العدد الحادي عشر
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“On Trauma The Medical Emergency Crisis And Its All Suitable Medical Support Methods”

Dr. Mohamed Nabil Rady

(On Emergency Rooms Crisis Case Trauma)

Head injuries:

Head injuries are among the most common types of trauma encountered in emergency departments (EDs). Many patients with severe brain injuries die before reaching a hospital, with almost 90% of prehospital trauma-related deaths involving brain injury. About 75% of patients with brain injuries who receive medical attention can be categorized as having minor injuries, 15% as moderate, and 10% as severe. Most recent United States data estimate 1,700,000 traumatic brain injuries (TBIs) annually, including 275,000 hospitalizations and 52,000 deaths. Survivors of TBI are often left with neuropsychologic impairments that result in disabilities affecting work and social activity. Every year, an estimated 80,000 to 90,000 people in the United States experience long-term disability from brain injury. In one average European country (Denmark), approximately 300 individuals per million inhabitants suffer moderate to severe head injuries annually, with more than one-third of these individuals requiring brain injury rehabilitation. Given these statistics, it is clear that even a small reduction in the mortality and morbidity resulting from brain injury can have a major impact on public health. The primary goal of treatment for patients with suspected TBI is to prevent secondary brain injury. Providing adequate oxygenation and maintaining blood pressure at a level that is sufficient to perfuse the brain are the most important ways to limit secondary brain damage and thereby improve the patient’s outcome. Subsequent to managing the ABCDEs, identification of a mass lesion that requires surgical evacuation is critical, and this is best achieved by immediately obtaining a computed tomographic (CT) scan of the head. However, obtaining a CT scan should not delay patient transfer to a trauma center that is capable of immediate and definitive neurosurgical intervention. The triage of a patient with brain injury depends on the severity of the injury and the facilities available within a particular community. For facilities without neurosurgical coverage, prearranged transfer agreements with higher-level facilities should be in place. Consultation with a neurosurgeon early in the course of treatment is strongly recommend.

Important Notes

1)Understanding basic intracranial anatomy and physiology is key to the management of head injury.

2)Learn to evaluate patients with head and brain injuries efficiently. In a comatose patient, secure and maintain the airway by endotracheal intubation. Perform a neurologic examination after normalizing the blood pressure and before paralyzing the patient **.**

Search for associated injuries **.**

(3 Practice performing a rapid and focused neurologic examination. Become familiar with the Glasgow Coma Scale (GCS) and practice its use **.**

Frequently reassess the patient’s neurologic status **.**

(4 Adequate resuscitation is important in limiting secondary brain injury. Prevent hypovolemia and hypoxemia. Treat shock aggressively and look for its cause. Resuscitate with Ringer’s lactate solution, normal saline, or similar isotonic solutions without dextrose. Do not use hypotonic solutions. The goal in resuscitating the patient with brain injuries is to prevent secondary brain injury **.**

(5 Determine the need for transfer, admission, consultation, or discharge. Contact a neurosurgeon as early as possible. If a neurosurgeon is not available at the facility, transfer all patients with moderate or severe head injuries **.**

Head and Neck Trauma **:**

Assessment and Management

A: Primary Survey STEP1 .ABCDEs **.**

STEP2 .Immobilize and stabilize the cervical spine **.**

STEP3 .Perform a brief neurologic examination, looking for: A. Pupillary response **.**

B. GCS score determination

C. Lateralizing signs

B: Secondary Survey and Management

STEP1 .Inspect the entire head, including the face ,looking for:

A. Lacerations

B. Presence of cerebrospinal fluid (CSF)leakage from the nose and ears

STEP2 .Palpate the entire head, including the face ,looking for : A. Fractures

B. Lacerations overlying fractures

STEP3 .Inspect all scalp lacerations, looking for : A .

Brain tissue

B. Depressed skull fractures C. Debris

D. CSF leaks

STEP4 .Determine the GCS score and pupillary response, including : A. Eye-opening response .

B. Best limb motor response

C. Verbal response

D. Pupillary response

STEP5. Examine the cervical spine.

A. Palpate for tenderness/pain and apply a semirigid cervical collar, if needed. B. Perform a cross-table lateral cervical spine x-ray examination, if needed .

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STEP6. Document the extent of neurologic injury .

STEP7. Reassess the patient continuously, observing for signs of deterioration .

A. Frequency

B. Parameters to be assessed

C. Serial GCS scores and extremity motor assessment

D. Remember, reassess ABCDEs

C: Evaluation of CT Scans of the Head

The diagnosis of abnormalities seen on CT scans of the head can be very subtle and difficult. Because of the inherent complexity in interpreting these scans, early review by a neurosurgeon or radiologist is important. The steps outlined here for evaluating a CT scan of the head provide one approach to assessing for significant, life-threatening pathology. Remember, obtaining a CT scan of the head should not delay resuscitation or transfer of the patient to a trauma center .

STEP1. Follow the process for initial review of CT scans of the head.

A. Confirm that the images being reviewed are of the correct patient .

B. Ensure that the CT scan of the head was done without an intravenous contrast agent.

C. Use the patient's clinical findings to focus the review of the CT scan, and use the image findings to enhance further physical evaluation .

STEP2. Assess the scalp component for contusion or swelling that can indicate a site of external trauma .

STEP3. Assess for skull fractures. Keep in mind that :

A. Suture lines (joining of the bones of the cranial vault) may be mistaken for fractures .

B. Depressed skull fractures (thickness of skull) require neurosurgical consultation.

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C. Open fractures require neurosurgical consultation.

D. Missile wound tracts may appear as linear areas of low attenuation .

STEP4. Assess the gyri and sulci for symmetry. If asymmetry exists, consider these diagnoses: A. Acute subdural hematomas :

•Typically are areas of increased density covering and compressing the gyri and sulci over the entire hemisphere

•Can cause a shift of the underlying ventricles across the midline •Occur more commonly than epidural hematomas

•Can have associated cerebral contusions and intracerebral hematomas

B. Acute epidural hematomas :

•Typically are lenticular or biconvex areas of increased density •Appear within the skull and compress the underlying gyri and sulci •Can cause a shift of the underlying ventricles across the midline

•Most often are located in the temporal or temporoparietal region

STEP5. Assess the cerebral and cerebellar hemispheres .

A. Compare both hemispheres for similar density and symmetry .

B. Intracerebral hematomas appear as areas of high density .

C. Cerebral contusions appear as punctate areas of high density .

D. Diffuse axonal injury can appear normal or have scattered, small areas of cerebral contusion and areas of low density .

STEP6. Assess the ventricles. A. Check size and symmetry .

B. Significant mass lesions compress and distort the ventricles, especially the lateral ventricles .

C. Significant intracranial hypertension is often associated with decreased ventricular size .

D. Intraventricular hemorrhage appears as regions of increased density (bright spots) in the ventricles .

STEP7. Determine the shifts. Midline shifts may be caused by a hematoma or swelling that causes the septum pellucidum, between the two lateral ventricles, to shift away from the midline.The midline is a line extending from the crista galli anteriorly to the tent like projection posteriorly (inion). After measuring the distance from the midline to the septum pellucidum, the actual shift is determined by correcting against the scale on the CT print. A shift of 5 mm or more is considered indicative of a mass lesion and the need for surgical decompression .

STEP8. Assess the maxillofacial structures. A. Assess the facial bones for fractures .

B. Assess the sinuses and mastoid air cells for air-fluid levels .

C. Facial bone fractures, sinus fractures, and sinus or mastoid air-fluid levels may indicate basilar skull or cribriform plate fractures .

STEP9. Look for the four Cs of increased density: A .

Contrast

B. Clot

C. Cellularity (tumor)

D. Calcification (pineal gland, choroid plexus)

Spine and Spinal Cord Trauma

Spine injury, with or without neurologic deficits, must always be considered in patients with multiple injuries. Approximately 5% of patients with brain injury have an associated spinal injury, whereas 25% of patients with spinal injury have at least a mild brain injury.

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Approximately 55% of spinal injuries occur in the cervical region, 15% in the thoracic region, 15% at the thoracolumbar junction, and 15% in the lumbosacral area. Approximately 10% of patients with a cervical spine fracture have a second, noncontiguous vertebral column fracture. Doctors and other medical personnel who treat patients with spine injuries must be constantly aware that excessive manipulation and inadequate immobilization of such patients may cause additional neurologic damage and worsen the patient's outcome. At least 5% of patients with spine injury experience the onset of neurologic symptoms or the worsening of preexisting symptoms after reaching the ED. This is usually due to ischemia or progression of spinal cord edema, but it may also result from inadequate immobilization. As long as the patient's spine is protected, evaluation of the spine and exclusion of spinal injury may be safely deferred, especially in the presence of systemic instability, such as hypotension and respiratory inadequacy. Cervical spine injury in children is a relatively rare event, occurring in less than 1% of cases. Additionally, anatomical differences, emotional distress, and inability to communicate make evaluation of the spine even more challenging in this population in a patient without neurological deficit, pain or tenderness along the spine, evidence of intoxication, or distracting injury, excluding the presence of a spinal injury is straightforward. In a neurologically intact patient, the absence of pain or tenderness along the spine virtually excludes the presence of a significant spinal injury. However, in a patient who is comatose or has a depressed level of consciousness, the process is not as simple. In this case, it is incumbent on the clinician to obtain the appropriate x-ray films to exclude a spinal injury. If the x-rays are inconclusive, the patient's spine should remain protected until further testing can be performed. Although the dangers of inadequate immobilization have been well documented, there also is some danger in prolonged immobilization of patients on a hard surface such as a backboard. In addition to causing severe discomfort in an awake patient, prolonged immobilization may lead to the formation of serious decubitus ulcers in patients with spinal cord injuries. Therefore, the long backboard should be used only as a patient transportation device, and every effort should be made to have the patient evaluated by the appropriate specialists and removed from the spine board as quickly as possible. If this is not feasible within 2 hours, the patient should be removed from the spine board and then logrolled every 2 hours, while maintaining the integrity of the spine, to reduce the risk of the formation of decubitus ulcers .

