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UNIT TERMINAL OBJECTIVE

4-1 At the completion of this unit, the EMT-Intermediate student will be able to apply the principles of kinematics to enhance the patient assessment and predict the likelihood of injuries based on the patient's mechanism of injury.

COGNITIVE OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-1.1 List and describe the components of a comprehensive trauma system. (C-1)
4-1.2 Describe the role of and differences between levels of trauma centers. (C-3)
4-1.3 Describe the criteria for transport to a trauma center. (C-1)
4-1.4 Describe the criteria and procedure for air medical transport. (C-1)
4-1.5 Define energy and force as they relate to trauma. (C-1)
4-1.6 Define laws of motion and energy and understand the role that increased speed has on injuries. (C-1)
4-1.7 Describe each type of impact and its effect on unrestrained victims (e.g., frontal impacts, lateral impacts, rear impacts, rotational impacts, rollover). (C-1)
4-1.8 Describe the pathophysiology of the head, spine, thorax, and abdomen that results from the above forces. (C-1)
4-1.9 Describe the organ collisions that occur in blunt trauma and vehicular collisions. (C-2)
4-1.10 Describe the effects that restraint systems (including seat belts, airbags, and child safety seats) have on the injury patterns found in motor vehicle crashes. (C-2)
4-1.11 List specific injuries and their causes as related to interior and exterior vehicle damage. (C-1)
4-1.12 Describe the kinematics of penetrating injuries. (C-1)
4-1.13 List the motion and energy considerations of mechanisms other than motor vehicle crashes. (C-1)
4-1.14 Define the role of kinematics as an additional tool for patient assessment. (C-1)

AFFECTIVE OBJECTIVES

None identified for this unit.

PSYCHOMOTOR OBJECTIVES

None identified for this unit.

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DECLARATIVE

I. Introduction
- A. Epidemiology
  1. A leading cause of death for people 1- 44 years of age
  2. 140,000 unexpected deaths per year
  3. Automobile related deaths are greater than 40,000
  4. Penetrating trauma may exceed blunt in near future
  5. Pre-incident, incident, post-incident phase
- B. History
  1. Complete and accurate history of incident will identify possibility for 95% of the injuries present
  2. Incident site
     - a. Indications of severity of injury
  3. Major factors of tissue injury
  4. Amount of energy exchanged
  5. Anatomical structures potentially involved

II. Trauma systems
- A. Components
  1. Injury prevention
  2. Prehospital care
     - a. Treatment
     - b. Transportation
     - c. Trauma triage guidelines
  3. Emergency Department care
  4. Interfacility transportation as necessary
  5. Definitive care
  6. Trauma critical care
  7. Rehabilitation
  8. Data collection/ trauma registry
- B. Trauma centers
  1. Levels
  2. Qualifications
     - a. Essential
     - b. Desired
  3. Role
- C. Transport considerations
  1. Level of receiving facility
  2. Mode of transport
     - a. Ground
       - (1) If appropriate facility can be reached within reasonable time
       - (2) To a more accessible landing zone for air medical transport
     - b. Air medical
       - (1) Indications
       - (2) Contraindications
       - (3) Procedure

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III. Energy
- A. Physical laws
  - 1. Newton's first law of motion
    - a. A body at rest or a body in motion will remain in that state until acted upon by an outside force
    - b. In a vehicle traveling at 50 mph, the occupant is also traveling at 50 mph
    - c. When the car stops, the occupant continues to travel at 50 mph until some force acts on the occupant
  - 2. Conservation of energy
    - a. Energy cannot be created nor destroyed
    - b. It can be changed in form
    - c. Energy can be absorbed producing deformation of substance
  - 3. Kinetic energy (KE)
    - a. KE = ½ the mass of the object multiplied by the velocity (speed) of the object squared (Mass/ 2 x V^2)
    - b. Velocity (V) influences KE more than mass
    - c. Greater speed means more energy generated
  - 4. Force
    - a. Force = mass x acceleration
    - b. Force = mass x deceleration
    - c. Mass x acceleration = force = mass x deceleration
    - d. To accelerate a bullet from the muzzle of a weapon requires the force from the explosion of the gunpowder; once the bullet is set in motion by this explosion, an equal amount of tissue destruction must occur inside the body to stop it as was used to start it
  - 5. Energy law summary
    - a. Motion is created by force (energy exchange)
    - b. Force (energy exchange) must stop this motion
    - c. If such energy exchange occurs inside the body tissue damage is produced
- B. Energy exchange
  - 1. Cavitation
    - a. Energy exchange produces particle motion
    - b. Temporary cavity
      - (1) Short lived
      - (2) Produced by stretching
      - (3) Dependent on the elasticity of the object involved
      - (4) Produces particle compression at the limits of the cavity
    - c. Permanent cavity
      - (1) Visible when the energy exchange has been completed
      - (2) Produced by compression and destruction
  - 2. Interaction between two bodies
    - a. At least one must be in motion
    - b. Both can be in motion
  - 3. Dependent on number of particles involved in the interface of the interaction
    - a. Density of the interacting bodies
      - (1) Air density (few particles)
        - (a) Lung

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(b) Intestinal tract
(2) Water density (more particles)
(a) Vascular system
(b) Liver
(c) Spleen
(d) Muscle
(3) Solid density (thick particles)
(a) Bone
(b) Asphalt
(c) Steel
b. Area on interaction
(1) Shape of object
(2) Position of object
(3) Fragmentation of object

C. Types of trauma based on ingress
1. Blunt
a. Tissue not penetrated
b. Cavitation away from site of impact
c. Cavitation in direction of impact
2. Penetrating
a. Tissue penetrated
b. Cavitation at 90° to bullet pathway
(1) Tissue in line to penetration is crushed

IV. Blunt trauma
A. Vehicle collisions
1. Frontal
2. Lateral
3. Rear
4. Rotational
5. Roll over
B. Occupant collisions
1. Frontal impacts
a. Down and under
(1) Feet impact floor pan
(2) Knees impact dash
(a) Tibia impact
i) Knee dislocation
ii) Popliteal artery disruption
iii) Knee support disruption
(b) Femur impact
i) Femur fracture
ii) Acetabular posterior fracture dislocation
(3) Torso rotates
(a) Steering column
(b) Dash
(c) Windshield

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b. Up and over
(1) Head impact
(a) Windshield
(b) Roof
(c) Mirror
(2) Chest impact
(a) Steering column
(b) Dash
(3) Abdominal impact
(a) Steering column
(b) Dash

2. Lateral impacts
a. Vehicle moves into and impacts body
(1) Chest
(2) Pelvis
(3) Body moves laterally
(a) Neck
i) Rotates
ii) Lateral flexion
iii) Combination

3. Rear impacts
a. Vehicle seat pushes body
(1) All body parts in contact with seat move
(2) Body parts not in contact dragged along with torso
b. Secondary impact if vehicle hits another object
(1) Similar to frontal impact

