PRIMARY SURVEY

Prior to the patient's arrival at the hospital, EMS providers inform the receiving ED about the mechanism of trauma, suspected injuries, vital sign values, clinical symptoms, examination findings, and treatments provided. In preparation for the patient's arrival, ED staff assign tasks to team members, prepare resuscitation and procedural equipment, and ensure the presence of surgical consultants and other care team members. For patients transported to EDs that are not trauma centers, consider immediately whether transfer to a trauma center is appropriate and what resuscitation or stabilization can or should be done prior to transfer.

A focused history obtained from the patient, family members, witnesses, or prehospital providers may provide important information regarding circumstances of the injury (e.g., single-vehicle crash, fall from height, environmental exposure, smoke inhalation), ingestion of intoxicants, preexisting medical conditions (diabetes, depression, cardiac disease, pregnancy), and medication use (steroids, β-blockers) that may suggest certain patterns of injury or the physiologic response to injury.

ED care of the trauma patient begins with an initial assessment for potentially serious injuries. A primary survey is undertaken quickly to identify and treat immediately life-threatening conditions, with simultaneous resuscitation and treatment. Specific injuries that should be immediately identified and addressed during the primary survey include airway obstruction, tension pneumothorax, massive internal or external hemorrhage, open pneumothorax, flail chest, and cardiac tamponade. After assessing the patient's airway, breathing, and circulation (ABCs), perform a more thorough head-to-toe examination (the secondary survey) (Table 250-4). Follow the secondary survey with appropriate diagnostic testing, further therapeutic interventions, and disposition. When derangements are identified in any of the systems assessed in the primary survey, treatment is undertaken immediately.

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**Table 250-4 Primary and Secondary Survey in Trauma Resuscitation**

**Primary Survey (Rapid identification and management of immediately life-threatening injuries)**

A. Airway and cervical spine
   - Assess, clear, and protect airway: jaw thrust/chin lift, suctioning.
   - Perform endotracheal intubation with in-line stabilization for patient with depressed level of consciousness or inability to protect airway.
   - Create surgical airway if there is significant bleeding or obstruction, or laryngoscopy cannot be performed.

B. Breathing
   - Ventilate with 100% oxygen, monitor oxygen saturation.
Auscultate for breath sounds.
Inspect thorax and neck for deviated trachea, open chest wounds, abnormal chest wall motion, crepitus at neck or chest.
Consider immediate needle thoracostomy for suspected tension pneumothorax.
Consider tube thoracostomy for suspected hemopneumothorax.

C. Circulation
Assess for blood volume status: skin color, capillary refill, radial/femoral/carotid pulse, blood pressure.
Place two large-bore peripheral IV catheters.
Begin rapid infusion of warm crystalloid solution, if indicated.
Apply direct pressure to sites of brisk external bleeding.
Consider central venous access if peripheral sites are unavailable.
Consider pericardiocentesis for suspected pericardial tamponade.
Consider left lateral decubitus position in late-trimester pregnancy.

D. Disability
Perform screening neurologic and mental status examination, assessing:
   Pupil size and reactivity
   Limb strength and movement, grip strength
   Orientation, Glasgow Coma Scale score
Consider measurement of capillary blood glucose level in patients with altered mental status.

E. Exposure
Completely disrobe the patient, inspect for burns, toxic exposures.
Log-roll patient, maintaining neutral position and in-line neck stabilization, to inspect and palpate thoracic spine, flank, back, and buttocks.

Secondary Survey (Head-to-toe examination for rapid identification and control of injuries or potential instability)
Identify and control scalp wound bleeding with direct pressure, sutures, or surgical clips.
Identify facial instability, potential for airway instability.
Identify hemotympanum.
Identify epistaxis or septal hematoma; consider tamponade or airway control if bleeding is profuse.
Identify avulsed teeth, jaw instability.
Evaluate for abdominal distention and tenderness.
Identify penetrating chest, back, flank, or abdominal injuries.
Assess pelvic stability, consider pelvic wrap or sling.
Inspect perineum for laceration or hematoma.
Inspect urethral meatus for blood.
Consider rectal examination for sphincter tone and gross blood.
Assess peripheral pulses for vascular compromise.
Identify extremity deformities and immobilize open and closed fractures and dislocations.