IMPORTANT NOTES

1 The spinal column consists of cervical, thoracic, and lumbar vertebrae. The spinal cord contains three important tracts: the corticospinal tract, the spinothalamic tract, and the dorsal columns .

2 Obtain images, when indicated, as soon as lifethreatening injuries are managed. Document the patient's history and physical examination so as to establish a baseline for any changes in the patient's neurologic status .

3 Spinal cord injuries may be complete or incomplete and may involve any level of the spinal cord .

4 Attend to life-threatening injuries first, minimizing movement of the spinal column. Establish and maintain proper immobilization of the patient until vertebral fractures and spinal cord injuries have been excluded. Obtain early consultation with a neurosurgeon and/or orthopedic surgeon whenever a spinal injury is suspected or detected .

5 Transfer patients with vertebral fractures or spinal cord injuries to a definitive care facility .

Spinal Cord Injury Assessment and Management

A: Primary Survey and Resuscitation—Assessing Spine Injuries

Note: The patient should be maintained in a supine, neutral position using proper immobilization techniques .

STEP1. Airway:

A. Assess the airway while protecting the cervical spine .

B. Establish a definitive airway as needed .

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STEP2. Breathing: Assess and provide adequate oxygenation and ventilatory support as needed .

STEP3. Circulation :

A. If the patient has hypotension, differentiate hypovolemic shock (decreased blood pressure, increased heart rate, and cool extremities) from neurogenic shock (decreased blood pressure, decreased heart rate, and warm extremities). B. Replace fluids for hypovolemia .

C. If spinal cord injury is present, fluid resuscitation should be guided by monitoring central venous pressure (CVP) .

)Note: Some patients may need inotropic support (.

D. When performing a rectal examination before inserting the urinary catheter, assess for rectal sphincter tone and sensation .

STEP4. Disability—Brief Neurologic Examination: A. Determine level of consciousness and assess pupils .

B. Determine Glasgow Coma Scale (GCS) score.

C. Recognize paralysis/paresis. B: Secondary Survey—Neurologic Assessment

STEP1. Obtain AMPLE history .

A. History and mechanism of injury

B. Medical history

C. Identify and record drugs given prior to the patient's arrival and during the assessment and management phases

STEP2. Reassess level of consciousness and pupils.

STEP3. Reassess GCS score.

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STEP4. Assess the spine (See Skill XII-C :

Examination for Level of Spinal Cord Injury)A. Palpate the entire spine posteriorly by carefully logrolling the patient and assessing for: • Deformity and/or swelling

- Crepitus
- Increased pain with palpation
- Contusions and lacerations/penetrating wounds

B. Assess for pain, paralysis, and paresthesia:

- Presence/absence
- Location
- Neurologic level

C. Test sensation to pinprick in all dermatomes and record the most caudal dermatome that feels the pinprick .

D. Assess motor function.

E. Measure deep tendon reflexes (least informative in the emergency setting) .

F. Document and repeat—record the results of the neurologic examination and repeat motor and sensory examinations regularly until consultation is obtained .

STEP5. Reevaluate—Assess for associated/occult injuries .

C: Examination for Level of Spinal Cord Injury

A patient with a spinal cord injury may have varying levels of neurologic deficit. The level of motor function and sensation must be reassessed frequently and carefully documented, because changes in the level of function can occur .

STEP1. Best Motor Examination

A. Determining the level of quadriplegia, nerve root level: • Raises elbow to level of shoulder—deltoid ,

C5

- Flexes forearm—biceps, C6
- Extends forearm—triceps, C7
- Flexes wrist and fingers, C8
- Spreads fingers, T1

B. Determining the level of paraplegia, nerve root level • Flexes hip—iliopsoas, L2• Extends knee—quadriceps, L3-L4

- Flexes knee—hamstrings, L4-L5 to S1
- Dorsiflexes big toe—extensor hallucis longus, L5
- Plantar flexes ankle—gastrocnemius, S1

STEP2. Sensory Examination: Determining the level of sensation is done primarily by assessing the dermatomes .

Remember, the cervical sensory dermatomes of C2 through C4 form a cervical cape or mantle that can extend down as far as the nipples. Because of this unusual pattern, the examiner should not depend on the presence or absence of sensation in the neck and clavicular area, and the level of sensation must be correlated with the motor response level .

D: Treatment Principles for Patients with Spinal Cord Injuries

STEP1. Patients with suspected spine injury must be protected from further injury. Such protection includes applying a semi rigid cervical collar and long back board, performing a modified logroll to ensure neutral alignment of the entire spine, and removing the patient from the long spine board as soon as possible. Paralyzed patients who are immobilized on a long spine board are at particular risk for pressure points and decubitus ulcers. Therefore, paralyzed patients should be removed from the long spine board as soon as possible after a spine injury is diagnosed, i.e., within 2 hours .

STEP2. Fluid Resuscitation and Monitoring :

A.CVP monitoring: Intravenous fluids usually are limited to maintenance levels unless specifically needed for the management of shock. A central venous catheter should be inserted to carefully monitor fluid administration .

B. Urinary catheter: A urinary catheter should be inserted during the primary survey and resuscitation phases to monitor urinary output and prevent bladder distention .

C. Gastric catheter: A gastric catheter should be inserted in all patients with paraplegia and quadriplegia to prevent gastric distention and aspiration .

E: Principles of Spine Immobilization and Logrolling

ADULT PATIENT

Four people are needed to perform the modified logrolling procedure and to immobilize the patient— for example, on a long spine board :

- one person to maintain manual, inline immobilization of the patient's head and neck - one for the torso (including the pelvis and hips)

- one for the pelvis and legs

-one to direct the procedure and move the spine board

This procedure maintains the patient's entire body in neutral alignment, thereby minimizing any untoward movement of the spine. This procedure assumes that any extremity suspected of being fractured has already been immobilized .

STEP1. Place the long spine board with straps next to the patient’s side. Position the straps for fastening later across the patient’s thorax, just above the iliac crests, across the thighs, and just above the ankles. Straps or tape can be used to secure the patient’s head and neck to the long board .

STEP2. Apply gentle, inline manual immobilization to the patient’s head and apply a semi rigid cervical collar .

STEP3. Gently straighten and place the patient’s arms (palm in) next to the torso.STEP4. Carefully straighten the patient’s legs and place them in neutral alignment with the patient’s spine. Tie the ankles together with a roller-type dressing or cravat .

STEP5. While maintaining alignment of the patient’s head and neck, another person reaches across and grasps the patient at the shoulder and wrist. A third person reaches across and grasps the patient’s hip just distal to the wrist with one hand, and with the other hand firmly grasps the roller bandage or cravat that is securing the ankles together .

STEP6. At the direction of the person who is maintaining immobilization of the patient’s head and neck, cautiously logroll the patient as a unit toward the two assistants at the patient’s side, but only to the least degree necessary to position the board under the patient. Maintain neutral alignment of the entire body during this procedure .

STEP7. Place the spine board beneath the patient and carefully logroll the patient in one smooth movement onto the spine board.

The spine board is used only for transferring the patient and should not be left under the patient for any length of time .

STEP8. Consider padding under the patient’s head to avoid hyperextension of the neck and for patient comfort .

STEP9. Place padding, rolled blankets, or similar bolstering devices on both sides of the patient’s head and neck, and firmly secure the patient’s head to the board. Tape the cervical collar, further securing the patient’s head and neck to the long board .

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PEDIATRIC PATIENT

A pediatric-sized long spine board is preferable when immobilizing a small child. If only an adult-sized board is available, place blanket rolls along the entire sides of the child to prevent lateral movement. A child's head is proportionately larger than an adult's. Therefore, padding should be placed under the shoulders to elevate the torso so that the large occiput of the child's head does not produce flexion of the cervical spine; this maintains neutral alignment of the child's spine. Such padding extends from the child's lumbar spine to the top of the shoulders and laterally to the edges of the board .

COMPLICATIONS

If left immobilized for any length of time (approximately 2 hours or longer) on the long spine board, pressure sores can develop at the occiput, scapulae, sacrum, and heels. Therefore, padding should be applied under these areas as soon as possible, and the patient should be removed from the long spine board as soon as his or her condition permits .

REMOVAL FROM A LONG SPINE BOARD

Movement of a patient with an unstable vertebral spine injury can cause or worsen a spinal cord injury. To reduce the risk of spinal cord damage, mechanical protection is necessary for all patients at risk. Such protection should be maintained until an unstable spine injury has been excluded .

