations. The perioperative team must be familiar with equipment weight limits, proper positioning, and safe patient handling techniques for the bariatric patient population. An obese trauma patient is also at an increased risk for respiratory complications and deep vein thrombosis (DVT). The perioperative nurse and scrub person must ensure the appropriate equipment and supplies are ready for the bariatric trauma patient to prevent delays in patient care.

Most OR beds have a weight limit of 500 pounds; newer OR beds are capable of supporting patients up to 1000 pounds. The newer OR beds may come with side extensions to accommodate the excess girth of the patient. If these are unavailable the OR team may use armboards attached to the lower end of the table to support the lower extremities. In addition, a footboard may be used to decrease the risk of peroneal and tibial nerve damage. To secure the patient to the OR bed, place one safety strap across the thighs and another across the lower legs.

Recommended methods for transferring the patient to the OR bed include using an air-assisted lateral transfer device, friction-reducing sliding aids, motorized lateral transfer aids, or a slide-and-roll board. The nurse must be familiar with the devices used in their OR and assess the patient to determine what transfer device is safest for the patient and staff members. The OR team must ensure adequate staff members are present to assist with the patient transfer to avoid injury.

Chronic obstructive pulmonary disease (COPD), sleep apnea, hypoxemia, and hypcapnia are common respiratory conditions associated with obesity and can rapidly cause decompensation because oxygen desaturation occurs three times faster in patients who are obese as a result of reduced functional residual capacity. Furthermore, patients with sleep apnea have an increased risk for failed endotracheal intubation. The perioperative nurse must be ready to assist the anesthesia provider with intubation and have the difficult airway cart immediately available.

In addition to these recommendations the bariatric trauma patient should have subcutaneous heparin and intermittent pneumatic compression devices for DVT prophylaxis. Intermittent pneumatic compression devices are usually indicated for this patient population and should be applied to the lower extremities.


measure but is inadequate to effectively ventilate the patient without a jet oscillating ventilator.

Successive Surgical Interventions. Often the multiple trauma patient requires a multitude of surgical procedures—either specialty-related or as a stepwise progression in the primary treatment of the initial injury. Initially the trauma patient is critically ill and requires intensive care facilities. When surgery is scheduled, the perioperative nurse may need additional assistance in transporting the patient as transport monitoring of the ECG, arterial line, and blood pressure is performed. Oxygen administration and mechanical ventilation with an Ambu bag are necessary for the intubated patient.

Acalculous cholecystitis is often a secondary complication of the trauma patient’s postoperative course that requires cholecystectomy. Fixation of initially undiscovered fractures, debridements, secondary wound closures, flap constructions, and other reconstructive procedures make up the majority of follow-up procedures. Depending on the patient’s condition, some procedures may be performed after discharge on an outpatient basis (Ambulatory Surgery Considerations).

Evaluation

The evaluation of the patient should reflect the effectiveness of the interventions. Did the patient remain free from untoward complications? Was there progress toward the expected outcomes as described in the perioperative plan of care? The following are examples of evaluation statements in relation to the sample plan of care:

- The patient demonstrated a decreased level of anxiety; he or she verbalized less apprehension, maintained eye contact, and was able to comply with requests even though anxiety persisted.
- The patient remained hemodynamically stable; fluid resuscitation was undertaken, blood pressure and pulse rate measurements were adequate considering the patient’s status, and the H&H values were within acceptable ranges.
- The patient achieved and maintained normothermia in the OR.
- The patient reported reasonable relief from pain during preparatory maneuvers in the OR.
- The airway was maintained, and induction of anesthesia proceeded without complication.

On completion of the procedure or procedures, the perioperative nurse is afforded an opportunity to further assess the trauma patient as well as evaluate the plan of care implemented. If the patient sustained numerous injuries and remains critically injured, the PACU may be bypassed and the patient may be transferred directly to the ICU. The perioperative nurse should accompany the patient, along with the anesthesia provider, to the ICU. Once the anesthesia report is given, the perioperative nurse can provide a wealth of information to the critical care nurse. At this point, family members may have been contacted or are present, allowing more specific medical history information to be obtained. However, the mechanism of injury and events surrounding the trauma are still significant. A high index of suspicion remains during postoperative care.
of the patient sustaining multiple injuries. Attention can be diverted from a less significant injury in the presence of a highly visible or obvious trauma. Once the obvious trauma undergoes intervention, pain or discomfort from other injuries becomes more apparent. In the care of a patient with neurologic deficit, physical assessment and continued evaluation are essential because patient self-report is nonexistent.

The nurse should also report the status of progress in the secondary assessment. Any additional laboratory work or interventions that have yet to be completed should be discussed. It is imperative in a thorough examination to view the back of the patient in an effort to locate all injuries.

Additional diagnostic procedures may be required after completion of the surgical procedure if the patient’s condition is stable. The perioperative nurse may be requested to accompany the patient to the diagnostic department with the anesthesia provider. In addition, respiratory care personnel may assist in patient transport and maintenance of the airway.

Patient and Family Education and Discharge Planning

Traumatic injury to a family member or significant other occurs without warning. Patients may be traveling or visiting out of town or state at the time of injury. Families or friends involved in a MVC may be triaged to several different facilities based on severity of injury or age. A family member or significant other may not be contacted until several hours or even days after the injury. Sometimes the patient’s identity either is unknown or must be kept confidential to prevent further harm. Both the patient and the family member are truly victims of traumatic injury. Consequently, patients and family members are in a time of crisis.