**Airway Management with Cervical Spine Control**

Determine airway patency by inspecting for foreign bodies or maxillofacial fractures that may result in airway obstruction. Performance of the jaw thrust maneuver (simultaneously with in-line stabilization of the head and neck) followed by the insertion of an oral or nasal airway should be part of the first response for a patient making inadequate respiratory effort. Insertion of an oral airway may be difficult in patients with an active gag reflex. Avoid nasal airway insertion in patients with suspected basilar skull fractures. *Whenever possible, use of a two-person spinal stabilization technique is suggested in which one provider devotes undivided attention to maintaining in-line immobilization and preventing excessive movement of the cervical spine while the other manages the airway.* If the patient vomits, log-roll the patient and provide pharyngeal suction to prevent aspiration. Perform endotracheal intubation in comatose patients [Glasgow Coma Scale (GCS) score between 3 and 8] to protect the airway and to prevent secondary brain injury from hypoxemia. Agitated trauma patients with head injury, hypoxia, or drug- or alcohol-induced delirium may be at risk for self-injury and are also candidates for intubation. Trauma patients are frequently difficult to intubate due to the need for neck immobilization, the presence of blood or vomitus, or upper airway injury. If anatomy or severe maxillofacial injury precludes endotracheal intubation, cricothyroidotomy may be needed. *In virtually all trauma patients requiring urgent intubation, a rapid-sequence intubation technique should be used* (see Chapter 30, Tracheal Intubation and Mechanical Ventilation). Attempts at intubation without optimal sedation and paralysis often result in failure.

Clearance of the cervical spine from serious injury involves careful clinical assessment, with or without radiologic imaging. Not all patients require cervical spine radiographs. Two studies have confirmed that a significant group of patients can be cleared clinically.

The *National Emergency X-Radiography Utilization Study (NEXUS)* tested five criteria that were negative predictors of bony injury and therefore could be used to determine the need for imaging ([Table 250-5]). In a cohort of 34,069 patients with 578 clinically significant cervical spine injuries, these criteria had a 99.6% sensitivity and 99.9% NPV for the presence of fractures. The *Canadian cervical spine study* derived a decision rule that incorporated both mechanistic factors and examination findings ([Figure 250-2]) and showed potentially better predictive value than the NEXUS criteria in validation studies. Many centers now use a combination of both rules, first applying the NEXUS criteria and then asking the patient to move the cervical spine 45 degrees in each direction. These decision rules are useful only in awake and alert patients and are not a substitute for good clinical judgment. Patients meeting NEXUS or Canadian criteria for low risk of cervical spine injury should undergo full examination of the cervical spine, including active range-of-motion testing in all directions and a thorough neurologic examination.

<table>
<thead>
<tr>
<th>Table 250-5 National Emergency X-Radiography Utilization Study (NEXUS) Criteria for Omitting Cervical Spinal Imaging*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No posterior midline cervical spine tenderness</td>
</tr>
<tr>
<td>No evidence of intoxication</td>
</tr>
</tbody>
</table>
Alert mental status
No focal neurologic deficits
No painful distracting injuries

*Failure to meet any one criterion indicates need for cervical spine imaging.

**Figure 250-2.**

Any high-risk factor that mandates radiography?
- Age > 65 yr or dangerous mechanism
  - or paresthesias in extremities
  - Yes
  - No

Any low-risk factor that allows safe assessment of range of motion?
- Simple rear-end motor vehicle collision
  - or sitting position in the emergency department
  - or ambulatory at any time
  - or delayed (not immediate) onset of neck pain
  - or absence of midline cervical-spine tenderness
  - No
  - Yes

Able to rotate neck actively?
- 45° left and right
  - Yes
  - No radiography
  - Unable


If the patient is obtunded, assume there is a cervical spine injury until proven otherwise. Even when plain radiographs or CT images show normal findings, it is possible for a patient to have unstable ligamentous injuries. Therefore, maintain spinal immobilization during resuscitation. Imaging of the spine should not delay urgent operative procedures, because imaging results will not change the immediate management.