STEP1. As previously described, properly secure the patient to a long spine board, which is the basic technique for splinting the spine. In general, this is done in the prehospital setting, and the patient arrives at the hospital already immobilized. The long spine board provides an effective splint and permits safe transfers of the patient with a minimal number of assistants. However, unpadded spine boards can soon become uncomfortable for conscious patients and pose a significant risk for pressure sores on posterior bony prominences (occiput, scapulae, sacrum, and heels). Therefore, the patient should be transferred from the spine board to a firm, well-padded gurney or equivalent surface as soon as it can be done safely. Before removing the patient from the spine board, cspine, chest, and pelvis x-ray films should be obtained as

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indicated, because the patient can be easily lifted and the x-ray plates placed beneath the spine board. While the patient is immobilized on the spine board, it is very important to maintain immobilization of the head and the body continuously. The straps used to immobilize the patient on the board should not be removed from the body while the head remains taped to the upper portion of the spine board .

STEP2. Remove the patient from the spine board as early as possible. Preplanning is required. A good time to remove the board from under the patient is when the patient is logrolled to evaluate the back .

STEP3. Safe movement of a patient with an unstable or potentially unstable spine requires continuous maintenance of anatomic alignment of the vertebral column. Rotation, flexion, extension, lateral bending, and shearing-type movements in any direction must be avoided. Manual, in-line immobilization best controls the head and neck. No part of the patient's body should be allowed to sag as the patient is lifted off the supporting surface. The transfer options listed below may be used, depending on available personnel and equipment resources .

STEP4. Modified Logroll Technique: The modified logroll technique, previously outlined, is reversed to remove the patient from the long spine board. Four assistants are required: one to maintain manual, inline immobilization of the patient's head and neck; one for the torso (including the pelvis and hips); one for the pelvis and legs; and one to direct the procedure and remove the spine board .

STEP5. Scoop Stretcher: The scoop stretcher is an alternative to using the modified logrolling techniques for patient transfer. The proper use of this device can provide rapid, safe transfer of the patient from the long spine board onto a firm, padded patient gurney. For example, this device can be used to transfer the patient from one transport device to another or to a designated place (e.g., x-ray table). The patient must remain securely immobilized until a spine injury is excluded. After the patient is transferred from the backboard to the gurney (stretcher) and the scoop stretcher is removed, the patient must again be immobilized securely on the gurney (stretcher). The scoop stretcher is not a device on which the patient is

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immobilized. In addition, the scoop stretcher is not used to transport the patient, nor should the patient be transferred to the gurney by picking up only the foot and head ends of the scoop stretcher. Without firm support under the stretcher, it can sag in the middle and result in loss of neutral alignment of the spine .

IMMOBILIZATION OF THE PATIENT WITH POSSIBLE SPINE INJURY

Patients frequently arrive in the ED with spinal protective devices in place. These devices should cause the examiner to suspect that a c-spine and/or thoracolumbar spine injury may exist, based on mechanism of injury. In patients with multiple injuries with a diminished level of consciousness, protective devices should be left in place until a spine injury is excluded by clinical and x-ray examinations. If a patient is immobilized on a spine board and is paraplegic, spinal instability should be presumed and all appropriate x-ray films obtained to determine the site of spinal injury. However, if the patient is awake, alert, sober, neurologically normal; is not experiencing neck or back pain; and does not have tenderness to spine palpation, spine x-ray examination and immobilization devices are not needed. Patients who sustain multiple injuries and are comatose should be kept immobilized on a padded gurney (stretcher) and logrolled to obtain the necessary x-ray films to exclude a fracture. Then, using one of the aforementioned procedures, they can be transferred carefully to a bed .

X-Ray Identification of Spine Injuries

A: Cervical Spine X-Ray Assessment

STEP1. Assess adequacy and alignment

A. Identify the presence of all 7 cervical vertebrae and the superior aspect of T1 .

B. Identify the:

- Anterior vertebral line
- Anterior spinal line
- Posterior spinal line

- Spinous processes

STEP2. Assess the bone

A. Examine all vertebrae for preservation of height and integrity of the bony cortex. B. Examine facets .

C Examine spinous processes.

STEP3. Assess the cartilage, including examining the cartilaginous disk spaces for narrowing or widening

STEP4. Assess the dens

A. Examine the outline of the dens.

B. Examine the predental space (3 mm).

C. Examine the clivus; it should point to the dens.

STEP5. Assess the extraaxial soft tissues.

A. Examine the extraaxial space and soft tissues

- 7mmatC3
- 3cmatC7

B. Examine the distances between the spinous processes .

B: Thoracic and Lumbar X-Ray Assessment ANTEROPOSTERIOR VIEW

STEP1. Assess for: A. Alignment

B. Symmetry of pedicles

C. Contour of bodies

D. Height of disk spaces

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E. Central position of spinous processes

LATERAL VIEW

STEP2. Assess for:

A. Alignment of bodies/angulation of spine B .

Contour of bodies

C. Presence of disk spaces

D. Encroachment of body on canal

Musculoskeletal Trauma

What impact do musculoskeletal injuries have on the primary survey? During the primary survey, it is imperative to recognize and control hemorrhage from musculoskeletal injuries. Deep soft tissue lacerations may involve major vessels and lead to exsanguinating hemorrhage . Hemorrhage control is best effected by direct pressure. Hemorrhage from long-bone fractures may be significant, and certain femoral fractures may result in significant blood loss into the thigh. Appropriate splinting of the fracture may significantly decrease bleeding by reducing motion and enhancing a tamponade effect of the muscle .

If the fracture is open, application of a sterile pressure dressing usually controls hemorrhage. Appropriate fluid resuscitation is an important supplement to these mechanical measures. Adjuncts to Primary Survey adjuncts to the primary survey of patients with musculoskeletal trauma include fracture immobilization and x-ray examination if the fractures are suspected as a cause of shock .

FRACTURE IMMOBILIZATION

The goal of initial fracture immobilization is to realign the injured extremity in as close to anatomic position as possible and to prevent excessive fracture-site motion. This is accomplished by the application of in-line traction to realign the extremity and maintained by an immobilization device . The proper application of a splint helps control blood loss, reduce

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pain, and prevent further soft tissue injury. If an open fracture is present, the clinician need not be concerned about pulling exposed bone back into the wound because open fractures require surgical debridement .

IMPORTANT NOTES

(1 Musculoskeletal injuries, although generally not life-threatening, may pose delayed threats to life and limb .

(2 The goal of the initial assessment of musculoskeletal trauma is to identify injuries that pose a threat to life and/or limb. Although uncommon, life-threatening musculoskeletal injuries must be properly assessed and managed. Most extremity injuries are appropriately diagnosed and managed during the secondary survey .

(3 It is essential to recognize and manage in a timely manner arterial injuries, compartment syndrome, open fractures, crush injuries, and fracturedislocations. Knowledge of the mechanism of injury and history of the injury-producing event enables the clinician to be aware of what associated conditions potentially exist with the injured extremity .

(4 Early splinting of fractures and dislocations may prevent serious complications and late sequelae .

Musculoskeletal Trauma: Assessment and Management

A: Physical Examination

LOOK, GENERAL OVERVIEW

External hemorrhage is identified by obvious external bleeding from an extremity, pooling of blood on the stretcher or floor, blood-soaked dressings, and bleeding that occurs during transport to the hospital.

The examiner should ask about characteristics of the injury incident and prehospital care. Remember, open wounds may not bleed, but may be indicative of an open fracture .

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STEP1. Splint deformed extremities, which are indicative of a fracture or joint injury, before patient transport or as soon as is safely possible .

STEP2. Assess the color of the extremity. The presence of bruising indicates muscle injury or significant soft tissue injury over bones or joints. These changes may be associated with swelling or hematoma. Vascular impairment may be first identified by a pale distal extremity .

STEP3. Note the position of the extremity, which can be helpful in determining specific injury patterns. Certain nerve deficits lead to specific positions of the extremity. For example, injury to the radial nerve results in wrist drop, and injury to the peroneal nerve results in foot drop .

STEP4. Observe spontaneous activity to help determine the severity of injury. Observing whether the patient spontaneously moves an extremity may suggest to the examiner other obvious or occult injuries. An example is a patient with a brain injury who does not follow commands and has no spontaneous lower-extremity movement; this patient could have a thoracic or lumbar fracture .

STEP5. Note gender and age, which are important clues to potential injuries. Children may sustain growth plate injuries and fractures that may not manifest themselves (e.g., buckle fracture) .

FEEL

Life- and limb-threatening injuries are excluded first .

STEP1. Palpate pulses in all extremities and document the findings. Any perceived abnormality or difference must be explained. Normal capillary refill (<2 seconds) of the pulp space or nail bed provides a good indication of satisfactory blood flow to the distal parts of the extremity. Loss or diminishment of pulses with normal capillary refill indicates a viable extremity; however, surgical consultation is required. If an extremity has no pulses and no capillary refill, a surgical emergency exists. A Doppler device is useful to assess pulses and determine the ankle/arm systolic pressure ratio. Blood pressure is measured at the ankle and on an uninjured arm. The normal ratio exceeds 0.9. If the ratio is below 0.9, a potential injury exists and surgical consultation is required .

STEP2. Palpate the muscle compartments of all the extremities for compartment syndromes and fractures. This is done by gentle palpation of the muscle and bone. If a fracture is present, the patient reports pain. A compartment syndrome should be considered if the muscle compartment is very firm or tender. Compartment syndromes may be associated with fractures .