Some families may handle the crisis with ease, whereas others become dysfunctional. Coping strategies may be inappropriate at times as the patient and family attempt to reestablish patterns of function. A family system already taxed before the event may be overwhelmed with the additional stress of a sudden traumatic event. On the other hand, family members may wish to be present during resuscitation efforts. Family presence requires a facilitator to explain procedures and the accompanying sights, sounds, and smells that may occur. Nurses base their decisions on medical concerns, which may be very different than patient and/or family concerns. In trauma situations, nurses do not know their patient’s preferences and may even be unaware that differences in opinion exist. Care may be improved when understandable terms are used to explain the situation, to provide realistic expectations, and to relay when clinicians will be available to answer questions (Murray, 2008).

The perioperative nurse must be prepared for a variety of responses, both from the patient and from the family or significant others. Interaction with the patient before surgical intervention may be impossible because of the severity of the injury, prior intubation, or hemodynamic instability. The perioperative nurse will need to offer brief, simple instructions and explanations if the patient is conscious. These may include the following:

- Background noise as caregivers prepare for emergent intervention
- Perception of cold within the OR room
- Placement of safety and restraining straps, armboards, warming devices, and pneumatic compression stockings, for example
- Invasive interventions, such as additional IV access or arterial line monitoring

A reassuring touch or holding the patient’s hand may be the only communication possible. Touch, placement of warm blankets, a gentle squeeze of the hand, and softly spoken words of reassurance are important comfort measures.

In accordance with hospital policies and procedures, the perioperative nurse may call the surgical waiting room with periodic updates on the patient’s condition. The information shared is subject to the surgeon’s discretion and is usually concise in nature, such as, “At this time the extent of injury is unknown; his/her condition is critical.” When implemented, these contacts with family members are appreciated because frequently they were unable to see or speak with the patient before surgery.

All of the patient’s injuries and possible subsequent complications may not be known at the time of operative intervention. The multiply injured patient frequently requires rehabilitation or an extended stay in a skilled nursing facility before discharge to home. In addition to coping with physical changes, some patients may experience post-traumatic stress disorder. Continued therapy, such as neuropsychology (for cognitive impairment) or occupational and physical therapy, may be provided on an outpatient basis. Consequently, information regarding recovery and rehabilitation is limited on admission to the hospital. Many facilities have access to or provide support groups for patients and families related to the type of injury and its subsequent lifelong effects.

End-of-Life Care

Unfortunately some accidental injuries result in death. Many facilities have a chaplain or social worker available to assist family members during this time of crisis. These caregivers assist in the initial family contact and provide immediate support. Providing end-of-life care for patients and family is relevant, even in trauma situations. Trauma is different in that the patient and family do not have a prior relationship with the healthcare team. This makes it difficult for the team to know and/or understand the wishes and values of the patient and family.

The Trauma End-of-Life Optimum Support (TELOS) best practice model was developed to provide a framework for optimum support to dying patients and their families. It was designed to be carried out in the prehospital setting, ED, and the ICU; however,
it can be implemented in any healthcare setting. The foundations of the best practices are engagement, ethics, education, economics, and evaluation. They direct healthcare workers to act in the best interest of the patient and to engage in authentic relationships that are patient-centered. Furthermore, TELOS requires healthcare professionals to comply with the continuing education requirements in order to remain current with evidence-based research to maximize patient outcomes (Burns et al, 2011).

**Critical Incident–Stress Debriefing**

When the end result of a traumatic injury is death, it can be particularly difficult for the perioperative team because most surgical interventions are of a curative or restorative nature. In many emergency medical systems is a critical incident–stress debriefing team. It is composed of mental health professionals and specially trained volunteers who are also professionals and peers in the healthcare field. Police officers, firefighters, paramedics, ED nurses, and ICU nurses also may be on the team. In the event of a particularly tragic death of a patient, the team can be contacted, and a meeting with that patient’s care providers is arranged. The benefit of this team is enhanced when intervention is timely for the care providers. Opportunity for them to discuss their feelings and emotions is provided and encouraged as each provider discusses feelings related to personal participation in the care of the patient. There are many benefits of critical incident–stress debriefing for the individual staff member and the organization. The debriefing provides the individual with information and resources to assist in coping with the traumatic situation. At the organizational level the debriefing fosters a therapeutic environment to discuss the emotional and cognitive responses to the incident (Blacklock, 2012).

**Surgical Interventions**

**Damage Control Surgery**

Damage control surgery is a well-recognized surgical strategy that sacrifices complete, immediate repair to adequately address the physiologic impact of trauma and surgery. Damage control surgery is a series of operations performed to accomplish definitive repair of abdominal injuries with consideration of the patient’s physiologic tolerance. The focus is on control of hemorrhage and contamination to stop bleeding and control any intestinal, biliary, or urinary leak into the abdominal cavity. Indications for the potential need for damage control surgery include hemodynamic instability, hemorrhagic shock, coagulopathy, hypotension, tachycardia, tachypnea, inaccessible major anatomic injury, concomitant major injury, and altered mental status.