4. Rotational impacts
a. Part of vehicle stops; the rest remains in motion
b. Combination of frontal and lateral impacts

5. Roll overs
a. Difficult to predict the body impacts

C. Organ collisions
1. Two types of injury from blunt trauma
a. Compression
b. Change in velocity
(1) Acceleration
(a) Shear
(b) Avulsion
(2) Deceleration
(a) Shear
(b) Avulsion

2. Organ collisions with different vehicular collisions
a. Frontal impacts
(1) Head
(a) Compression
i) Skull fractures
ii) Cerebral contusion

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(b) Deceleration
- i) Opposite end separation
- ii) Hemorrhage
- iii) Brain stem stretch

(2) Neck
- (a) Compression
  - i) Vertebral body
    - a) Compression fracture
    - b) Hyperextension injury
      - Posterior element compression
      - Anterior body separation
    - c) Hyperflexion injury
      - Anterior body compression
      - Posterior element separation
- (b) Shear
  - i) Not significant

(3) Thorax
- (a) Chest wall
  - i) Compression
    - a) Fracture rib(s) - producing single rib fractures, flail chest, and/ or pneumothorax
  - ii) Shear
    - a) Fracture thoracic spine
- (b) Heart
  - i) Compression
    - a) Contusion
    - b) Rupture
  - ii) Shear
    - a) Not significant
- (c) Aorta
  - i) Compression
    - a) Not significant
  - ii) Shear
    - a) Junction arch and descending portions
    - b) Aortic origin at the aortic valve
    - c) At the diaphragm
- (d) Lung
  - i) Compression
    - a) Pneumothorax
    - b) Rib fracture and penetration
  - ii) Shear
    - a) Not significant

(4) Abdomen
- (a) Abdominal cavity
  - i) Diaphragm
    - a) Compression tears
    - b) Shear - not significant

ii) Abdominal wall
a) Compression tears
b) Shear - not significant
(b) Liver
i) Compression
a) Burst type injuries
ii) Shear
a) Tears from Ligamentum Teres
b) Avulsion of liver from inferior vena cava at the hepatic veins
(c) Spleen
i) Compression
a) Burst
ii) Shear
a) Avulsion of pedicle
(d) Gastrointestines
i) Compression
a) Rupture
ii) Shear
a) Avulsion of mesenteric vessels from aorta or vena cava
b) Tears along mesenteric vessels
c) Avulsion of vessels from intestine
(e) Gall bladder
i) Compression
a) Rupture
ii) Shear
a) Avulsion from liver
b) Avulsion of cystic duct

b. Lateral impacts
(1) Head
(a) Compression
i) Similar to frontal except lateral and compression is on the side of the impact to the vehicle
(b) Shear
i) Shear of brain and vessels opposite side of the impact
(2) Cervical spine
(a) Compression
i) Minimal unless head hits the top of the passenger compartment or the support for the windows
(b) Shear
i) Two fold mechanism
ii) Rotation
a) Center of gravity of the head is anterior to the pivot point of the head and the spine at the odontoid process; as lateral impact occurs the torso and then the C-spine are pushed under the

head; the head rotates in relative position to the body, toward the impact
b) The center of gravity of the head is also cephalad to the point of support at the cervical spine; as the lateral forces push the torso away from the point of impact the motion of the head produces lateral flexion of the head
c) The combination of these two forces is lateral flexion of the neck opening the facets opposite the side of impact and rotation of the vertebral bodies in relation to each other; the result is jumped facets and if the force is great enough significant torsion of the spinal cord

(3) Thorax
(a) Compression
i) Impact of the door into the thorax
a) Lateral ribs - Fractures and flail chest
b) Lung - Pneumothorax
c) Spleen or liver - Lacerations and hemorrhage
(b) Shear
i) Lateral motion of the thoracic spine as the torso is pushed away from the impact
ii) Thoracic aorta moves with the spine
iii) Arch and heart do not move until traction on the arch
iv) Shear forces tear the aorta at the junction of the movable arch and the descending aorta that is attached to the thoracic spine

(4) Abdomen
(a) Compression
i) Liver or spleen depending of the side of the impact
ii) Kidneys depending of the side of the impact
iii) Diaphragm similar to frontal impact
(b) Shear
i) Abdominal aorta moves with the lumbar spine
a) Shear of the renal vessels
b) Shear of the splenic vessels

(5) Pelvis
(a) Compression
i) Impact on the femur
a) Femoral head driven through the acetabulum
b) Fracture of the ileum
c) Sacro-iliac joint fracture
d) Fracture of the other bones of the pelvis
(b) Shear

(6) Extremities
(a) Compression
i) Clavicle compressed between the humerus and the

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sternum
ii) Lateral compression of the humerus
(b) Shear

c. Rear impacts
(1) Physics
(a) Energy (velocity) imparted to the rear
i) Moves all attached parts of the vehicle
ii) Occupants in direct contact with vehicle move also
iii) Parts of the occupants not in direct contact do not move until pulled along
a) Newton's first law of motion
b) Unrestricted body parts will be separated or at least stretched by this differential velocity
iv) The force of the energy exchange depends on the differential energy of the two vehicles and the exchange of energy between the two
(2) Head
(a) Compression
i) Into structures behind the seat
ii) Energy of compression depends on the force of the change of energy between the vehicle and the impact into the head
(b) Shear
i) Separation of the brain and skull in front
(3) Neck
(a) Compression
i) Unrestrained occupant into the top of the passenger compartment or into the rear seat
(b) Shear
i) Head restraint not in the correct position to move the head forward with the motion of the vehicle
ii) Neck hyperextended over the malpositioned head restraint; usually only ligamentous and tendon stretch and no fractures
(4) Torso
(a) As most of the torso is in contact with the seat and springs of the seat, only minimal differential energy is exchanged onto the body parts
(b) Unless there is rebound when the vehicle hits another vehicle there is little injury to the torso
(5) Extremities
(a) The extremities move with the torso and receive very little differential exchange

d. Rotational impacts
(1) In the pure rotational impact, one part of the vehicle hits an immovable object, while the rest continues in motion (Newton's first law of motion)
(2) As the one part stops and the rest of the vehicle continues to move the

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vehicle moves around the fixed point
(3) The motion to the occupant is a combination of two motions
(a) Frontal and lateral
(b) Rear and lateral
(4) The injuries are combinations of the two motions with emphasis on the initial impact motion
e. Roll overs
(1) Pattern of injuries is very difficult as the unrestrained occupant can hit all parts of the vehicle
f. Ejections
(1) If the force is such and the occupant is unrestrained, then ejection is possible
(2) The major injuries occur inside the vehicle and on the way out rather than afterward on impact with the ground or some other object
(3) Since the major part of the injuries occur on the way out, the EMT-Intermediate can better predict the injuries by focusing on the first part of the collision rather than the latter portion