STEP3. Assess joint stability by asking the cooperative patient to move the joint through a range of motion. This should not be done if there is an obvious fracture or deformity, or if the patient cannot cooperate. Palpate each joint for tenderness, swelling, and intra-articular fluid. Assess joint stability by applying lateral, medial, and anteriorposterior stress. Any deformed or dislocated joint should be splinted and x-rayed before testing for stability .

STEP4. Perform a rapid, thorough neurologic examination of the extremities and document the findings.

Repeat and record testing as indicated by the patient's clinical condition.

Test sensation by light touch and pinprick in each of the extremities. Progression of the neurologic findings indicates a potential problem .

A. C5—Lateral aspect of the upper arm (also axillary nerve)

B. C6—Palmar aspect of the thumb and index finger

)median nerve(

C. C7—Palmar aspect of the long finger D. C8—Palmar aspect of the little finger (ulnar nerve)

E. T1—Medial aspect of the forearm

F. L3—Medial aspect of the thigh

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G. L4—Medial aspect of the lower leg, especially over the medial malleolus

H. L5—Dorsum of the foot between the first and second toes (common peroneal)

I. S1—Lateral aspect of the foot

STEP5. Perform motor examination of the extremities .

A. Shoulder abduction—Axillary nerve, C5

B. Elbow flexion—Musculocutaneous nerve, C5 and

C6 C. Elbow extension—Radial nerve, C6, C7, and C8

D. Hand and wrist—Power grip tests dorsiflexion of the wrist (radial nerve, C6) and flexion of the fingers (median and ulnar nerves, C7 and C8)

E. Finger add/abduction—Ulnar nerve, C8 and T1

F. Lower extremity—Dorsiflexion of the great toe and ankle tests the deep peroneal nerve, L5, and plantar dorsiflexion tests the posterior tibial nerve, S1

G. Muscle power is graded in the standard form. The motor examination is specific to a variety of voluntary movements of each extremity .

STEP6. Assess the deep tendon reflexes .

STEP7. Assess the patient's back .

B: Principles of Extremity Immobilization

STEP1. Assess the ABCDEs, and treat lifethreatening situations first .

STEP2. Remove all clothing and completely expose the patient, including the extremities. Remove watches, rings, bracelets, and other potentially constricting devices.

Remember to prevent the development of hypothermia .

STEP3. Assess the neurovascular status of the extremity before applying the splint. Assess for pulses and external hemorrhage, which must be controlled, and perform a motor and sensory examination of the extremity .

STEP4. Cover any open wounds with sterile dressings .

STEP5. Select the appropriate size and type of splint for the injured extremity. The device should immobilize the joint above and the joint below the injury site .

STEP6. Apply padding over bony prominences that will be covered by the splint .

STEP7. Place the extremity in a splint if normally aligned. If mal-aligned, the extremity needs to be realigned and then splinted. Do not force realignment of a deformed extremity with a normal pulse. Careful rotation and realignment may be required if circulation is compromised; this is best done by an experienced provider .

STEP8. Obtain orthopedic consultation .

STEP9. Document the neurovascular status of the extremity before and after every manipulation or splint application .

STEP10. Administer appropriate tetanus prophylaxis .

C: Realigning a Deformed Extremity

Physical examination determines whether a deformity is from a fracture or a dislocation. The principle of realigning an extremity fracture is to restore length by applying gentle longitudinal traction to correct the residual angulation and then rotational deformities. While maintaining realignment with manual traction, a splint is applied and secured to the extremity by an assistant .

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STEP1. Grasp the elbow and manually apply distal traction .

STEP2. After alignment is obtained, apply a splint and secure the arm to the chest wall with a sling and swath .

FOREARM

STEP1. Manually apply distal traction through the wrist while holding the elbow and applying counter traction .

STEP2. Secure a splint to the forearm and elevate the injured extremity .

FEMUR

STEP1. Realign the femur by manually applying traction through the ankle if the tibia and fibula are not fractured .

STEP2. As the muscle spasm is overcome, the leg will straighten and the rotational deformity can be corrected. This maneuver may take several minutes, depending on the size of the patient .

TIBIA

STEP1. Manually apply distal traction at the ankle and counter traction just above the knee, provided that the femur is intact .

VASCULAR AND NEUROLOGIC DEFICITS

Fractures associated with neurovascular deficits require prompt realignment. Immediate consultation with a surgeon is necessary. If the vascular or neurologic status worsens after realignment and splinting, the splint should be removed and the extremity returned to the position in which blood flow and neurologic status are maximized. The extremity is then immobilized in that position. D: Application of a Traction Splint

Note: Application of this device requires two people —one person to handle the injured extremity, and the second to apply the splint .

STEP1. Remove all clothing, including footwear, to expose the extremity .

STEP2. Apply sterile dressings to open wounds .

STEP3. Assess the neurovascular status of the extremity .

STEP4. Cleanse any exposed bone and muscle of dirt and debris before applying traction. Document that the exposed bone fragments were reduced into the soft tissues .

STEP5. Determine the length of the splint by measuring the uninjured leg. The upper cushioned ring should be placed under the buttocks and adjacent to the ischial tuberosity. The distal end of the splint should extend beyond the ankle by approximately 6 inches (15 cm). The straps on the splint should be positioned to support the thigh and calf .

STEP6. Align the femur by manually applying traction through the ankle. After realignment is achieved, gently elevate the leg to allow the assistant to slide the splint under the extremity so that the padded portion of the splint rests against the ischial tuberosity .

STEP7. Reassess the neurovascular status of the distal injured extremity after applying traction .

STEP8. Position the ankle hitch around the patient's ankle and foot while the assistant maintains manual traction on the leg. The bottom strap should be slightly shorter than, or at least the same length as, the two upper crossing straps .

STEP9. Attach the ankle hitch to the traction hook while the assistant maintains manual traction and support. Apply traction in increments using the windlass knob until the extremity appears stable, or until pain and muscular spasm are relieved .

STEP10. Reassess the neurovascular status of the injured extremity. If perfusion of the extremity distal to the injury appears worse after applying traction, gradually release the traction.

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STEP11. Secure the remaining straps .

STEP12. Frequently reevaluate the neurovascular status of the extremity. Document the neurovascular status after every manipulation of the extremity .

STEP13. Administer tetanus prophylaxis, as indicated .

E: Compartment Syndrome: Assessment and Management

STEP1. Consider the following important facts: Compartment syndrome can develop insidiously .

- Compartment syndrome can develop in an extremity as the result of compres-sion or crushing forces and without obvious external injury or fracture .

- Frequent reevaluation of the injured extremity is essential .

- The patient who has had hypotension or is unconscious is at increased risk for compartment syndrome .

- Pain is the earliest symptom that heralds the onset of compartment ischemia, especially pain on passive stretch of the involved muscles of the extremity.

- Unconscious or intubated patients cannot communicate the early signs of extremity ischemia .

- Loss of pulses and other classic findings of ischemia occur late, after irreversible damage has occurred .

STEP2. Palpate the muscular compartments of the extremities, comparing the compartment tension in the injured extremity with that in the noninjured extremity.

A. Asymmetry may be a significant finding .

B. Frequent examination for tense muscular compartments is essential .

C. Measurement of compartment pressures may be helpful .

STEP3. Obtain orthopedic or general surgical consultation early .

F: Identification of Arterial Injury

STEP1. Recognize that ischemia is a limbthreatening and potentially life-threatening condition .

STEP2. Palpate peripheral pulses bilaterally (dorsalis pedis, anterior tibial, femoral, radial, and brachial) for quality and symmetry .

STEP3. Document and evaluate any evidence of asymmetry in peripheral pulses .

STEP4. Reevaluate peripheral pulses frequently, especially if asymmetry is identified. Use Doppler and measurement of ankle/brachial index to assess the presence and quality of distal pulses .

STEP5. Obtain early surgical consultation .

Thoracic Trauma

What are the immediately life-threatening chest injuries ?

Thoracic trauma is a significant cause of mortality. Many patients with thoracic trauma die after reaching the hospital; however, many of these deaths could be prevented with prompt diagnosis and treatment. Less than 10% of blunt chest injuries and only 15% to 30% of penetrating chest injuries require operative intervention (typically thoracoscopy or thoracotomy). In fact, most patients who sustain thoracic trauma can be treated by technical procedures within the capabilities of clinicians who take this course. Many of the principles outlined in this chapter also apply to iatrogenic thoracic injuries, such as hemothorax or pneumothorax with central line placement and esophageal injury during endoscopy. Hypoxia, hypercarbia, and acidosis often result from chest injuries. Tissue hypoxia results from the inadequate delivery of oxygen to the tissues because of hypovolemia (blood loss), pulmonary ventilation/ perfusion mismatch (e.g., contusion, hematoma, and alveolar collapse), and changes in the intrathoracic pressure relationships (e.g., tension pneumothorax and open pneumothorax). This hypoperfusion leads to metabolic acidosis. Hypercarbia with resultant respiratory acidosis most often follows inadequate ventilation caused bychanges in the intrathoracic pressure relationships and depressed level of consciousness. The initial assessment and treatment of patients with thoracic trauma consists of the primary survey, resuscitation of vital functions, detailed secondary survey, and definitive care. Because hypoxia is the most serious aspect of chest injury, the goal of early intervention is to prevent or correct hypoxia. Injuries that are an immediate threat to life are created as quickly and simply as is possible. Most life-threatening thoracic injuries can be treated with airway control or an appropriately placed chest tube or needle. The secondary survey is influenced by the history of the injury and a high index of suspicion for specific injuries .