Abdominal packing is the foundation principle of damage control surgery, first reported in the early twentieth century. Later reports detailed survival of patients with severe liver injuries that were packed. In 1981 a report described operative management that included initial abandonment of laparotomy, use of intra-abdominal packing, correction of coagulopathy and metabolic acidosis, and later reoperation for definitive repair (Germanos et al, 2008). The term damage control was first used in 1993 along with a detailed approach. The components are stop bleeding, close perforations; continue resuscitation, emphasizing correction of coagulopathy, acidosis, and hyperthermia; plan reoperation for definitive repair.

There are five decision-making stages for damage control.

- **Stage 1:** Patient selection and decision to perform damage control: The emphasis is on early recognition for potential damage control surgery, including rapid transport to the hospital and early decisions related to control of hemorrhage.
- **Stage 2:** Operation and intraoperative reassessment of laparotomy: This consists of control of hemorrhage and contamination with rapid packing and temporary abdominal closure.
- **Stage 3:** Physiologic restoration in the ICU: The focus here is restoration of physiologic status, which may include rewarming and fluid replacement.
- **Stage 4:** Return to OR for definitive procedures: The focus is on removal of packing, repair of injuries, and closure. Indications for emergency reoperation include massive ongoing bleeding, evidence of bowel leak or ischemic organ, and presence of abdominal compartment syndrome.
- **Stage 5:** Abdominal wall closure/reconstruction: It is not always possible to close the abdominal wall in stage 4, necessitating further repair.

**Injuries of the Head and Spinal Column**

Trauma to the head is responsible for half of all trauma deaths. Brain injury occurs either as a direct result of the trauma to the tissue or as a complication. Often forces of energy from the impact are tolerated by the rigid skull, but the soft tissue of the brain is traumatized, resulting in the formation of subdural (Figure 28-7), epidural, or intracerebral hematomas. Blood clots are classified by their location in the brain and range from mild to life-threatening. A clot under the skull but on top of the dura is an epidural hematoma, which often results from a tear in an artery under the skull. A clot under the skull and dura but outside the brain is a subdural hematoma, often resulting from a tear in a vein or from a cut on the brain itself.
An injury to the brain itself, a contusion, is an intracerebral hematoma, a result of a skull fracture or other blood clot causing swelling inside the brain. In addition, cerebral swelling can result in herniation of the brain despite treatment (Figure 28-8).

A baseline neurologic examination is extremely important. The pupils are examined, and the presence or absence of posturing is noted. The Glasgow Coma Scale (see Table 21-2) provides a universally accepted mechanism to assess the baseline data for the trauma team. However, in the presence of alcohol or drug intoxication or chemical paralysis, the scale cannot be used. For patients with a score of 8 or less, intubation with controlled ventilation is the immediate treatment of choice. In the highly combative patient, intubation may also be performed to allow adequate assessment of the extent of injury.

Previously, hyperventilation was routinely used to decrease ICP in the initial management of patients with neurologic deterioration. No studies have shown improved outcomes for these patients, and other methods of assessment have shown that hyperventilation can cause significant constriction of cerebral vessels and may reduce cerebral blood flow to an ischemic level. Occasionally, hyperventilation may be necessary with persistently high ICP unresponsive to other treatment modalities.

An osmotic diuretic, such as mannitol, can be used to treat increased ICP. Osmotic effects take place in 15 to 30 minutes (Hodgson and Kizior, 2013) and instigate an osmotic gradient to extract water from neurons. Osmotic diuretics such as mannitol have proven benefits in lowering ICP without reducing cerebral blood flow. They are given by bolus administration to create an acute reduction phase in ICP. These agents are excreted in the urine and cause a rise in serum and urine osmolality. Patients with serum osmolalities higher than 320 mOsm/kg (Kulaylat and Dayton, 2012) are at risk of acute tubular necrosis. Hypovolemia should be avoided with the infusion of isotonic fluids as necessary. Because such agents act quickly, fluid intake and output and the potential for fluid and electrolyte imbalances mandate close hemodynamic monitoring. Elevating the head of the bed 30 degrees and keeping the patient’s head midline (to promote venous drainage) also can be beneficial.

Skull fractures usually do not require operative intervention when there is no displacement and the fracture is linear. Depressed fractures or the presence of bone in the brain frequently requires elevation and debridement (Figure 28-9). Hematoma evacuation is based on the location as well as the size and number of hematomas.

**FIGURE 28-8** Cross section showing herniation of lower portion of temporal lobe (uncus) through tentorium caused by temporoparietal epidural hematoma. Herniation may occur also in cerebellum. Note mass effect and midline shift.

(Patient-Centered Care) You are the nurse caring for a trauma patient in the OR, who is having a craniotomy for evacuation of a subdural hematoma. The patient’s family just arrived; they are in the waiting room and are asking for information. It’s important to remember this is a stressful time for family members and that communication needs to be very basic to meet their needs; their capacity for understanding may be compromised by the critical surroundings, concern for their loved one, and prior healthcare experiences.

Keeping the patient first, the nurse should first let the surgeon and anesthesia provider know that the family members are in the waiting area and requesting information. The nurse should ask what information is appropriate to report to the family at this time. It may be beneficial to find out what the family has been told about the situation by the social worker or case manager. When providing the family with the update from the surgeon, the nurse explains the procedure in layman’s terms. Rather than saying the patient has a subdural hematoma, the nurse might explain to the family that the patient had a head injury that resulted in a collection of blood over the surface of the brain and that the blood needs to be drained to relieve the pressure on the brain. The nurse assesses the family’s understanding by asking them to repeat the information back and inviting further questioning.
The standard indicators of possible cord injury are absence of rectal tone and bradycardia in the presence of hypotension. The body's normal response is to increase heart rate in the presence of decreased blood flow or hypotension. These responses are not present in injury of the spinal cord, and vagal control results in bradycardia.