D. Restraints
1. Restraints are systems for absorbing the energy of the impact before the occupant hits something hard and limiting the distance the body has to travel, thus helping to decrease velocity (speed)
2. Belt restraint
a. Contrary to popular belief the belt restraint works in lateral impacts as well as in frontal impacts (they are not quite as effective in lateral impacts because the hard parts of the passenger compartment are closer on the sides than in the front, therefore the belt systems do not have as much distance to be effective)
b. The benefit of the belt restraint can be seen on any Sunday at the automobile race track
c. Lap belts
(1) Attached to the floor behind the occupant at a 45° angle to the floor
(2) Benefits
(a) Hold the lower torso closely to the seat and away from the dash or steering column
(b) Prevent
i) Forward motion of the lower torso in frontal collisions
ii) Moves the torso with the vehicle and away from the impact in lateral impact collisions
iii) Multiple impacts in rollover collisions
iv) Ejection
v) Forward motion of the pelvis by supporting the anterior part of the pelvis
(c) No impingement on the soft intra-abdominal contents
(3) Limitations
(a) Upper torso is not supported
(b) If positioned above the anterior iliac spine, the belt stops the forward motion of the body against the lumbar spine with the intra-abdominal organs crushed between the belt and the spine

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(c) High position can fracture or dislocate the lumbar spine
(d) Increased intra-abdominal pressure can rupture the diaphragm

d. Shoulder restraints
(1) Benefits
(a) Prevent
i) Forward motion of the upper torso in frontal impact collisions
ii) Hyperflexion of the upper torso around the lap belts preventing spinal injuries
(b) Moves the upper torso with the vehicle in lateral impact collisions
(2) Limitations
(a) If worn without the lap belt, neck injuries can occur
(b) Lessened benefit if the seat is very close to the dash or steering column

e. Air bags
(1) Benefits
(a) Supplemental protection
(b) Frontal impact protection only with frontal bags
(2) Limitations
(a) Minimally effective alone
(b) Can produce significant injuries if too close to the occupant
i) Bag expansion
ii) Protective cover into the face or chest
(c) Projects standing children into the seat producing cervical spine fractures
(d) Facial and forearm abrasions
(e) Deployed air bag may hide structural damage to the vehicle that may aid in assessment

f. Child safety seats
(1) Age and types
(2) Proper use
(3) Injury patterns
(4) Proper use with airbags

E. Motorcycle collisions
1. Frontal impact
a. Bike stops
b. Occupant continues forward
(1) Impacts parts of the bike
(a) Face
(b) Chest
(c) Abdomen
(d) Upper legs (femur)
(2) Ejected over the bike
(a) Into vehicle
(b) Onto ground
(c) Into objects in the path

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(3) Injuries
(a) Cervical spine fractures
(b) Torso
i) Compression injuries
a) Solid organ crush
b) Hollow organ rupture (e.g., lungs)
ii) Deceleration (shear injuries)
a) Aorta
b) Pedicled organs
(c) Compound tibia/ fibula fractures

2. Angular impact
a. Collapse of bike onto vehicle
(1) Legs trapped between bike and vehicle
(2) Open fracture and/ or dislocation
b. Lateral motion of torso into vehicle
c. Injuries
(1) Cervical spine
(a) Similar to lateral impact in vehicle
(2) Torso
(a) Compression
i) Lateral chest
ii) Lateral abdomen
(b) Deceleration
i) Aorta
ii) Pedicled organs

3. Protection
a. Head
(1) Helmet
(a) 300% increase in brain injury without helmet
(b) Spine
i) Small protection
ii) No increase
b. Skin
(1) Leathers
(2) Very protective during slides on asphalt
c. Ankles and feet
(1) Strong boots

F. Pedestrian versus motor vehicle
1. Injury pattern depends on
a. Height
b. Body area facing impact
2. Three phases
a. Vehicle-pedestrian impact
(1) Legs
(a) Feet stay in place on asphalt
(b) Legs pushed by bumper
(c) Torso moves after the legs

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(2) Torso
(a) Pelvis
(b) Crushed by front of vehicle
(c) Lateral or posterior angulation
i) Lumbar fractures
ii) Thoracic fractures

b. Pedestrian rotates onto hood
(1) Impact onto torso
(a) Compression injuries
(b) Acceleration (shear) injures
(2) Cervical spine
(a) Severe flexion or lateral flexion
(b) Torsion
(c) Fractures and dislocations

c. Pedestrian rolls off onto the ground (asphalt)
(1) Beside vehicle
(a) Impact into the ground as fall from height
(2) In front of vehicle
(a) Run over by the vehicle
(b) Dragged by the vehicle

G. Falls

1. Factors
a. Height of fall
b. Surface of the impact
c. Objects struck during the fall
d. Body part of first impact

2. Feet first
a. Impact onto calcaneus
b. Continued motion of the torso
(1) Ankles, knees, femur
(2) Acetabulum, pelvis
(3) Spine
(a) Break the “S”
(b) Arch
i) Convexity stretched and opened
ii) Concavity compressed
(4) Torso
(a) Deceleration (shear)
i) Liver
ii) Kidney
iii) Spleen
iv) Aorta

3. Head first
a. Compression
(1) Skull fracture
(2) Brain
(a) Contusion

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(b) Laceration
(3) Spine
b. Deceleration (shear)
(1) Aorta
(2) Kidney
(3) Other
4. Parallel to ground
a. Compression
(1) All parts of the impact

V. Penetrating injuries
A. Energy exchange
1. Number of particles involved
a. Density of tissue
(1) Gas
(a) Lung
(b) Gastrointestinal tract
(2) Liquid
(a) Blood vessels
(b) Muscle
(c) Solid organs
i) Spleen
ii) Liver
iii) Kidney
iv) Other
(3) Solid
(a) Bone
b. Area of interaction
(1) Deformation of bullet
(2) Tumble
(3) Fragmentation
2. Cavitation
a. Permanent
(1) Visible when examined
(2) Crushed tissue
b. Temporary
(1) Compression wave of tissue particles
(2) Away from the pathway of the bullet
(3) Lasts only a few microseconds
(4) Tissue damage produced by stretch
3. Available energy
a. $KE = M/ 2 \times V^2$
(1) Velocity more important than the mass
b. Mass x acceleration = force = mass x deceleration
(1) The energy used to place the mass in motion must be completely exchanged into the body tissues to stop the mass
c. Energy potential

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(1) Continuum of energy increase
(2) Can be broken down into artificial but workable groups
(3) Energy
(a) Low energy objects
i) Hand driven
a) Knife
b) Ice pick
c) Ax
d) Other
ii) Minimal cavitation
iii) Damage only by cutting edge
(b) Medium energy
i) Muzzle velocity greater than 1500 feet/ second
ii) Hand guns, low power rifle
iii) Small projectile
iv) Cavitation 6-10 times bullet frontal area
(c) High energy
i) Muzzle velocity less than 1500 feet/ second
ii) Military high velocity small caliber weapons
a) Examples (M16, AK 47/74)
b) Other
iii) Cavitation 20-30 times frontal area of missile
(d) Implications of soft body armor