IMPORTANT NOTES

(1Thoracic injury is common in the poly-trauma patient and can pose life-threatening problems if not promptly identified and treated during the primary survey. These patients can usually be treated or their conditions temporarily relieved by relatively simple measures, such as intubation, ventilation, tube thoracostomy, and fluid resuscitation. The ability to recognize these important injuries and the skill to perform the necessary procedures can be lifesaving. The primary survey includes management of the following conditions :

-Airway obstruction

- Tension pneumothorax
- Open pneumothorax
- Flail chest and pulmonary contusion - Massive hemothorax- Cardiac tamponade

(2 The secondary survey includes identification and initial treatment of the following potentially lifethreatening injuries, utilizing adjunctive studies, such as x-rays, laboratory tests, and ECG :

- Simple pneumothorax
- Hemothorax

- Pulmonary contusion
- Tracheobronchial tree injury - Blunt cardiac injury
- Traumatic aortic disruption
- Traumatic diaphragmatic injury
- Blunt esophageal rupture

(3Several manifestations of thoracic trauma are indicative of a greater risk of associated injuries :

- Subcutaneous emphysema
- Crush injuries of the chest- Injuries to the upper ribs (1–3), scapula, and sternum

Chest Trauma Management

A : Needle Thoracentesis

Note: This procedure is appropriate for patients in critical condition with rapid deterioration who have a life-threatening tension pneumothorax and in whom placement of an expeditious chest tube is not possible. Success rate in the presence of a tension pneumothorax is 50–75% due to length of needle and catheter, size of chest wall,and kinking of the catheter. If this technique is used and the patient does not have a tension pneumothorax, a pneumothorax and/or damage to the lung may occur .

STEP1. Assess the patient's chest and respiratory status .

STEP2. Administer high-flow oxygen and apply ventilation as necessary .

STEP3. Identify the second intercostal space, in the midclavicular line on the side of the tension pneumothorax .

STEP4. Surgically prepare the chest .

STEP5. Locally anesthetize the area if the patient is conscious and if time permits .

STEP6. Place the patient in an upright position if a cervical spine injury has been excluded .

STEP7. Keeping the Luer-Lok in the distal end of the catheter, insert an over-the-needle catheter (2 in. [5 cm] long) into the skin and direct the needle just over (i.e., superior to) the rib into the intercostal space .

STEP8. Puncture the parietal pleura .

STEP9. Remove the Luer-Lok from the catheter and listen for the sudden escape of air when the needle enters the parietal pleura, indicating that the tension pneumothorax has been relieved .

STEP10. Remove the needle and replace the LuerLok in the distal end of the catheter. Leave the plastic catheter in place and apply a bandage or small dressing over the insertion site .

STEP11. Prepare for a chest tube insertion. The chest tube is typically inserted at the nipple level just anterior to the midaxillary line of the affected hemithorax .

STEP12. Connect the chest tube to an underwaterseal device or a flutter-type valve apparatus and remove the catheter used to relieve the tension pneumothorax initially .

STEP13. Obtain a chest x-ray film .

COMPLICATIONS OF NEEDLE

THORACENTESIS - Local hematoma

-Pneumothorax

-Lung laceration

B: Chest Tube Insertion

STEP1. Determine the insertion site, usually at the nipple level (fifth intercostal space), just anterior to the midaxillary line on the affected side. A second chest tube may be used for a hemothorax .

STEP2. Surgically prepare and drape the chest at the predetermined site of the tube insertion .

STEP3. Locally anesthetize the skin and rib periosteum .

STEP4. Make a 2- to 3-cm transverse (horizontal) incision at the predetermined site and

bluntly dissect through the subcutaneous tissues, just over the top of the rib .

STEP5. Puncture the parietal pleura with the tip of a clamp and put a gloved finger into the incision to avoid injury to other organs and to clear any adhesions, clots, and so on. Once the tube in the proper place, remove the clamp from the tube .

STEP6. Clamp the proximal end of the thoracostomy tube and advance it into the pleural space to the desired length. The tube should be directed posteriorly along the inside of the chest wall .

STEP7. Look for “fogging” of the chest tube with expiration or listen for air movement .

STEP8. Connect the end of the thoracostomy tube to an underwater-seal apparatus .

STEP9. Suture the tube in place .

STEP10. Apply an occlusive dressing and tape the tube to the chest .

STEP11. Obtain a chest x-ray film .

STEP12. Obtain arterial blood gas values and/or institute pulse oximetry monitoring as necessary .

COMPLICATIONS OF CHEST TUBE INSERTION

-Laceration or puncture of intrathoracic and/or abdominal organs, which can be prevented by using the finger technique before inserting the chest tube

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-Introduction of pleural infection—for example, thoracic empyema - Damage to the intercostal nerve, artery, or vein:

- Converting a pneumothorax to a hemopneumothorax
- Resulting in intercostal neuritis/neuralgia

- Incorrect tube position, extrathoracic or intrathoracic

- Chest tube kinking, clogging, or dislodging from the chest wall, or disconnection from the underwaterseal apparatus

- Persistent pneumothorax :

- Large primary leak
- Leak at the skin around the chest tube; suction on tube too strong
- Leaky underwater-seal apparatus

- Subcutaneous emphysema, usually at tube site

- Recurrence of pneumothorax upon removal of chest tube; seal of thoracostomy wound not immediate

- Lung fails to expand because of plugged bronchus; bronchoscopy required - Anaphylactic or allergic reaction to surgical preparation or anesthetic X-Ray Identification of Thoracic Injuries

A: Process for Initial Review of Chest X-Rays

I. OVERVIEW

STEP1. Confirm that the film being viewed is of your patient .

STEP2. Quickly assess for suspected pathology .

STEP3. Use the patient's clinical findings to focus the review of the chest x-ray film, and use the x-ray findings to guide further physical evaluation

II. TRACHEA AND BRONCHI

STEP1. Assess the position of the tube in cases of endotracheal intubation .

STEP2. Assess for the presence of interstitial or pleural air that can represent tracheobronchial injury .

STEP3. Assess for tracheal lacerations that can present as pneumomediastinum, pneumothorax, subcutaneous and interstitial emphysema of the neck, or pneumoperitoneum .

STEP4. Assess for bronchial disruption that can present as a free pleural communication and produce a massive pneumothorax with a persistent air leak that is unresponsive to tube thoracostomy .

III. PLEURAL SPACES AND LUNG PARENCHYMA

STEP1. Assess the pleural space for abnormal collections of fluid that can represent a hemothorax .

STEP2. Assess the pleural space for abnormal collections of air that can represent a pneumothorax —usually seen as an apical lucent area without bronchial or vascular markings .

STEP3. Assess the lung fields for infiltrates that can suggest pulmonary contusion, hematoma, aspiration, and so on. Pulmonary contusion appears as air-space consolidation that can be irregular and patchy, homogeneous, diffuse, or extensive .

STEP4. Assess the parenchyma for evidence of laceration. Lacerations appear as hematomas, vary according to the magnitude of injury, and appear as areas of consolidation .

IV. MEDIASTINUM

STEP1. Assess for air or blood that can displace mediastinal structures, blur the demarcation between tissue planes, or outline them with radiolucency .

STEP2. Assess for radiologic signs associated with cardiac or major vascular injury .

A. Air or blood in the pericardium can result in an enlarged cardiac silhouette. Progressive changes in cardiac size can represent an expanding pneumopericardium or hemopericardium .

B. Aortic rupture can be suggested by:

•A widened mediastinum—most reliable finding

- Fractures of the first and second ribs
- Obliteration of the aortic knob
- Deviation of the trachea to the right
- Presence of a pleural cap
- Elevation and rightward shift of the right mainstem bronchus
- Depression of the left mainstem bronchus • Obliteration of the space between the pulmonary artery and aorta • Deviation of the esophagus (nasogastric [NG] tube) to the right

V. DIAPHRAGM

Note: Diaphragmatic rupture requires a high index of suspicion, based on the mechanism of injury, signs and symptoms, and x-ray findings. Initial chest x-ray examination may not clearly identify a diaphragmatic injury. Sequential films or additional studies may be required .

STEP1. Carefully evaluate the diaphragm for: A. Elevation (may rise to fourth intercostal space with full expiration)

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B. Disruption (stomach, bowel gas, or NG tube above the diaphragm)

C. Poor identification (irregular or obscure) due to overlying fluid or soft-tissue masses

STEP2. X-ray changes suggesting injury include: A. Elevation, irregularity, or obliteration of the diaphragm—segmental or total

B. A mass-like density above the diaphragm that can be due to a fluid-filled bowel, omentum, liver, kidney, spleen, or pancreas (may appear as a “loculated pneumothorax”)

C. Air or contrast-containing stomach or bowel

above the diaphragm D. Contralateral mediastinal

shift

E. Widening of the cardiac silhouette if the peritoneal contents herniate into the pericardial sac

F. Pleural effusion

STEP3. Assess for associated injuries, such as splenic, pancreatic, renal, and liver .