Injuries involving the spinal cord can range from a contusion of the cord to complete transection, without hope of recovery. Fractures or dislocation of a vertebra can result in the protrusion of small pieces into the spinal canal. This is known as a burst fracture. Several vertebrae may be fractured or have fractured components. The decision to surgically treat vertebral fractures is based on many factors. In patients with minimal compression and no neurologic signs or symptoms, spinal bracing may be an option. Cerebral arteriography is performed to assess for intracranial lesions. Before performing a craniotomy or drilling a burr hole, the CT scan, the neurologic status of the patient, the morbidity or mortality associated with the procedure, and the presence of other injuries or underlying medical problems, if known, are evaluated. An ICP monitor may be placed in the patient who is at risk for increased ICP. (Chapter 21 discusses neurosurgical procedures.)

The patient with a cervical spine injury at or near C3 to C5 is at great risk for respiratory difficulties because this is the area of diaphragmatic innervation. There is also the possibility of swelling above the area of injury, and the perioperative nurse should be alert for the potential of respiratory distress even if it is not initially present. A 24- to 48-hour dose of methylprednisolone (Solu-Medrol), calculated by body weight, is considered to decrease initial cord swelling.

Figure 28-9 Treatment of compound depressed fracture of skull. A, Depressed skull fracture and scalp injury. B, Incision to expose fracture and remove the portion of the scalp that is devitalized. C, Removal of impacted bone by burr hole to locate and identify normal dura, followed by resection of bone fragments. D, Watertight closure of dura after brain debridement. E, Replacement and fixation of bone fragments.
may be used to screen patients with cervical vertebral fractures for blunt vertebral artery injuries (BVIs). According to deSouza and colleagues current literature recommends CT angiography as the preferred method for screening patients with BVIs. Patients are treated with anticoagulant therapy if not contraindicated; contraindications include patients with active bleeding or patients with multiple trauma including the head (deSouza et al, 2011).

Treating spinal column fractures can involve surgery. Stabilizing the fracture may be necessary, depending on the severity of the injury. For cervical spine fractures, traction may be used initially to reduce the fracture, followed by surgical intervention as soon as the patient’s condition permits. Internal fixation devices are discussed in Chapter 20.

**Injuries of the Face**

MVCs account for about 60% of maxillofacial injuries. Mandibular fractures alone are highly associated with assault as the MOI. In the patient who presents with facial injury, the airway must be secured. This requires ensuring patency and removing any items that pose the threat of aspiration. If a midface fracture is present, the anesthesia provider avoids nasogastric tube placement and nasotracheal intubation. A tracheostomy may need to be performed before initiation of the operative procedure. Control of scalp or facial hemorrhage can be achieved through a pressure dressing until surgical intervention is possible because exsanguinations can occur. Treatment of the fracture may be delayed until the immediate life threats have been successfully managed. Goals of operative intervention are to reduce and immobilize the fracture, prevent infection, and restore facial cosmesis and function.

Facial fractures can be categorized into Le Fort I, II, or III (see Figure 22-24). A Le Fort I fracture is the most common maxillary fracture. It involves a horizontal interruption of the anterior and lateral wall of the maxillary sinus. Le Fort II is a pyramidal fracture along the maxilla and lacrimal bones and through the infraorbital rim. Le Fort III is otherwise known as **craniofacial disjunction**. The midface is completely disengaged from the cranial base, resulting from a fracture across the frontomaxillary sutures. (Specific information regarding these injuries is in Chapter 22.)

**Injuries of the Eye**

Eye injuries can result from blunt or penetrating types of trauma. Penetrating objects in the globe are stabilized and not removed until the patient is in the OR. These injuries threaten loss of vision because of the injury itself, inflammation, or infection. Blunt injury to the eye can result in hematomas and accompanying fractures. A blow-out fracture is the result of a blunt force to the eye that pushes soft tissue through the thin bony orbital floor. The eye recedes into the orbit and the patient loses the ability to gaze upward. Surgical repair is often indicated. (Chapter 18 discusses ophthalmic procedures.)

**Injuries of the Neck**

Injury to the neck and soft tissue structures is most commonly a result of penetrating trauma. The neck can be divided into three zones with respect to injury and consequence. Zone I is the base of the neck below the clavicles. Anatomic structures located in this region are the great vessels and aortic arch, innominate veins, trachea, esophagus, and lungs. Zone II is the area in the middle of the neck between the clavicles and the mandible. Structures located in this area include the carotid artery, internal jugular vein, trachea, and esophagus. Zone III is located between the angle of the mandible and the base of the skull. The primary target of evaluation in these injuries is vascular structures.

Zone II injuries may necessitate an otorhinolaryngologist. Penetrating injuries to the larynx and trachea can be primarily repaired. Blunt force to the larynx can result in a fracture and impose immediate airway obstruction. These patients require immediate tracheotomy followed by repair of the fracture when it is unstable or displaced. Chapter 19 provides specific information concerning otorhinolaryngologic procedures.