B. Anatomy
1. Organs injured
2. Pathway of missile
a. Entrance wound
(1) Hole is crushed inward
(2) Round or oval shaped
(3) Rim
(a) Dark
(b) 1-2 mm width
(c) Produced by grease and other substance on the bullet
(4) Abrasion
(a) Produced by spinning of the bullet
(b) Largest with greatest contact of skin
i) Larger when impact is at an angle
(5) Burn
(a) Flame from barrel
(b) End of weapon 4-6 inches from the skin
b. Exit wound
(1) Pushed outward
(2) Stellate or slit

VI. Blast
A. Introduction
1. The blast effect is broken down into three phases depending on the type of force that

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occurs during that phase
2. Each phase has a different energy pattern

B. Phases
1. Primary
a. Pressure wave of the blast
(1) Major effect on gas-containing organs
(a) Organ systems
i) Lungs
ii) Intestinal tract
(b) Pathology
i) Rupture of the organ
(c) Air emboli
b. Heat wave
(1) Burns on unprotected part of body
(2) Skin burns
(3) Eye burns
2. Secondary
a. Struck by flying particles
(1) Glass
(2) Bricks
(3) Wood
(4) Metal
b. Pathology
(1) Compression
(2) Lacerations
3. Tertiary
a. Patient becomes flying object
(1) Impact into other objects
(2) Similar to falls

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UNIT TERMINAL OBJECTIVE

4-2 At the completion of this unit, the EMT-Intermediate student will be able to utilize the assessment findings to formulate a field impression and implement the treatment plan for the patient with hemorrhage or shock.

COGNITIVE OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-2.1 Describe the epidemiology, including the morbidity, mortality and prevention strategies for shock and hemorrhage. (C-1)
4-2.2 Discuss the various types and degrees of hemorrhage and shock. (C-1)
4-2.3 Discuss the pathophysiology of hemorrhage and shock. (C-1)
4-2.4 Discuss the assessment findings associated with hemorrhage and shock. (C-1)
4-2.5 Identify the need for intervention and transport of the patient with hemorrhage or shock. (C-1)
4-2.6 Discuss the treatment plan and management of hemorrhage and shock. (C-1)
4-2.7 Discuss the management of external and internal hemorrhage. (C-1)
4-2.8 Differentiate between controlled and uncontrolled hemorrhage. (C-3)
4-2.9 Differentiate between the administration rate and amount of IV fluid in a patient with controlled versus uncontrolled hemorrhage. (C-3)
4-2.10 Relate internal hemorrhage to the pathophysiology of compensated and decompensated hypovolemic shock. (C-3)
4-2.11 Relate internal hemorrhage to the assessment findings of compensated and decompensated hypovolemic shock. (C-3)
4-2.12 Describe the body's physiologic response to changes in perfusion. (C-1)
4-2.13 Describe the effects of decreased perfusion at the capillary level. (C-1)
4-2.14 Discuss the cellular ischemic phase related to hemorrhagic shock. (C-1)
4-2.15 Discuss the capillary stagnation phase related to hypovolemic shock. (C-1)
4-2.16 Discuss the capillary washout phase related to hypovolemic shock. (C-1)
4-2.17 Discuss the assessment findings of hypovolemic shock. (C-1)
4-2.18 Relate pulse pressure changes to perfusion status. (C-3)
4-2.19 Define compensated and decompensated shock. (C-1)
4-2.20 Discuss the pathophysiological changes associated with compensated shock. (C-1)
4-2.21 Discuss the assessment findings associated with compensated shock. (C-1)
4-2.22 Identify the need for intervention and transport of the patient with compensated shock. (C-1)
4-2.23 Discuss the treatment plan and management of compensated shock. (C-1)
4-2.24 Discuss the pathophysiological changes associated with decompensated shock. (C-1)
4-2.25 Discuss the assessment findings associated with decompensated shock. (C-1)
4-2.26 Identify the need for intervention and transport of the patient with decompensated shock. (C-1)
4-2.27 Discuss the treatment plan and management of the patient with decompensated shock. (C-1)
4-2.28 Differentiate between compensated and decompensated shock. (C-3)
4-2.29 Relate external hemorrhage to the pathophysiology of compensated and decompensated hypovolemic shock. (C-3)
4-2.30 Relate external hemorrhage to the assessment findings of compensated and decompensated hypovolemic shock. (C-3)
4-2.31 Differentiate between the normotensive, hypotensive, and profoundly hypotensive patient. (C-3)
4-2.32 Differentiate between the administration of fluid in the normotensive, hypotensive, and profoundly hypotensive patient. (C-3)
4-2.33 Discuss the physiologic changes associated with the pneumatic anti-shock garment (PASG). (C-1)
4-2.34 Discuss the indications and contraindications for the application and inflation of the PASG. (C-1)

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4-2.35 Apply epidemiology to develop prevention strategies for hemorrhage and shock. (C-1)
4-2.36 Integrate the pathophysiological principles to the assessment of a patient with hemorrhage or shock. (C-3)
4-2.37 Synthesize assessment findings and patient history information to form a field impression for the patient with hemorrhage or shock. (C-3)
4-2.38 Develop, execute, and evaluate a treatment plan based on the field impression for the hemorrhage or shock patient. (C-3)
4-2.39 Differentiate between the management of compensated and decompensated shock. (C-3)

AFFECTIVE OBJECTIVES
None identified for this unit.

PSYCHOMOTOR OBJECTIVES
At the completion of this unit, the EMT-Intermediate student will be able to:

4-2.40 Demonstrate the assessment of a patient with signs and symptoms of hypovolemic shock. (P-2)
4-2.41 Demonstrate the management of a patient with signs and symptoms of hypovolemic shock. (P-2)
4-2.42 Demonstrate the assessment of a patient with signs and symptoms of compensated hypovolemic shock. (P-2)
4-2.43 Demonstrate the management of a patient with signs and symptoms of compensated hypovolemic shock. (P-2)
4-2.44 Demonstrate the assessment of a patient with signs and symptoms of decompensated hypovolemic shock. (P-2)
4-2.45 Demonstrate the management of a patient with signs and symptoms of decompensated hypovolemic shock. (P-2)
4-2.46 Demonstrate the assessment of a patient with signs and symptoms of external hemorrhage. (P-2)
4-2.47 Demonstrate the management of a patient with signs and symptoms of external hemorrhage. (P-2)
4-2.48 Demonstrate the assessment of a patient with signs and symptoms of internal hemorrhage. (P-2)
4-2.49 Demonstrate the management of a patient with signs and symptoms of internal hemorrhage. (P-2)