VI. BONY THORAX

STEP1. Assess the clavicle for evidence of :

A. Fracture

B. Associated injury, such as great-vessel injury

STEP2. Assess the scapula for evidence of :

A. Fracture

B. Associated injury, such as airway or great-vessel injury, pulmonary contusion

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STEP3. Assess ribs 1 through 3 for evidence of:

A. Fracture

B. Associated injury, such as pneumothorax, major airway, or great-vessel injury

STEP4. Assess ribs 4 through 9 for evidence of:A. Fracture, especially in two or more contiguous ribs in two places (flail chest)

B. Associated injury, such as pneumothorax, hemothorax, pulmonary contusion

STEP5. Assess ribs 9 through 12 for evidence of :

A. Fracture, especially in two or more places (flail chest)

B. Associated injury, such as pneumothorax, pulmonary contusion, spleen, liver, and/or kidney

STEP6. Assess the sternomanubrial junction and sternal body for evidence of fracture or dislocation. (Sternal fractures can be mis-taken on the anteroposterior [AP] film for a mediastinal hematoma. After the patient is stabilized, a coneddown view, over-penetrated film, lateral view, or computed tomography [CT] may be obtained to better identify suspected sternal fracture.)

STEP7. Assess the sternum for associated injuries, such as myocardial contusion and great-vessel injury (widened mediastinum), although these combinations are relatively infrequent .

VII. SOFT TISSUES

STEP1. Assess for:

A. Displacement or disruption of tissue planes B. Evidence of subcutaneous air

VIII. TUBES AND LINES

STEP1. Assess for placement and positioning of: A .

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Endotracheal tube

B. Chest tubes

C. Central access lines

D. NG tube

E. Other monitoring devices

IX. X-RAY REASSESSMENT

The patient's clinical findings should be correlated with the x-ray findings, and vice versa. After careful, systematic evaluation of the initial chest film, additional x-rays or radiographic and/or imaging studies may be necessary as historical facts and physical findings dictate. Remember, neither the physical examination nor the chest x-ray film should be viewed in isolation. Findings on the physical examination should be used to focus the review of the chest x-ray film, and findings on the chest x-ray film should be used to guide the physical examination and direct the use of ancillary diagnostic procedures. For example, review of the previous x- ray film and repeat chest films may be indicated if significant changes occur in the patient's status. Thoracic CT, thoracic arteriography, or pericardial ultrasonography/echocardiography may be indicated for specificity of diagnosis .

Abdominal and Pelvic Trauma

What priority is abdominal and pelvic trauma in the management of multiply injured patients ?

Evaluation of the abdomen and pelvis is a challenging component of the initial assessment of injured patients. The assessment of circulation during the primary survey includes early evaluation of the possibility of hemorrhage in the abdomen and pelvis in any patient who has sustained blunt trauma. Penetrating torso wounds between the nipple and perineum also must be considered as potential causes of intraperitoneal injury. The mechanism of injury, injury forces, location of injury, and hemodynamic status of the patient determine the priority and best method of abdominal and pelvic assessment. Unrecognized abdominal and pelvic injury continues to be a cause of preventable death after truncal trauma. Rupture of a hollow viscus, bleeding from a solid organ, and bleeding from the bony pelvis may not be easily recognized, and patient assessment is often compromised by alcohol intoxication, use of illicit drugs, injury to the brain or spinal cord, and injury to adjacent structures such as the ribs and spine. Significant blood loss can be present in the abdominal cavity without any dramatic change in appearance or dimensions and without obvious signs of peritoneal irritation. Any patient who has sustained significant blunt torso injury from a direct blow, deceleration, or a penetrating injury must be considered to have an abdominal visceral, vascular, or pelvic injury until proven otherwise .

IMPORTANT NOTES

(1 The three distinct regions of the abdomen are the peritoneal cavity, retroperitoneal space, and pelvic cavity. The pelvic cavity contains components of both the peritoneal cavity and retroperitoneal space .

(2 Early consultation with a surgeon is necessary whenever a patient with possible intraabdominal injuries is brought to the ED. Once the patient's vital functions have been restored, evaluation and management varies depending on the mechanism of injury .

(3 Hemodynamically abnormal patients with multiple blunt injuries should be rapidly assessed for intraabdominal bleeding or contamination from the gastrointestinal tract by performing a FAST or DPL .

(4 Indications for CT scan in hemodynamically normal patients include an unevaluable abdomen, pain, or tenderness. The decision to operate is based on the specific organ(s) involved and the magnitude of injury .

(5 All patients with penetrating wounds in proximity to the abdomen and associated

hypotension, peritonitis, or evisceration require emergent laparotomy. Patients with gunshot wounds that obviously traverse the peritoneal cavity or visceral/vascular area of the retroperitoneum on physical examination or routine x-rays also require laparotomy. Asymptomatic patients with anterior abdominal stab wounds that penetrate the fascia or

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peritoneum on local wound exploration require further evaluation; there are several acceptable alternatives .

(6 Asymptomatic patients with flank or back stab wounds that are not obviously superficial are evaluated by serial physical examinations or contrast-enhanced CT. Exploratory laparotomy is an acceptable option with these patients as well .

(7 Management of blunt and penetrating trauma to the abdomen and pelvis includes :

- Reestablishing vital functions and optimizing oxygenation and tissue perfusion

- Prompt recognition of sources of hemorrhage with efforts at hemorrhage control •

Laparotomy

• Pelvic stabilization

• Angiographic embolization

- Delineating the injury mechanism

- Meticulous initial physical examination, repeated at regular intervals

- Selecting special diagnostic maneuvers as needed, performed with a minimal loss of time

- Maintaining a high index of suspicion related to occult vascular and retroperitoneal injuries

Focused Assessment Sonography in Trauma (FAST)

The FAST exam is a tool for the rapid assessment of a trauma patient .

FAST includes the following views :

- Pericardial view

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- right upper quadrant (RUQ) view to include diaphragm-liver interface and Morrison's pouch

- Left upper quadrant (LUQ) view to include diaphragm-spleen interface and spleen-kidney interface

- Suprapubic view

The only equipment necessary to perform a FAST exam is an ultrasound machine and water-based gel

The FAST exam is performed with a low frequency (3.5 MHz) transducer, which allows the depth of penetration necessary to obtain appropriate images. Either the curved array transducer or the phased array cardiac transducer, with a smaller footprint that fits more easily between the ribs, may be used. Higher frequency transducers may be appropriate for children or extremely thin adults. Even lower frequency transducers may be necessary for the morbidly obese .

STEP1. Start with the heart to ensure that the gain is set appropriately—fluid within the heart should be black. The heart can be imaged using the subxiphoid or the parasternal view .

STEP2. The RUQ view is a sagittal view in the midaxillary line, at approximately the 10th or 11th rib space. Structures to visualize include the diaphragm, liver, and kidney

The entire hepatorenal fossa (Morrison's pouch) should be visualized.

STEP3. The LUQ view is a sagittal view in the midaxillary line, at approximately the 8th or 9th rib space. Structures to visualize include the diaphragm, spleen, and kidney. The entire splenorenal fossa should be visualized. Air artifacts from the stomach and colon, in addition to the smaller acoustic window, make this the most difficult view to obtain; it may be necessary to move the transducer posteriorly .

STEP4. The suprapubic view is a transverse view optimally obtained prior to placement of a Foley catheter Artifacts may be introduced due to posterior enhancement; if areas of fluid disappear with side-toside movement of the transducer, they are likely artifact .

Trauma in pregnancy

Principal causes are similar to those in the nonpregnant: road traffic collisions, falls and assaults. Contrary to popular opinion, the use of seat belts does decrease risk of serious injury in pregnancy. The 'lap' belt should lie over the anterior superior iliac spines .

Anatomical considerations

The following are worthy of consideration :

- As the uterus enlarges it rises out of the pelvis with the bladder — both increased risk of injury .
- The size of the uterus and stretching of the peritoneum make abdominal
- The bony pelvis is less prone to fracture, but retroperitoneal haemorrhage may be torrential due to increased vascularity .
- The pregnant uterus may obstruct the inferior vena cava, causing supine hypotension and increased bleeding from lower limb wounds .
- The diaphragm is higher in pregnancy .
- The pituitary doubles in size and is at risk of infarction in untreated hypovolaemic shock. Physiological considerations

Pregnancy is associated with dramatic changes in physiology :

- Pregnant patients may tolerate up to 35 % loss of blood volume before manifesting classic signs of hypovolaemic shock, largely at the risk of uteroplacental circulation .
- The decreased functional residual capacity and increased O 2 requirement result in hypoxia developing more quickly .
- There is an increased risk of regurgitation of gastric contents .

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- Coagulation may be deranged or rapidly become so. Injuries to the uterus, placenta, and foetus Foetal injury Both blunt and penetrating trauma may damage the foetus. It is, however, more likely to suffer as a result of maternal hypoxia/ hypovolaemia or placental abruption. Placental abruption Deceleration forces in blunt trauma may shear the inelastic placenta from the elastic uterus. Haemorrhage (maternal and foetal) may be significant and result in DIC. This may present with vaginal bleeding (much may be concealed internally), uterine tenderness, or foetal distress .

Uterine rupture This is relatively uncommon. Major rupture causes severe bleeding. The uterus and foetus may be felt separately. Amniotic fluid embolism rare and carries a poor prognosis. Presents with sudden collapse, dyspnoea, decreased BP, fitting, and bleeding (from DIC) .

Approach to the injured pregnant patient

Follow that outlined in Major trauma, with the additional specific points .

History

Determine gestation and any problems in this and previous pregnancies .

Examination

- Involve an obstetrician early: examine vagina for bleeding or rupture of membranes .

- Palpate for fundal height (mark skin), abdominal tenderness, uterine contractions .