**Injuries of the Chest and Heart**

Trauma to the chest area is the primary cause of death in approximately 20% to 25% of trauma victims (Mancini, 2012). Blunt trauma is most often associated with high-speed MVCs. Penetrating traumas may be associated with violent crimes. Penetrating injuries at or immediately below the nipple line or level of the scapular tips are evaluated for both chest and abdominal involvement. Diaphragmatic injury is also a possibility.

Deceleration injury, such as that occurring from a fall or from striking the steering wheel in a MVC, may cause contusions of the chest wall, fractures of the ribs or sternum, contusions of the heart or lungs, or rupture of the aorta and other major vessels. Rib fractures are also associated with a hemothorax or pneumothorax. A flail-chest segment may result when two or more adjacent ribs are broken in two or more places. This results in paradoxical chest wall movement as a result of loss of bony support; that is, the affected segment of the chest wall moves in the opposite direction. If respiratory distress and diminished breath sounds are present, a chest tube is indicated immediately; an autotransfusion chest drainage device is also considered. Chest tube output must be closely monitored intraoperatively because accumulation of 1000 to 1500 mL of blood is an indication for chest exploration. Penetrating wounds, as a result of either gunshot or stab injuries, may cause hematoma and pneumothorax as well. Lacerations or perforation of the lung, heart, great vessels, trachea, esophagus, and bronchus is possible.

Myocardial contusion usually involves the right ventricle and can be evidenced by dysrhythmias on patient arrival or shortly thereafter. The patient is monitored on a telemetry unit, and surgical intervention is not required. Rupture of a heart valve can occur, depending on the timing of the contusion in relation to the phase of the cardiac cycle. If valve rupture has occurred, surgical repair is necessary. Heart sounds should be evaluated during the secondary assessment to document the presence or absence of murmurs. Heart valve rupture can occur as a late complication of myocardial contusion. Péricardiocentesis is performed for signs and symptoms of pericardial tamponade (Figure 28-10), which include jugular venous distention, muffled heart sounds, and a narrowing pulse pressure. Patients may present to the OR for a pericardial window either emergently or during the recovery phase.

An emergency thoracotomy may be indicated in the patient with penetrating trauma to the chest in full arrest or pulseless electrical activity on ECG. If a laceration to the heart is suspected and the patient is rapidly deteriorating, the surgeon may perform a thoracotomy in the ED. The laceration may be primarily repaired and the patient transferred to the OR for irrigation, wound débride-ment, and closure. Otherwise, surgical intervention is initiated in the OR. Wounds located across the mediastinum accompanied by hemodynamic instability, massive penetrating lung injuries, and disruption of the trachea, bronchus, or esophagus also require surgical intervention. Rupture of the thoracic aorta is another injury...
Infections of the Abdomen

The spleen is the most common organ injured in blunt trauma, and the liver, because of its large size, is the most common organ injured in penetrating trauma. Historically, initial efforts were aimed at performing splenectomy in response to splenic injury. However, because of the role of the spleen in the body’s defense against infection, the surgeon makes every effort to control hemorrhage in the spleen and avoid its removal. Treatment is determined by the condition of the spleen and of the patient. Injury to the spleen occurs with deceleration injuries, resulting in fracture of the organ because of its multiple fixation points. Splenic injury may be associated with fractures of the left tenth through twelfth ribs. The patient may exhibit left shoulder pain (Kehr sign), upper left quadrant tenderness, abdominal wall muscle rigidity, spasm or involuntary guarding, or signs and symptoms of hemorrhage and hypovolemic shock. Splenic injuries (Table 28-9) range from laceration of the capsule to ruptured subcapsular hematomas or parenchymal laceration. The most serious injury is a severely fractured spleen or vascular tear, producing massive blood loss and splenic ischemia. Rupture of the spleen can be immediate or delayed. Splenic...
lacerations may be treated nonoperatively by close monitoring and bed rest or operatively for lacerations of a more severe nature. The surgeon creates a midline incision, which allows for exposure of all abdominal contents. Topical hemostatic agents are also used with success, as well as suturing and the argon laser in some instances. In some cases, angiographic embolization may be attempted. A laceration involving the splenic hilum or complete shattering of the organ usually necessitates splenectomy.

The severity of hepatic injury ranges from controlled hematoma to severe vascular injury of the hepatic veins or hepatic avulsion (Table 28-10). Because liver tissue is so friable and has an extensive blood supply as well as blood storage capacity, hepatic injuries often result in profuse hemorrhage and require surgical control of bleeding. The patient usually exhibits upper quadrant pain, abdominal wall muscle rigidity, involuntary guarding, rebound tenderness, hypoactive or absent bowel sounds, and signs of hemorrhage or hypovolemic shock. Nonoperative treatment is indicated in minor capsular and subcapsular injuries. This can be accomplished with bed rest and close monitoring. Topical hemostatic agents and suturing are used in management of minor injuries. Fibrin glue is also used in some institutions as a topical hemostatic agent. Some surgeons may request to use a kaolin-based gauze. This type of gauze speeds up the clotting cascade process and hemostasis is usually achieved within 3 to 5 minutes (Z-Medica, 2012). More severe injuries with active expanding hematomas or lobe disruption require surgical exploration and may necessitate hepatic resection or ligation of associated vasculature. With massive hemorrhage, control of bleeding is the primary concern. Packing with soft goods may be indicated, along with manual compression of the organ if intraoperative hypotension becomes severe. The surgeon may apply a pressure dressing and temporary wound closure until associated coagulopathies, hypothermia, and hemodynamic instability can be corrected. The patient usually returns to the OR within 24 to 72 hours postoperatively or when his or her condition permits further exploration and removal of the soft goods.