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DECLARATIVE

I. Pathophysiology, assessment, and management of hemorrhage
- A. Hemorrhage
  - 1. Epidemiology
    - a. Incidence
    - b. Morbidity/ mortality
    - c. Prevention strategies
  - 2. Pathophysiology
    - a. Location
      - (1) External
        - (a) Controlled
        - (b) Uncontrolled
      - (2) Internal
        - (a) Trauma
        - (b) Non-trauma
          - i) Common sites
          - ii) Uncommon sites
        - (c) Controlled
        - (d) Uncontrolled
    - b. Anatomical type
      - (1) Arterial
      - (2) Venous
      - (3) Capillary
    - c. Timing
      - (1) Acute
      - (2) Chronic
    - d. Severity
      - (1) Amounts of blood loss tolerated by
        - (a) Adults
        - (b) Children
        - (c) Infants
    - e. Physiological response to hemorrhage
      - (1) Clotting
      - (2) Localized vasoconstriction
    - f. Stages of hemorrhage
      - (1) Stage 1
        - (a) Up to 15% intravascular loss
        - (b) Compensated by constriction of vascular bed
        - (c) Blood pressure maintained
        - (d) Normal pulse pressure, respiratory rate, and renal output
        - (e) Pallor of the skin
        - (f) Central venous pressure low to normal
      - (2) Stage 2
        - (a) 15-25% intravascular loss
        - (b) Cardiac output cannot be maintained by arteriolar constriction
        - (c) Reflex tachycardia
        - (d) Increased respiratory rate
        - (e) Blood pressure maintained
        - (f) Catecholamines increase peripheral resistance

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(g) Increased diastolic pressure
(h) Narrow pulse pressure
(i) Diaphoresis from sympathetic stimulation
(j) Renal output almost normal

(3) Stage 3
(a) 25-35% intravascular loss
(b) Classic signs of hypovolemic shock
i) Marked tachycardia
ii) Marked tachypnea
iii) Decreased systolic pressure
iv) 5-15 ml per hour urine output
v) Alteration in mental status
vi) Diaphoresis with cool, pale skin

(4) Stage 4
(a) Loss greater than 35%
(b) Extreme tachycardia
(c) Pronounced tachypnea
(d) Significantly decreased systolic blood pressure
(e) Confusion and lethargy
(f) Skin is diaphoretic, cool, and extremely pale

3. Assessment
a. Bright red blood from wound, mouth, rectum, or other orifice
b. Coffee ground appearance of vomitus
c. Melena
d. Hematochezia
e. Dizziness or syncope on sitting or standing
f. Orthostatic hypotension
g. Signs and symptoms of hypovolemic shock

4. Management
a. Airway and ventilatory support
b. Circulatory support
(1) Bleeding from nose or ears after head trauma
(a) Refrain from applying pressure
(b) Apply loose sterile dressing to protect from infection
(2) Bleeding from other areas
(a) Control bleeding
i) Direct pressure
ii) Elevation if appropriate
iii) Pressure points
iv) Tourniquet
v) Splinting
vi) Packing of large gaping wounds with sterile dressings
vii) PASG
(b) Apply sterile dressing and pressure bandage
(3) Transport considerations
(4) Psychological support/ communication strategies

II. Pathophysiology, assessment, and management of shock
A. Shock
1. Epidemiology

a. Morbidity/ mortality
b. Prevention strategies

2. Pathophysiology
   a. Perfusion depends on cardiac output (CO), systemic vascular resistance (SVR), and transport of oxygen
      (1) CO = HR X SV
         (a) HR - heart rate
         (b) SV - stroke volume
      (2) BP = CO X SVR
      (3) Hypoperfusion can result from
         (a) Inadequate cardiac output
         (b) Excessive systemic vascular resistance
         (c) Inability of red blood cells to deliver oxygen to tissues
   b. Compensation for decreased perfusion
      (1) Occurrence of event resulting in decreased perfusion, e.g., blood loss, myocardial infarction, loss of vasomotor tone, or tension pneumothorax
      (2) Baroreceptors sense decreased flow and activate vasomotor center
         (a) Normally stimulated between 60-80 mmHg systolic (lower in children)
         (b) Located in carotid sinuses and aortic arch
         (c) Arterial pressure drop decreases stretch
            i) Nerve impulse through Vagus and Hering's nerve to glossopharyngeal nerve
            ii) Impulse transmitted to vasomotor center
            iii) Frequency of inhibitory impulses decreases
            iv) Increase in vasomotor activity
            v) Sympathetic nervous system stimulated
         (d) Decrease in systolic pressure less than 80 mmHg stimulates vasomotor center to increase arterial pressure
      (3) Chemoreceptors are stimulated by decrease in PaO_2 and increase in $PaCO_2$
      (4) Sympathetic nervous system
      (5) Adrenal medulla glands secrete epinephrine and norepinephrine
         (a) Epinephrine
            i) Alpha 1
               a) Vasoconstriction
               b) Increase in peripheral vascular resistance
               c) Increased afterload from arteriolar constriction
            ii) Alpha 2 regulated release of alpha 1
            iii) Beta 1
               a) Positive chronotropy
               b) Positive inotropy
               c) Positive dromotropy
            iv) Beta 2
               a) Bronchodilation
               b) Gut smooth muscle dilation
         (b) Norepinephrine
            i) Primarily alpha 1 and alpha 2
               a) Vasoconstriction
               b) Increase in peripheral vascular resistance

c) Increased afterload from arteriolar constriction
(6) Failure of compensation to preserve perfusion
(7) Preload decreases
(8) Cardiac output decreases
(9) Myocardial blood supply and oxygenation decrease
(a) Myocardial perfusion decreases
(b) Cardiac output decreases further
(c) Coronary artery perfusion decreases
(d) Myocardial ischemia
(10) Capillary and cellular changes
(a) Ischemia
i) Minimal blood flow to capillaries
ii) Cells go from aerobic to anaerobic metabolism
(b) Stagnation
(c) Precapillary sphincter relaxes in response to
a) Lactic acid
b) Vasomotor center failure
c) Increased carbon dioxide
i) Postcapillary sphincters remain constricted
ii) Capillaries engorge with fluid
iii) Anaerobic metabolism continues, increasing lactic acid production
a) Aggregation of red blood cells and formation of microemboli
b) Potent vasodilator
c) Destroys capillary cell membrane
iv) Plasma leaks from capillaries
v) Interstitial fluid increases
a) Distance from capillary to cell increases
b) Oxygen transport decreases secondary to increased capillary-cell distance
vi) Myocardial toxin factor released by ischemic pancreas
(d) Washout
i) Postcapillary sphincter relaxes
ii) Hydrogen, potassium, carbon dioxide, thrombosed erythrocytes wash out
iii) Metabolic acidosis results
iv) Cardiac output drops further

c. Stages of shock
(1) Compensated or nonprogressive
(a) Characterized by signs and symptoms of early shock
(b) Arterial blood pressure is normal or high
(c) Treatment at this stage will typically result in recovery
(2) Decompensated or progressive
(a) Characterized by signs and symptoms of late shock
(b) Arterial blood pressure is abnormally low
(c) Treatment at this stage will sometimes result in recovery
(3) Irreversible
(a) Characterized by signs and symptoms of late shock
(b) Arterial blood pressure is abnormally low