- Listen for foetal heart sounds and rate using a foetal stethoscope (Pinard) or Doppler probe .

- Remember that head injury may mimic eclampsia and vice-versa .

Investigation

- Check BMG, coagulation screen, Rhesus/antibody status, and Kleihauer test .

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- Consider CVP monitoring (remembering the CVP is lower in pregnancy) .
- Monitor foetal heart (cardiotocograph) — the rate should be 120–160/min .
- USS investigates foetal viability, placental injury, gestational age, and free peritoneal fluid .
- Do not withold essential X-rays, but do consider early USS to look for free intra-abdominal fluid and foetal viability. Seek senior advice. Remember that the greatest risks from X-rays to the foetus are in early pregnancy. In later pregnancy, risks to the foetus may be outweighed by failure to identify injuries by not obtaining X-rays .
- DPL has been largely superceded by USS (FAST scan) — but if indicated, use a supra-umbilical open approach .

Treatment

- Give O 2 and summon senior obstetric, ICU, and surgical help early .
- If chest drains are required insert 1–2 intercostal spaces higher than usual .
- Decompress the inferior vena cava by manually displacing the uterus to the left or by using a 15 ° right lateral (Cardiff) wedge, or if neck injury has been excluded, by nursing in left lateral position .
- Treat fluid losses with aggressive IV fluid replacement .
- An NG tube decreases risk of regurgitation and aspiration .
- Remember tetanus prophylaxis .
- Consider anti-D immunoglobulin if the patient is Rh –ve .
- Even if there is no overt maternal injury refer for foetal monitoring for 4hr .
- Abdominal tenderness, hypovolaemia or foetal distress may require urgent laparotomy .

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• If the patient has a cardiac arrest, perform emergency Caesarian section if the patient is > 24wks pregnant and 5mins has elapsed without output .

Cardiac arrest in pregnancy

Rate Estimated in late pregnancy at 7 1 in 30,000 .

Causes stroke, PE, uteroplacental haemorrhage, amniotic fluid embolism, eclamptic fits and hemorrhage, anesthetic problems, and drug reactions, underlying heart disease. Ischemic heart disease is rarely implicated: the underlying rhythm is more commonly pulseless electrical activity than ventricular fibrillation. Unfortunately, this is reflected in the poor prognosis .

Remember the following physiological factors

• The airway is difficult to control (large breasts, full dentition, neck oedema and obesity). Ventilation may be difficult and intubation technically challenging .

• Increased aspiration risk (Decreased lower oesophageal pressure, Increased intragastric pressure) therefore securing definitive airway early is essential .

• Increased O2 requirements in pregnancy, yet harder to ventilate (decreased chest compliance) .

• Chest compression is awkward (flared ribs, raised diaphragm, obesity, breast hypertrophy) .

•Gravid uterus compresses inferior vena cava diminishing venous return .

•There are 2 patients: mother and foetus. Approach to resuscitation Follow Resuscitation guidelines for managing adult cardiac arrest . The special situation of pregnancy means some additional points apply. If there is advanced warning, think ahead. In addition to the usual team needed for airway control, IV access and chest compressions, organize :

• An anaesthetist for the airway, an obstetrician to perform a Caesarian section and a paediatrician to resuscitate the baby .

- The neonatal resuscitation equipment (overhead warmer, suction, airway equipment and oxygen) .

- A member of staff to apply cricoid pressure at the beginning of resuscitation and until the airway is secured .

- A member of staff to manually displace the uterus to the left until a left lateral tilt has been established with a Cardiff wedge .

It may take time for help to arrive and there may be no warning prior to patient arrival. In the meantime, proceed as follows :

- Call the obstetrician, pediatrician, and ED consultant immediately .

- Apply cricoid pressure (Sellick maneuver) at the beginning of resuscitation and until the airway is secured .

- Aim to secure the airway with a cuffed tracheal tube at an early stage .

- Decompress the inferior vena cava by either manual displacement of the uterus to the left, or the use of sandbags or a special 15 ° right lateral ('Cardiff ') wedge .

- Consider and treat the cause (eg remember that hypovolaemic shock from unseen haemorrhage may respond to a large IV fl uid challenge) .

- If there is no return of spontaneous circulation within 5min perform a Caesarian section (providing the patient is > 24 weeks pregnant) .

Pediatric trauma Anatomic and physiologic differences in children

There are significant anatomical and physiological differences between children and adults. For example, the internal organs are closer in proximity to each other in children than in adults; this places children at higher risk of traumatic injury. Children present a unique challenge in trauma care because they are so different from adults - anatomically, developmentally, physiologically and emotionally. An important part of managing trauma in children is weight estimation. A number of methods to estimate weight exist, The Broselow tape is the most accurate for weight estimation in children ≤25 kg, while the Theron formula performs better with patients weighing >40 kg. Due to basic geometry, a child's weight to surface area ratio is lower than an adult's, children more readily lose their body heat through radiation and have a higher risk of becoming hypothermic. Smaller body size in children often makes them more prone to poly traumatic injury .

Paediatric basic life support

Evaluate responsiveness

Check the child's responsiveness — gently stimulate and ask loudly 'are you alright?' Do not shake if you suspect cervical spine injury. If the child does not respond, shout for help ± get someone to go for assistance .

Open airway

Open the airway by head tilt and chin lift. Desirable degrees of tilt are neutral <1 year and 'sniffing the morning air' > 1 year. Do not press on the soft tissues under the chin as this may block the airway. If it is still difficult to open the airway, try a jaw thrust. If there is any suspicion that there may have been a neck injury, instruct a second rescuer to manually immobilize it, and use either chin lift or jaw thrust alone. If this is unsuccessful, add the smallest amount of head tilt needed to open the airway .

Check breathing

Whilst keeping the airway open, look listen and feel for breathing for 10sec. If the child is not breathing or is making infrequent irregular breaths, carefully remove any obvious obstruction, give 5 initial rescue breaths (with the rescuer taking a breath between each rescue breath) .

Rescue breaths

For children >1 year , whilst maintaining head tilt and chin lift, give breaths mouth to mouth, pinching off the nose. Blow steadily for 1–1.5sec watching for the chest to rise. Take your mouth away, watch the chest fall and repeat this sequence 5 times .

For the infant (<1 year) ensure the neutral position of the head and apply chin lift. Give mouth to mouth and nose breaths, ensuring a good seal. Blow steadily for 1–1.5sec watching for chest rise. Take your mouth away, watch the chest fall and repeat this sequence 5 times. Difficulty achieving an effective breath suggests airway obstruction. Open the mouth and remove visible obstruction (no blind fi nger sweep), ensure appropriate head tilt/chin lift and neck position. Try a jaw thrust if head tilt/chin lift has not worked. Try up to 5 times to give effective breaths. If still unsuccessful, move to chest compression .

Check pulse

Over the next 10sec check for signs of life: any movement, coughing or normal breathing and check for a pulse (use carotid for > 1yr and brachial for those <1 year). If there are no signs of life and/or no pulse or pulse <60/min with poor perfusion or you are unsure: start chest compression .

Chest compression

For infants , perform chest compressions (100–120/ min) by placing both thumbs flat side by side on the lower third of the sternum with the tips pointing towards the infant's head. Encircle the rib cage with tips of fingers supporting the infant's back. Press down with thumbs at least one third of the depth of the chest. In children > 1 year using the heel of one hand, compress the lower half of the sternum by at least one-third of the depth of the chest at a rate of 100–120/min. Use two hands if necessary to achieve the depth required .

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Paediatric advanced life support notes

Airway

O2 Give high fl ow oxygen (use a well-fi tting mask with a reservoir). Suction Use a rigid suction catheter to aspirate pharyngeal contents. Oropharyngeal airway An airway may help when ventilating with a bag valve mask device while personnel and equipment are prepared for tracheal intubation. Size the airway by matching its length to the distance between the

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central incisor teeth and the angle of the mandible. Use a tongue depressor or laryngoscope to displace the large tongue and insert the airway the 'right way up' in order to avoid trauma to the palate. Bag-valve-mask ventilation Attach high fl ow O 2 to a self-infl ating bag-valve-mask device. Use a 500mL (up to age 1 year) or 1600mL bag (> 1 year). Tracheal intubation This method of securing the airway requires experience and practice. Call for senior help. Always use a capnograph. Follow the same technique as that described for adults , except :

- Use a straight-bladed laryngoscope in infants (<1

year .(

- Use correct size of endotracheal (ET) tubes in children, either cuffed or uncuffed .
- Correct size of ET tube: internal diameter (mm)

=(age in years/4) + 4

If intubation is not achieved within 30sec, ventilate with high fl ow O2 via bag-valvemask. Consider a rescue airway, such as a laryngeal mask. Equipment sizes, drugs, and doses Become familiar with and use the Broselow tape. Venous access First attempt to secure peripheral venous access. If this is not

obtained within 90sec, attempt intra-osseous access .