Injuries to the GI system are also associated with abdominal trauma. Bowel injuries may be missed on abdominal CT scan during the initial diagnostic period. The small bowel is frequently injured because deceleration may lead to shearing, which causes avulsion or tearing. The most commonly affected areas of the small bowel are areas relatively fixed or looped. Associated with any perforation of the GI tract is a chance for peritonitis and sepsis or compartment syndrome from increased pressure. Crystalloid resuscitation and capillary leakage contribute to tissue swelling. The resulting abdominal edema creates a pressurized compartment that must be explored to render relief to the compromised organs.

If the abdomen is difficult to close, alternative wound closure techniques may be used to prevent the occurrence of abdominal compartment syndrome. One such method is to use a silo-bag closure, in which heavy plastic is trimmed to fit and sutured to skin edges (Figure 28-11). A sterile absorbent drape may also be placed inside the abdomen to absorb fluid.

In the event of a penetrating injury, the trajectory of the missile or the implement is examined, and organs within the area are considered potentially injured. Exploration is indicated, and the surgeon thoroughly examines all components of the GI system for any perforations, contusion, hemorrhage, or compromise of vasculature, such as a mesenteric hematoma. When an injury is identified, suturing, stapling, or segmental excision may be indicated. (Chapter 11 discusses GI surgery, and Chapter 12 addresses surgery of the liver, biliary tract, pancreas, and spleen.)

Diagnostic laparoscopy is frequently used for direct visualization of abdominal organs to decrease the need for open abdominal exploration. This procedure allows the surgeon to effectively evaluate the presence of any injury and develop an appropriate plan of

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**TABLE 28-9**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Injury</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Subcapsular: &lt;10% of surface area</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear: &lt;1 cm parenchymal depth</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Subcapsular: 10%-50% of surface area; intraparenchymal: &lt;5 cm in diameter</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear: 1-3 cm; parenchymal depth that does not involve a trabecular vessel</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>Subcapsular: &gt;50% of surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma: &gt;5 cm or expanding</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth or involving parenchymal vessels</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Laceration involving segmental or hilar vessels, producing major devascularization (&gt;25% of spleen)</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Completely shattered spleen</td>
</tr>
<tr>
<td>V</td>
<td>Vascular</td>
<td>Hilar vascular injury that devascularizes spleen</td>
</tr>
</tbody>
</table>


**TABLE 28-10**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Injury</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Hematoma</td>
<td>Subcapsular: &lt;10% of surface area</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear: &lt;1 cm parenchymal depth</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Subcapsular: 10%-50% of surface area; intraparenchymal: &lt;10 cm in diameter</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>Capsular tear: 1-3 cm parenchymal depth; &lt;10 cm in length</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>Subcapsular: &gt;50% surface area of ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma: &lt;10 cm or expanding</td>
</tr>
<tr>
<td></td>
<td>Laceration</td>
<td>&gt;3 cm parenchymal depth</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>Parenchymal disruption involving 25%-75% of hepatic lobe or 1-3 of 8 Couinaud segments</td>
</tr>
<tr>
<td>V</td>
<td>Laceration</td>
<td>Parenchymal disruption involving &gt;75% of hepatic lobe or &gt;3 of 8 Couinaud segments within a single lobe</td>
</tr>
<tr>
<td>V</td>
<td>Vascular</td>
<td>Juxtahepatic venous injuries (i.e., retrohepatic vena cava/central major hepatic veins)</td>
</tr>
<tr>
<td>VI</td>
<td>Vascular</td>
<td>Hepatic avulsion</td>
</tr>
</tbody>
</table>

treatment in the stable patient. However, there is some concern that bowel injuries may not always be identified. Some therapeutic interventions may also be performed through the laparoscope so that the more invasive open approach is avoided. Increased IAP required in laparoscopic insufflation may create an adverse ventilatory effect. In the presence of abdominal vein injury with low pressures, CO₂ could leak into the vasculature and result in CO₂ emboli to the heart or lungs. Tension pneumothorax may be created in patients with a diaphragmatic injury. Consequently, indications for these procedures in the trauma setting continue to be evaluated.

**Injuries of the Genitourinary System**

Laceration of the kidney is closely associated with fracture of the ribs and transverse vertebral processes (Table 28-11). Because the kidney is retroperitoneal, the presence of bleeding may not be observed on diagnostic peritoneal lavage. Renal contusions often produce hematuria. Gross clots may also be seen in more serious injury, but it should be noted that hematuria is not present in a complete avulsion injury. Management of renal contusions can be nonoperative with monitoring of hematuria. Lacerations involving the collecting system, severe crush injuries, or pedicle injuries necessitate surgical intervention (Figure 28-12). Nephrectomy may be indicated with severe injury of the pedicle or massive hemorrhage.