(c) Even aggressive treatment at this stage does not result in recovery

d. Etiologic classifications
- (1) Hypovolemic
  - (a) Hemorrhage
  - (b) Plasma loss
  - (c) Fluid and electrolyte loss
  - (d) Endocrine
- (2) Distributive (vasogenic)
  - (a) Increased venous capacitance
  - (b) Low resistance, vasodilation
- (3) Cardiogenic
  - (a) Myocardial insufficiency
  - (b) Filling or outflow obstruction (obstructive)
- (4) Spinal neurogenic shock
  - (a) Refers to temporary loss of all types of spinal cord function distal to injury
  - (b) Flaccid paralysis distal to injury site
  - (c) Loss of autonomic function
    - i) Hypotension
    - ii) Vasodilatation
    - iii) Loss of bladder and bowel control
    - iv) Priapism
    - v) Loss of thermoregulation
  - (d) Does not always involve permanent primary injury
- (5) Spinal shock
  - (a) Also called spinal vascular shock
  - (b) Temporary loss of autonomic function of cord at level of injury which controls cardiovascular function
  - (c) Presentation includes
    - i) Loss of sympathetic tone
    - ii) Relative hypotension
      - a) Systolic pressure 80 - 100 mmHg
    - iii) Skin pink, warm, and dry
      - a) Due to cutaneous vasodilation
    - iv) Relative bradycardia
  - (d) Occurrence is rare
  - (e) Shock presentation is usually the result of hidden volume loss
    - i) Chest injury
    - ii) Abdominal injury
    - iii) Other violent injury
  - (f) Treatment
    - i) Focus primarily on volume replacement

e. Assessment
- (1) Early or compensated
  - (a) Tachycardia
  - (b) Pale, cool skin
  - (c) Diaphoresis
  - (d) Level of consciousness
    - i) Normal

ii) Anxious or apprehensive
(e) Blood pressure maintained
(f) Narrow pulse pressure
i) Pulse pressure is the difference between the systolic and diastolic pressures, i.e., pulse pressure = systolic - diastolic
ii) Pulse pressure reflects the tone of the arterial system and is more sensitive to changes in perfusion than the systolic or diastolic alone
(g) Positive orthostatic tilt test
(h) Dry mucosa
(i) Complaints of thirst
(j) Weakness
(k) Possible delay of capillary refill
(2) Late or progressive
(a) Extreme tachycardia
(b) Extreme pale, cool skin
(c) Diaphoresis
(d) Significant decrease in level of consciousness
(e) Hypotension
(f) Dry mucosa
(g) Nausea
(h) Cyanosis with white waxy-looking skin
f. Differential shock assessment findings
(1) Shock is assumed to be hypovolemic until proven otherwise
(2) Cardiogenic shock
(a) Differentiated from hypovolemic shock by presence of one or more of the following
i) Chief complaint (chest pain, dyspnea, tachycardia)
ii) Heart rate (bradycardia or excessive tachycardia)
iii) Signs of congestive heart failure (jugular vein distention, rales)
iv) Dysrhythmia
(3) Distributive shock
(a) Differentiated from hypovolemic shock by presence of one or more of the following
i) Mechanism that suggests vasodilation, e.g., spinal cord injury, drug overdose, sepsis, anaphylaxis
ii) Warm, flushed skin, especially in dependent areas
iii) Lack of tachycardia response (not reliable though, since significant number of hypovolemic patients never become tachycardic)
(4) Obstructive shock
(a) Differentiated from hypovolemic shock by presence of signs and symptoms suggestive of
i) Cardiac tamponade
ii) Tension pneumothorax

3. Management
a. Airway and ventilatory support
(1) Ventilate and suction as necessary

(2) Administer high concentration oxygen
(3) Reduce increased intrathoracic pressure in tension pneumothorax

b. Circulatory support
(1) Hemorrhage control
(2) Intravenous volume expanders
(a) Types
i) Isotonic solutions
ii) Hypertonic solutions
iii) Synthetic solutions
(b) Rate of administration
i) External hemorrhage that can be controlled
ii) External hemorrhage that cannot be controlled
iii) Internal hemorrhage
a) Blunt trauma
b) Penetrating trauma
(3) Pneumatic anti-shock garment (PASG)
(a) Effects
i) Increased arterial blood pressure above garment
ii) Increased systemic vascular resistance
iii) Immobilization of pelvis and possibly lower extremities
iv) Increased intra-abdominal pressure
(b) Mechanism
i) Increases systemic vascular resistance through direct compression of tissues and blood vessels
ii) Negligible autotransfusion effect
(c) Indications
i) Hypoperfusion with unstable pelvis
ii) Conditions of decreased SVR not corrected by other means
iii) As approved locally, other conditions characterized by hypoperfusion with hypotension
iv) Research studies
(d) Contraindications
i) Advanced pregnancy (no inflation of abdominal compartment)
ii) Object impaled in abdomen or evisceration (no inflation of abdominal compartment)
iii) Ruptured diaphragm
iv) Cardiogenic shock
v) Pulmonary edema
(4) Needle chest decompression of tension pneumothorax to improve impaired cardiac output
(5) Recognize the need for expeditious transport of suspected cardiac tamponade for pericardiocentesis

c. Pharmacological interventions
(1) Hypovolemic shock
(a) Volume expanders
(2) Cardiogenic shock
(a) Volume expanders
(b) Positive cardiac inotropes

(c) Rate altering medications
(3) Distributive shock
(a) Volume expanders
(b) Positive cardiac inotropes
(c) PASG
(4) Obstructive shock
(a) Volume expanders
(5) Spinal shock
(a) Volume expanders
d. Non-pharmacological interventions
e. Transport considerations
(1) Indications for rapid transport
(2) Indications for transport to a trauma center
(3) Considerations for air medical transportation
f. Psychological support/ communication strategies

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UNIT TERMINAL OBJECTIVE

4-3 At the completion of this unit, the EMT-Intermediate student will be able to utilize the assessment findings to formulate a field impression and implement the management plan for the patient with a burn injury.