In the past, plain radiography of the cervical spine (anteroposterior, lateral, and open-mouth odontoid views) was considered part of the initial survey, but in many EDs, CT of the cervical spine is the preferred radiologic imaging modality. **Plain radiography may miss up to 15% of all cervical spine**
fractures, although the significance of these small injuries is unclear. CT provides far better images that can undergo sagittal and coronal reconstruction, with an overall sensitivity of 98%. Patients who may benefit from CT scanning as a method of screening for cervical spine injuries include patients >65 years of age; those with a high-risk mechanism of injury; those undergoing other scanning such as head, chest, or abdominal CT; and those for whom adequate visualization of the lower cervical and upper thoracic spine is anticipated to be difficult. In patients with suspected head injury or altered mental status, CT of the cervical spine should be performed in conjunction with the head CT. Images should include the upper thoracic spine down to at least T3, so that small or occult pneumothoraces undetected on plain chest radiography will be identified.

**Breathing**

Once the airway is controlled, inspect, auscultate, and palpate the thorax and neck to detect abnormalities such as a deviated trachea (tension pneumothorax); crepitus (pneumothorax); paradoxical movement of a chest wall segment (flail chest); sucking chest wound; fractured sternum; and absence of breath sounds on either side of the chest (simple or tension pneumothorax, massive hemothorax, or right mainstem intubation). Any of these findings warrants immediate intervention, including needle thoracostomy for tension pneumothorax; insertion of large-bore chest tubes (36F) to relieve hemothorax; and application of an occlusive dressing to a sucking chest wound. For asymmetric or absent breath sounds in the intubated patient, partially withdraw the endotracheal tube from the right mainstem bronchus, or reintubate. If no breath sounds are heard, and if massive hemothorax or vascular injury is suspected (initial chest tube output of >1000 mL, or >200 mL/h), a thoracotomy or video-assisted thoracic surgery is indicated to identify and control the source of bleeding.

**Circulation with Hemorrhage Control**

Rapidly assess the patient's hemodynamic status during the primary survey. This includes evaluation of level of consciousness, skin color, and presence and magnitude of peripheral pulses. Note the heart rate and pulse pressure (systolic minus diastolic blood pressure), particularly in young, previously healthy trauma patients.

Any hypotensive trauma patient is at risk for development of hemorrhagic shock, a common cause of postinjury death. One commonly used system for classifying the degree of hemorrhage is given in Table 250-6, although it has not yet been validated. Hemorrhage and shock are on a continuum, and some patients can compensate for significant blood loss. Hemorrhage of up to 30% of total blood volume may be associated with only mild tachycardia and a decrease in pulse pressure, but may quickly progress to profound hypoperfusion and decompensated shock if not recognized early.

| Table 250-6 Classification of Hemorrhage Based on Estimated Blood Loss at Initial Presentation |
|---------------------------------|---------------|---------------|---------------|---------------|
| Blood loss (mL)*                | Class I       | Class II      | Class III     | Class IV      |
| Up to 750                       | 750–1500      | 1500–2000     | >2000         |
| Blood loss (% blood volume)     | Up to 15      | 15–30         | 30–40         | 40            |
| Pulse rate (beats/min)          | <100          | 100–120       | 120–140       | >140          |
| Blood pressure                  | Normal        | Normal        | Decreased     | Decreased     |
Apply direct pressure or a compression bandage to control active external bleeding. Establish two large-bore IV lines (18 gauge or larger) and obtain blood samples or specimens for laboratory studies, particularly blood type and screen. In patients who are in unstable condition or in whom upper extremity peripheral veins are not easily cannulated, establishment of central venous access via the subclavian or femoral vein is appropriate. Avoid placement of a central venous line distal to a potential venous injury. Hypotensive patients without an obvious indication for surgery should be reassessed after rapid infusion of 2 L of crystalloid solution [lactated Ringer's (LR) or normal saline]. If there is no marked improvement, type O blood should be transfused (O-negative for females of childbearing age). The focused assessment with sonography for trauma (FAST) examination is rapid and effective for the identification of major intraperitoneal bleeding and pericardial tamponade as the source of hypotension or shock. The FAST examination is a screening tool used during the resuscitation phase and should be performed to identify causes of shock immediately after the primary survey. For definitive imaging of the abdomen, a CT scan with IV contrast should be performed. A full discussion of the long-standing controversies over volume, timing, and composition of fluid resuscitation is beyond the scope of this chapter. A major study demonstrated higher mortality in patients receiving immediate IV fluid resuscitation than in those from whom fluid was withheld until operative intervention. The study speculated that aggressive fluid resuscitation before operative control of bleeding was harmful. There is consensus that early operative intervention in patients experiencing penetrating trauma who are in shock results in better outcomes.