Rupture of the bladder and urethral injury are most often associated with pelvic fractures. Both blunt trauma and penetrating trauma are causative factors. The type of bladder injury is a direct result of the amount of urine present in the bladder at the time of injury. Blunt forces applied to a full bladder result in an intraperitoneal rupture. This type of rupture is closely associated with alcohol consumption because of alcohol’s diuretic effect. Pelvic fracture is associated with an extraperitoneal bladder rupture. Most often these patients present with gross hematuria. A small extraperitoneal rupture may be managed by urinary catheter drainage. A large extraperitoneal rupture and intraperitoneal rupture require surgical intervention. The surgeon may place a suprapubic cystostomy tube, and repair the bladder. Pelvic fracture reduction and fixation are also performed.

Urethral injuries require exploration and primary repair. These types of injuries are more common in the male because the male

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**TABLE 28-11**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type of Injury</th>
<th>Description of Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Contusion</td>
<td>Normal urinalysis except possible microscopic or gross hematuria</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma</td>
<td>Subcapsular, no parenchymal laceration</td>
</tr>
<tr>
<td>III</td>
<td>Hematoma</td>
<td>Perirenal, confined to renal retroperitoneum</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration</td>
<td>&gt;1 cm depth of renal cortex</td>
</tr>
<tr>
<td>V</td>
<td>Vascular</td>
<td>&gt;1 cm parenchymal depth of renal cortex</td>
</tr>
</tbody>
</table>

Vascular Involves main renal artery or vein

Vascular Completely shattered kidney Includes avulsion of renal hilum, which devascularizes kidney

urethra is longer and less protected than the female urethra (Figure 28-13). A fall or straddle type of injury is usually responsible. This injury is detected by the presence of blood at the urinary meatus. In these instances an indwelling urethral catheter should not be inserted. Blood at the urinary meatus may indicate a tear in the anterior urethra. A retrograde urethrogram may be performed to evaluate for extravasation of urine and potential injury. Suspicion of a pelvic fracture raises the index of suspicion of a concomitant urethral injury. (Chapter 15 provides additional information on urologic procedures.)

Skeletal Injuries

Trauma to the skeletal system usually results in contusion or fracture. After stabilization of the patient, radiographs are taken of any body part that is distorted, edematous, painful, or highly suspicious for fracture or dislocation. Treatment of fractures is aimed at restoring function with a minimum of complications. Immobilization of fractures can be accomplished by casting, bracing, splinting, application of traction, or hardware fixation. Femur fractures in particular can be associated with a high risk of hemorrhage and require traction before surgical repair. Closed and open reductions, application of internal and external fixators, and some types of traction may be performed in the OR (Patient and Family Education). The perioperative nurse involved in care of the trauma patient must have a working knowledge of orthopedics. Fractures must be repaired in a timely manner to avoid untoward complications; however, immediate life threats are corrected first. Open fractures are at an increased risk of infection. (Chapter 20 contains information on the surgical procedures used in fracture management.)

Pelvic fractures may pose an additional challenge to the perioperative team. Fractures within the pelvic ring are associated with significant internal blood loss and shock. Systemic peripheral vascular resistance is increased. A method to quickly minimize or tamponade blood loss in severe pelvic fractures is the application of a PASG or PASG trousers to provide stabilization of the fracture and reduce associated hemorrhage. The use of PASG trousers may be effective in patients who are 20 to 40 minutes away from the hospital and have pelvic fracture, hypotension, and decompensated shock (Adler, 2011). If a PASG is applied, the patient may be transported to the OR with the trousers still inflated. The perioperative nurse must be familiar with deflation procedures. The attending anesthesia provider directs deflation in collaboration with the surgeon. Blood pressure and other vital signs are closely monitored. The abdominal compartment is deflated first. Deflation continues slowly while IV fluids are infused to maintain blood pressure. A 5 mm Hg drop in blood pressure requires fluid resuscitation of approximately 200 mL before deflation of the next compartment. If the patient remains stable after 5 minutes of rest, each leg compartment is deflated slowly. The legs must be deflated one at a time, with a resting period of 5 minutes between deflations; if one leg is injured, begin deflating the uninjured leg first (Adler, 2011).

Some trauma centers apply external fixator devices in the ED during initial resuscitation. A pelvic C-clamp, sheet wrap, or a commercially available support binder may be used for initial stabilization of pelvic fractures. Severe hemorrhage associated with the fracture may be controlled by arterial embolization performed in the radiology department if surgical intervention for fracture fixation must be delayed.

**PATIENT AND FAMILY EDUCATION**

**Home Care Instructions for External Fixation Devices**

In many cases trauma patients may be discharged to home with external fixators in place. The nurse is responsible for providing education to the patient and family regarding the care of these devices. A best practice for patient teaching is to have the patient and family teach-back the information to the nurse so the nurse can gauge comprehension and learning.

**External Fixator Home Care Instructions**
- Examine the fixation device every day; check for loose pins and nuts. You may tighten loose nuts. Do not make any adjustments to the device.
- Clean the frame twice a week with a clean gauze sponge and rubbing alcohol mixed with water. After cleaning the frame, dry it with a clean towel. You may clean your frame in the shower after your physician tells you it is ok to shower.
- Pin sites should be cleaned twice a day after you wash your hands thoroughly. Make a cleaning solution in a sterile container with equal parts hydrogen peroxide and saline solution. Use a sterile cotton swab dipped in the solution; around the base of your pin site, use a circular motion. Gently push down any skin that is moving up onto the pin and remove any crusts that may have formed. After the base of the pin is clean you may continue to clean the upper portion of the pin. Use a new sterile swab for each pin and dry each pin with a clean swab.
- Seek medical attention when:
  - A pin moves or loosens
  - You experience pain at a pin site
  - The pin site is red or swollen
  - Fluid leaks around the pin site
  - You are experiencing pain where the bone was broken

Intraoperative Hypothermia and Surgical Site Infection

The Centers for Disease Control and Prevention (CDC) reports, approximately 30 million surgical procedures take place in the United States annually. Furthermore, surgical site infections (SSIs) comprise 38% of all healthcare-associated infections (HAIs). Research has shown that patients requiring emergency trauma procedures are at a greater risk for developing an SSI than patients who have elective surgery.