COGNITIVE OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-3.1 Describe the anatomy and physiology pertinent to burn injuries. (C-1)
4-3.2 Describe the epidemiology, including incidence, morbidity/ mortality, risk factors, and prevention strategies for the patient with a burn injury. (C-1)
4-3.3 Describe the pathophysiologic complications and systemic complications of a burn injury. (C-1)
4-3.4 Identify and describe types of burn injuries, including a thermal burn, an inhalation burn, a chemical burn, an electrical burn, and a radiation exposure. (C-1)
4-3.5 Identify and describe the depth classifications of burn injuries, including a superficial burn, a partial-thickness burn, a full-thickness burn, and other depth classifications described by local protocol. (C-1)
4-3.6 Identify and describe methods for determining body surface area percentage of a burn injury including the "rules of nines," the "rules of palms," and other methods described by local protocol. (C-1)
4-3.7 Identify and describe the severity of a burn including a minor burn, a moderate burn, a severe burn, and other severity classifications described by local protocol. (C-1)
4-3.8 Differentiate criteria for determining the severity of a burn injury between a pediatric patient and an adult patient. (C-3)
4-3.9 Describe special considerations for a pediatric patient with a burn injury. (C-1)
4-3.10 Discuss considerations which impact management and prognosis of the burn injured patient. (C-1)
4-3.11 Discuss mechanisms of burn injuries. (C-1)
4-3.12 Discuss conditions associated with burn injuries, including trauma, blast injuries, airway compromise, respiratory compromise, and child abuse. (C-1)
4-3.13 Describe the management of a burn injury, including airway and ventilation, circulation, pharmacologic, non-pharmacologic, transport considerations, psychological support/ communication strategies, and other management described by local protocol. (C-1)
4-3.14 Describe the epidemiology of a thermal burn injury. (C-1)
4-3.15 Describe the specific anatomy and physiology pertinent to a thermal burn injury. (C-1)
4-3.16 Describe the pathophysiology of a thermal burn injury. (C-1)
4-3.17 Identify and describe the depth classifications of a thermal burn injury. (C-1)
4-3.18 Identify and describe the severity of a thermal burn injury. (C-1)
4-3.19 Describe considerations which impact management and prognosis of the patient with a thermal burn injury. (C-1)
4-3.20 Discuss mechanisms of burn injury and conditions associated with a thermal burn injury. (C-1)
4-3.21 Describe the management of a thermal burn injury, including airway and ventilation, circulation, pharmacologic, non-pharmacologic, transport considerations, and psychological support/ communication strategies. (C-1)
4-3.22 Describe the epidemiology of an inhalation burn injury. (C-1)
4-3.23 Describe the specific anatomy and physiology pertinent to an inhalation burn injury. (C-1)
4-3.24 Describe the pathophysiology of an inhalation burn injury. (C-1)
4-3.25 Differentiate between supraglottic and infraglottic inhalation injuries. (C-3)
4-3.26 Identify and describe the severity of an inhalation burn injury. (C-1)
4-3.27 Describe considerations which impact management and prognosis of the patient with an inhalation burn

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injury. (C-1)
4-3.28 Discuss mechanisms of burn injury and conditions associated with an inhalation burn injury. (C-1)
4-3.29 Describe the management of an inhalation burn injury, including airway and ventilation, circulation, pharmacologic, non-pharmacologic, transport considerations, and psychological support/ communication strategies. (C-1)
4-3.30 Describe the epidemiology of a chemical burn injury and a chemical burn injury to the eye. (C-1)
4-3.31 Describe the specific anatomy and physiology pertinent to a chemical burn injury and a chemical burn injury to the eye. (C-1)
4-3.32 Describe the pathophysiology of a chemical burn injury, including types of chemicals and their burning processes and a chemical burn injury to the eye. (C-1)
4-3.33 Identify and describe the depth classifications of a chemical burn injury. (C-1)
4-3.34 Identify and describe the severity of a chemical burn injury. (C-1)
4-3.35 Describe considerations which impact management and prognosis of the patient with a chemical burn injury and a chemical burn injury to the eye. (C-1)
4-3.36 Discuss mechanisms of burn injury and conditions associated with a chemical burn injury. (C-1)
4-3.37 Describe the management of a chemical burn injury and a chemical burn injury to the eye, including airway and ventilation, circulation, pharmacologic, non-pharmacologic, transport considerations, and psychological support/ communication strategies. (C-1)
4-3.38 Describe the epidemiology of an electrical burn injury. (C-1)
4-3.39 Describe the specific anatomy and physiology pertinent to an electrical burn injury. (C-1)
4-3.40 Describe the pathophysiology of an electrical burn injury. (C-1)
4-3.41 Identify and describe the depth classifications of an electrical burn injury. (C-1)
4-3.42 Identify and describe the severity of an electrical burn injury. (C-1)
4-3.43 Describe considerations which impact management and prognosis of the patient with an electrical burn injury. (C-1)
4-3.44 Discuss mechanisms of burn injury and conditions associated with an electrical burn injury. (C-1)
4-3.45 Describe the management of an electrical burn injury, including airway and ventilation, circulation, pharmacologic, non-pharmacologic, transport considerations, and psychological support/ communication strategies. (C-1)
4-3.46 Describe the epidemiology of a radiation exposure. (C-1)
4-3.47 Describe the specific anatomy and physiology pertinent to a radiation exposure. (C-1)
4-3.48 Describe the pathophysiology of a radiation exposure, including the types and characteristics of ionizing radiation. (C-1)
4-3.49 Identify and describe the depth classifications of a radiation exposure. (C-1)
4-3.50 Identify and describe the severity of a radiation exposure. (C-1)
4-3.51 Describe considerations which impact management and prognosis of the patient with a radiation exposure. (C-1)
4-3.52 Discuss mechanisms of burn injury associated with a radiation exposure. (C-1)
4-3.53 Describe the management of a radiation exposure, including airway and ventilation, circulation, pharmacologic, non-pharmacologic, transport considerations, and psychological support/ communication strategies. (C-1)
4-3.54 Apply the to formulate a field impression and implement the management plan for a thermal burn injury. (C-3)
4-3.55 Apply the to formulate a field impression and implement the management plan for an inhalation burn injury. (C-3)
4-3.56 Apply the to formulate a field impression and implement the management plan for a chemical burn injury. (C-3)

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4-3.57 Apply the to formulate a field impression and implement the management plan for an electrical burn injury. (C-3)
4-3.58 Apply the to formulate a field impression and implement the management plan for an radiation exposure. (C-3)

AFFECTIVE OBJECTIVES
At the completion of this unit, the EMT-Intermediate student will be able to:

4-3.59 Value the changes of a patient's self-image associated with a burn injury. (A-2)
4-3.60 Value the impact of managing a burn injured patient. (A-2)
4-3.61 Advocate empathy for a burn injured patient. (A-2)
4-3.62 Value and defend the sense of urgency in burn injuries. (A-3)

PSYCHOMOTOR OBJECTIVES
At the completion of this unit, the EMT-Intermediate student will be able to:

4-3.63 Take body substance isolation procedures during assessment and management of patients with a burn injury. (P-2)
4-3.64 Perform assessment of a patient with a burn injury. (P-2)

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DECLARATIVE

I. Introduction
  A. Epidemiology
    1. Incidence
      a. Supportive statistics
    2. Morbidity/ mortality
      a. Supportive statistics
    3. Risk factors
    4. Prevention strategies
  B. Review the anatomy and physiology of the integumentary system