Three decades of study have failed to demonstrate an advantage of colloid therapy over crystalloid infusion. Therefore, a balanced salt crystalloid (normal saline or LR) is the fluid of choice for initial resuscitation. There is some theoretical advantage of LR over saline when large volumes are given in order to avoid hyperchloremic acidosis, although this is unlikely to be significant for most patients during initial resuscitation.

Patients requiring massive transfusions generally require urgent surgical intervention to control hemorrhage. A well-defined source of bleeding may be evident on external examination, assessment of chest tube output, FAST examination, or conventional or CT imaging of the chest or abdomen. There may also be considerable blood loss from blunt trauma to the pelvis and limbs without a discrete source. Open pelvic fractures must be immobilized in a pelvic wrap or sling, and limb fractures must be reduced and immobilized to tamponade bleeding from fractured bone ends.

Major trauma patients may develop a bleeding diathesis almost from the time of injury, which results in defective clotting and platelet function. Data from both military and civilian experience reveal that patients receiving >10 units of packed red blood cells showed decreased mortality when they simultaneously receive fresh frozen plasma in a ratio of packed red blood cells to fresh frozen plasma of 1:1 rather than 1:4 (26% vs. 87.5% mortality). Another consensus article examining use of blood products worldwide supported the administration of platelets in massive transfusion protocol in a 1:1:1 ratio with packed red blood cells and fresh frozen plasma. Both acidosis and hypothermia contribute to the coagulopathy and should be corrected as quickly as possible. The indications for the administration of recombinant Factor VII in cases of traumatic
hemorrhage are unclear, and it should be considered only in extreme situations. Factor VII should be used only after clotting factors and platelets have been replaced and hypothermia and acidosis have been corrected. There is no evidence that the prophylactic use of Factor VII in patients with major injuries and ongoing bleeding without documented coagulopathy is effective.

Disability

Once airway, breathing, and circulation have been addressed and stabilized, an abbreviated neurologic evaluation should be performed, including assessment of level of consciousness, pupillary size and reactivity, and motor function. The GCS (see Chapter 254, Head Trauma in Adults and Children) should be used to quantify the patient's level of consciousness, ranging from a score of 3 (no response) to 15 (normal response on all measures). A search for the cause of depressed level of consciousness should include measurement of capillary blood glucose level and consideration of possible intoxicants. Despite the concomitant use of drugs and alcohol in many trauma patients, altered mental status in the setting of trauma should not be attributed to intoxication. Assume that a patient with an appropriate mechanism for head trauma and with altered mental status or a GCS score of <15 has a significant head injury until proven otherwise. The GCS assessment can be insensitive in patients with normal or near-normal scores, and a GCS score of 15 does not completely exclude the presence of traumatic brain injury. However, patients with a persistent GCS score of ≤8 generally have a graver prognosis, and a definitive airway should be secured to protect against aspiration or asphyxia. Principal efforts should be directed toward resuscitating brain-injured patients in order to maintain normal cerebral perfusion. Blood glucose levels should be checked and euglycemia maintained. Mild hyperventilation may reduce intracranial pressure through cerebral vasoconstriction. However, aggressive hyperventilation should be avoided. Intubated patients should undergo continuous capnography, and CO₂ levels should be maintained in lower end of eucapnia (30 to 35 mm Hg).

Exposure

No primary survey is complete without completely disrobing the patient and examining carefully for occult bruising, lacerations, impaled foreign bodies, and open fractures. Once the patient is in hemodynamically stable condition and the airway is secured, log-roll the patient, with one team member assigned to maintain in-line cervical stabilization. Palpate the spinous processes of the thoracic and lumbar spine for tenderness or deformity, and then carefully log-roll the patient back to a neutral position. The utility of routine rectal examination has been debated, but it is useful to identify gross rectal bleeding or loss of rectal tone in patients with suspected spinal injury. Examine the perineum for bruising, laceration, or bleeding. Cover the patient with warm blankets to prevent heat loss. Some have advocated the use of hypothermia in cases of severe brain injury. However, as of this writing, there is no conclusive evidence in favor of this therapy. Potential therapeutic benefits must be weighed against the coagulopathy and increased bleeding that hypothermia also causes in trauma patients.