High dose adrenaline is not recommended and may be harmful. Consider it only in exceptional circumstances. Atropine 20mcg/ kg (minimum dose 100mcg, max 600 mcg) may be used for patients with bradycardia related to increased vagal tone. There is no evidence of effi cacy for atropine. Magnesium is indicated for polymorphic VT or documented hypomagnesaemia — give 25–50mg/kg over several min to a max of 2g. Calcium chloride (0.2mL/kg of 10 % solution) is given for hypocalcaemia, hyperkalaemia and clinically severe overdose of calcium channel blocking drugs. Do not give in the same IV/IO line as bicarbonate. Sodium bicarbonate is not recommended routinely, but consider it in prolonged arrest, hyperkalaemia, and arrhythmias associated with tricyclic antidepressant overdose. The dose is 1–

2mL/kg of 8.4 % solution IV/IO **.**

Ensure adequate fl ushing after giving it. Avoid mixing with other agents (it inactivates adrenaline and precipitates out calcium) **.**

Glucose Treat hypoglycaemia with IV glucose (0.5g/ kg) **.**

IV fluids Give a 20mL/kg IV normal saline bolus where cardiac arrest is secondary to hypovolaemia or sepsis **.**

Geriatric Trauma

How do I apply ATLS airway principles to the treatment of elderly patients **?**

Airway

The “A” of the ABCDE mnemonic of the primary survey is the same in the elderly as for any other injured patient. Establishing and maintaining a patent airway to provide adequate oxygenation is the first objective. Supplemental oxygen should be administered as soon as possible, even in the presence of chronic pulmonary disease. Because of the elderly patient’s limited cardiopulmonary reserve, early intubation should be considered for elderly trauma patients presenting in shock and those with chest wall injury or alteration in the level of consciousness. Features that affect management of the airway in the elderly include dentition, nasopharyngeal fragility, macroglossia (enlargement of tongue), microstomia small oral aperture), and cervical arthritis. Less than full dentition can interfere with achieving a proper seal on a face mask. Consequently, whereas broken dentures should be removed, intact well-fitted dentures are often best left in place until after airway control is achieved. Care must be taken when placing nasogastric and nasotracheal tubes because of nasopharyngeal friability, especially around the turbinates. Profuse bleeding can ensue. The oral cavity may be compromised by either macroglossia, associated with amyloidosis or acromegaly, or microstomia, such as the constricted, birdlike mouth of progressive systemic sclerosis.

Arthritis can affect the temporomandibular joints and the cervical spine, making endotracheal intubation more difficult and increasing the risk of spinal cord injury with manipulation of the osteoarthritic spine. Degenerative changes and calcification in laryngeal cartilage place he elderly population at increased risk of injury from minor blows to the neck. The principles of airway management remain the same, with endotracheal intubation as the preferred method for definitive airway control. If acute airway obstruction exists or the vocal cords cannot be visualzed, surgical cricothyroidotomy should be considered as an option .

Breathing and Ventilation

Many of the changes that occur in the airway and lungs of elderly patients are difficult to ascribe purely to the process of aging and may be the result of chronic exposure to toxic agents such as tobacco smoke and other environmental toxins throughout life. The loss of respiratory reserve due to the effects of aging and chronic diseases makes careful monitoring of the geriatric paient's respiratory system imperative. Administration of supplemental oxygen is mandatory, although caution should be exercised with its use because some elderly patients rely on hypoxic drive to maintain ventilation. Oxygen administration can result in loss of this hypoxic drive, causing CO_2 retention and respiratory acidosis. In an acute trauma situation, however, hypoxemia should be corrected by administering oxygen while accepting the risk of hypercarbia .

In these situations, if respiratory failure is imminent, intubation and mechanical ventilation is necessary .

Chest injuries occur in patients of all ages with similar frequency, but the mortality rate for elderly patients is higher. Chest wall injuries with rib fractures or pulmonary contusions are common and not well tolerated. Patients older than 65 years of age with multiple rib fractures have increased rates of morbidity and mortality. Simple pneumothorax and hemothorax also are poorly tolerated, and geriatric patients with these injuries should be considered for intensive care unit (ICU) observation, as respiratory failure can be gradual or precipitous. Respiratory failure may result from the increased work of breathing combined with a decreased energy reserve. Adequate pain control and vigorous pulmonary toilet are essential for a satisfactory outcome. The balance between adequate pain control and narcotic side effects can be difficult in the elderly, and the use of epidural catheters may improve outcome in these patients. Pulmonary complications—such as atelectasis, pneumonia, and pulmonary edema— occur in the elderly with great frequency. Marginal cardiopulmonary reserve coupled with overzealous crystalloid infusion increases the potential for pulmonary edema and worsening of pulmonary contusions. Admission to the hospital usually is necessary, even with apparently minor injuries .

Circulation

CHANGES WITH AGING

As the heart ages, there is progressive loss of function. By the age of 65 years, nearly 50% of the population has coronary artery stenosis. The cardiac index falls off linearly with age, and the maximal heart rate also begins to decrease after 40 years of age. The formula for maximal heart rate is 220 minus the individual's age in years. Although the resting heart rate varies little, the maximum tachycardic response decreases with age .

The cause of this diminution of function is multifaceted. With aging, total blood volume decreases and circulation time increases. There is increasing myocardial stiffness, slowed electrophysiologic conduction, and loss of myocardial cell mass. The response to endogenous catecholamine release with stress is also different, which is likely related to a reduction in responsiveness of the cellular membrane receptors .

These changes predispose the aged heart to reentry dysrhythmias. Diastolic dysfunction makes the heart more dependent on atrial filling to increase cardiac output .

The kidney loses mass after the age of 50 years. This loss involves entire nephron units and is accompanied by a gradual decline in the glomerular filtration rate and renal blood flow. Levels of serum creatinine usually remain within normal limits, presumably because of a reduction in creatinine production by muscles. The aged kidney is less able to resorb sodium and excrete potassium or hydrogen ions. The maximum concentrating ability of the kidney of an individual between 80 and 90 years old is only 850 mOsm/kg, which is 70% of the ability

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of a 30-year-old individual's kidney. A decrease in the production of, and responsiveness of the kidney to, renin and angiotensin occurs with age. As a result, creatinine clearance in the elderly is reduced, and the aged kidney is more susceptible to injury from hypovolemia, medications, and other nephrotoxins .

EVALUATION AND MANAGEMENT

A common pitfall in the evaluation of geriatric trauma patients is the mistaken impression that "normal" blood pressure and heart rate indicate normovolemia. Early monitoring of the cardiovascular system must be instituted. Blood pressure generally increases with age. Thus, a systolic blood pressure of 120 mm Hg can represent hypotension in an elderly patient whose preinjury systolic blood pressure was 170 mm Hg. Early stages of shock can be masked by the absence of early tachycardia. The onset of hypotension also may be delayed. In addition, the chronic high afterload state induced by elevated peripheral vascular resistance can limit cardiac output and ultimately cerebral, renal, coronary, and peripheral perfusion. Geriatric patients have a limited physiologic reserve and may have difficulty generating an adequate response to injury. Severely injured elderly patients with hypotension and metabolic acidosis frequently die, especially if they have sustained brain injury. Fluid requirements—once corrected for the lesser, lean body mass—are similar to those of younger patients. Elderly patients with hypertension who are on chronic diuretic therapy may have a chronically contracted vascular volume and a serum potassium deficit; therefore careful monitoring of the administration of crystalloid solutions is important to prevent electrolyte disorders. Geriatric patients should be resuscitated in a manner similar to younger patients. However, they may be more sensitive to volume overload due to a higher incidence of cardiac disease .

The optimal hemoglobin level for an injured elderly patient is a point of controversy. Many authors suggest that, in people over the age of 65 years, hemoglobin concentrations of over 10 g/dL should be maintained to maximize oxygen-carrying capacity and delivery. There is little support in the literature for this position. Indiscriminate blood transfusion should be avoided because of the attendant risk of bloodborne infections, impairment of the immune host response and resulting complications, and the effect of a high hematocrit on blood viscosity, which can adversely affect myocardial function. The indication for blood transfusion should be the same as in younger patients. Early recognition and correction of coagulation defects is crucial, including reversal of drug-induced anticoagulation. Because elderly patients may have significant limitation in cardiac reserve, a rapid and complete assessment for all sources of blood loss is necessary. The focused assessment sonography in trauma (FAST) examination is a rapid means of determining the presence of abnormal intraabdominal and pericardial fluid collections. Nonoperative management of blunt abdominal solid viscus injuries in elderly patients must be done by an experienced surgeon. The risk of nonoperative management may be greater than the risk of an early operation. The retroperitoneum is an often-unrecognized source of blood loss. Exsanguinating retroperitoneal hemorrhage may develop in elderly patients after relatively minor pelvic or hip fractures. A patient with pelvic, hip, or lumbar vertebral fractures who demon-strates continuing blood loss without a specific source should be considered for prompt angiography and control with transcatheter embolization. The process of aging and superimposed disease states make close monitoring mandatory, especially in cases of injury with acute intravascular volume loss and shock. The mortality rate in patients who on initial assessment appear to be uninjured or to have only minor injuries can be significant (up to 44%). Approximately 33% of elderly patients do not die from direct consequences of their injury, but from “inexplicable” sequential organ failure, which may reflect early, unsuspected states of hypo-perfusion. Failure to recognize inadequate oxygen delivery creates an oxygen deficit from which the geriatric patient may not be able to recover. Because of associated coronary artery dis-ease, hypotension and hypovolemia frequently results in impaired cardiac performance from myocardial ischemia. Thus, hypovolemic and cardiogenic shock may coexist. Early invasive monitoring with a pulmonary artery catheter may be beneficial. Hemodynamic resuscitation may require the use of inotropes after volume restoration in these patients. Prompt transfer to a trauma center may be lifesaving .