Patients undergoing emergent laparotomy procedures are hypothermic, coagulopathic, and are at an increased risk for developing an SSI. Research suggests that one intraoperative temperature of 95°F (35°C) during an emergent laparotomy can double a patient’s risk for acquiring a postoperative SSI. When a patient is hypothermic the sympathetic nervous system increases serum norepinephrine levels, leading to peripheral vasoconstriction of the skin and subcutaneous tissues. The decrease in oxygen caused by vasoconstriction leads to decreased wound oxygen tensions and wound hypoxia, thus altering the host immune defense system.

Researchers suggest using an aggressive approach to intraoperative warming to prevent SSI and improve patient outcomes. Common methods to prevent hypothermia during a trauma laparotomy are to increase operating room temperature to 78.8°F (26°C), warm water blankets underneath the patient, forced-air warming unit, intravenous fluid, and blood warmer devices using high-flow tubing.
patient may be declared dead. Depending on the cause of death and preexisting medical conditions, the patient may be an organ-donor candidate. Both federal and state laws mandate that local organ-procurement facilities are notified of potential donors and that families are informed that organ donation exists as an option. Organ-donation agencies can be contacted early and will assist in assessing the potential donor, as well as providing a protocol for donor management once the patient is declared dead. The organ donation agency will also confirm the patient’s enrollment in the organ donation registry. The organ donation agency will assist the family members in understanding the organ donation process and convey the patient’s consent for organ donation if wishes were unknown to the family.

Brain death criteria for organ donation began around 1968, attributed to the Harvard Ad Hoc Committee on Brain Death. Most organ donations in this country are from patients who experience brain death. In 1980 the Uniform Declaration of Death Act offered an additional option: cardiopulmonary death, defined as irreversible cessation of circulatory and respiratory function. This may present an ethical dilemma to some perioperative nurses. With brain death, withdrawal of support can occur in the ICU or the OR depending on hospital policy. The patient has 60 and 90 minutes to expire. If the patient continues into cardiopulmonary arrest, the team must wait an additional 2 to 5 minutes to ensure autotransfusion does not occur and then the physician can declare the patient’s death (Everidge, 2012). During this timeframe, the organ procurement team and OR staff are present in the surgical suite waiting for the patient to arrive to begin the procurement. Definitions of brain and cardiopulmonary death are not uniform throughout the United States. The perioperative nurse should be familiar with the state’s definitions of brain and cardiopulmonary death and the institution’s criteria for the declaration.

After a patient is declared dead and becomes a potential organ donor, the patient’s family does not incur any financial costs acquired from that point. The patient is not disfigured in any way that will interfere with bereavement rituals.

A transplantation coordinator assists in managing the organ-donor patient in the ICU setting until the procurement teams arrive. The perioperative nurse must prepare for the organ-procurement procedure. The procurement of organs and tissue may take several hours. Different organ-procurement agencies will provide a surgical team, but additional scrub and circulating personnel are needed. The transplantation coordinators actively seek tissue and organ recipients during the procurement procedure. Most organ-transplantation agencies contact the institution and provide follow-up information regarding the ultimate success of the transplantation procedures and information about the recipients.

The heart is removed first, followed by the lungs, pancreas, liver, and kidneys. Tissue dissection is performed in such a manner as to allow for optimal organ transplantation. Sterile technique remains important. In addition, traffic control is of concern during these procedures. Traffic should be limited to essential personnel. Bone, skin, and corneas can also be removed. Some procurement agencies remove bone and corneas in the morgue rather than in the OR.

KEY POINTS

- Understanding the mechanism of injury will assist the perioperative nurse with patient assessment.
- A pregnant trauma patient who is 20 weeks or more into pregnancy should be placed in the left lateral decubitus position to avoid a hypotensive episode and maintain blood flow to the uterus and placenta. If this is not possible, manual displacement of the uterus by lateral abdominal pressure should be attempted.
- Osmotic diuretics such as mannitol have proven beneficial in lowering intracranial pressure (ICP) without reducing cerebral blood flow.
- The perioperative nurse must become familiar with the primary and secondary assessments performed with trauma patients. There may be times when the perioperative nurse has to complete the secondary assessment following the interventions to correct the immediate life threats.

CRITICAL THINKING QUESTION

You are the on-call nurse working in the OR when the trauma surgeon calls over to tell you a patient is arriving for an exploratory laparotomy, now. The ED charge nurse calls to give report and explains the patient was an unrestrained driver involved in a high-speed, frontal impact MVC. The vehicle’s airbag did not deploy and the patient has bruises on the chest and abdomen. The OR room was just opened and you hear the trauma team entered the holding area. What information would you expect to be reported off during the transfer of patient care? How would you assess this patient? Note the critical assessment factors you would include and perioperative nursing interventions to address them.

REFERENCES


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