II. General system pathophysiology, assessment, and management
  A. Pathophysiology
    1. Pathophysiologic and systemic complications of a burn injury
      a. Fluid loss
      b. Electrolyte loss
      c. Increased catecholamine release
      d. Acidosis
      e. Vasoconstriction
      f. Renal failure
      g. Liver failure
      h. Heart failure
      i. Hypoxia
      j. Anoxia
      k. Arrhythmia
      l. Formation of eschar
      m. Hypothermia
      n. Hypovolemia
      o. Infection
      p. Complications of a circumferential burn
  B. Assessment findings
    1. Types of burn injuries
      a. Thermal
      b. Inhalation
      c. Chemical
      d. Electrical
        (1) Lightning
      e. Radiation exposure
    2. Depth classification of a burn injury
      a. Superficial
      b. Partial-thickness
      c. Full-thickness
      d. Other depth classifications according to local protocol
    3. Methods for determining body surface area percentage of a burn injury
      a. The "rule of nines"
        (1) Adult

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(2) Pediatric
b. The "rule of palms"
c. Other methods according to local protocol

4. Severity of a burn
   a. Minor
   b. Moderate
   c. Severe
   d. Other severity classifications according to local protocol
5. Criteria for determining severity of a burn injury
   a. The adult patient
   b. The pediatric patient
      (1) Special considerations
6. Considerations which impact management and prognosis of the burn injured patient
   a. Age
   b. Preexisting medical conditions
   c. Trauma
7. Mechanisms of burn injuries
   a. Burn trauma
   b. Blast/ explosion trauma
   c. Fall injury
   d. Other injuries
8. Conditions associated with burn injuries
   a. Trauma
      (1) Soft tissue injuries
      (2) Musculoskeletal injuries
   b. Blast injuries
   c. Airway compromise
   d. Respiratory compromise
   e. Child abuse
9. Signs and symptoms of burn injuries
   a. Pain
   b. Changes in skin condition relative to the affected burn site
   c. Adventitious sounds
   d. Sloughing of the affected skin
   e. Hoarseness
   f. Dysphagia
   g. Dysphasia
   h. Burnt hair
   i. Nausea/ vomiting
   j. Unconsciousness
   k. Altered level of consciousness
   l. Edema
   m. Paresthesia
   n. Hemorrhage
   o. Other soft tissue injuries
   p. Musculoskeletal injuries
   q. Dyspnea

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r. Chest pain

C. Management
1. Airway and ventilatory support
2. Circulatory support
3. Pharmacological interventions
   a. Analgesia
4. Non-pharmacological interventions
5. Transport considerations
   a. Appropriate mode
   b. Appropriate facility
6. Psychological support/ communication strategies
   a. Patient and family advocacy

III. Specific burn injuries
A. Thermal burn injury
1. Epidemiology of a thermal burn injury
   a. Incidence
      (1) Supportive statistics
   b. Morbidity/ mortality
      (1) Supportive statistics
   c. Risk factors
   d. Prevention strategies
2. Review the specific anatomy and physiology pertinent to the integumentary system
3. Review of heat energy and the components of the burning agent
4. Pathophysiology of a thermal burn injury
   a. The process of burn shock
      (1) Emergent phase
      (2) Fluid shift phase
      (3) Hypermetabolic phase
      (4) Resolution phase
   b. Inhalation injury (present in 60-70% of all burn patients who die)
      (1) Carbon monoxide poisoning
      (2) Cyanide intoxication
   c. Infectious insult
   d. Eschar formation
      (1) Respiratory compromise secondary to circumferential eschar around the thorax
      (2) Circulatory compromise secondary to circumferential eschar around an extremity
      (3) Escharotomies
5. Assessment findings
   a. Depth classifications of a thermal burn
   b. Severity of a thermal burn
   c. Criteria for determining severity of a burn injury
      (1) The adult patient
      (2) The pediatric patient
   d. Considerations which impact care and prognosis of the thermal burn injured

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patient
e. Mechanisms of burn injury
(1) Scalding
(2) Steam
(3) Flame
(4) Flash
(5) Retained heat
(6) Other trauma
f. Conditions associated with thermal burn injuries
6. Management
a. Remove patient to safe area
b. Stop the burning process
c. Airway and ventilatory support
d. Circulatory support
e. Pharmacological interventions
(1) Topical applications
(2) Tetanus and antibiotic therapy
(3) Fluid therapy
f. Non-pharmacological interventions
(1) Thermal burn injury management according to local protocol
g. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
(3) Transport considerations in conjunction with burn injury management according to local protocol
h. Psychological support/ communication strategies
B. Inhalation burn injury
1. Epidemiology
a. Incidence
(1) Supportive statistics (e.g., 20-35% of the patients admitted to burn centers have an inhalation injury)
(2) Chemical inhalation injuries are more frequent than thermal inhalation injuries
b. Morbidity/ mortality
(1) Supportive statistics
c. Risk factors
(1) Often associated with a burn environment
(2) Factors that increase the risk for inhalation injury
(a) Standing
(b) Screaming
(c) Enclosed area
d. Prevention strategies
2. Review the specific anatomy and physiology pertinent to the respiratory system
3. Pathophysiology
a. Compromises the upper airway (supraglottic)
b. Compromises the lower airway (infraglottic)
c. Complications may occur later

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4. Assessment findings
    a. Mechanism of injury
        (1) Toxic inhalations
        (2) Smoke inhalation
        (3) Carbon monoxide poisoning
        (4) Thiocyanate intoxication
        (5) Thermal burn
        (6) Chemical burn
    b. Criteria for determining severity of a burn injury
        (1) The adult patient
        (2) The pediatric patient
    c. Considerations which impact care and prognosis
    d. Conditions associated with inhalation burn trauma
5. Focused history
6. Management
    a. Airway and ventilatory support
    b. Circulatory support
    c. Pharmacological interventions
    d. Non-pharmacological interventions
        (1) Thermal burn injury management according to local protocol
        (2) Hyperbaric therapy - for carbon monoxide
    e. Transport considerations
        (1) Appropriate mode
        (2) Appropriate facility
    f. Psychological support/ communication strategies

C. Chemical burn injury
1. Epidemiology
    a. Incidence
        (1) Supportive statistics
    b. Morbidity/ mortality
        (1) Supportive statistics
    c. Risk factors
    d. Prevention strategies
2. Anatomy and physiology review
3. Pathophysiology
    a. Types of chemicals which cause chemical burn injuries
        (1) Acids
        (2) Bases (alkali)
            (a) Cement
        (3) Dry chemicals
        (4) Phenols
    b. Characteristics of the burning process of chemicals
        (1) The burning process of an acid
        (2) The burning process of an alkali
        (3) The burning process of dry chemicals
4. Assessment
    a. Mechanism of injury

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(1) Industrial accidents most frequent
b. Depth classification
c. Severity
d. Criteria for determining severity of a burn injury
(1) The adult patient
(2) The pediatric patient
e. Considerations which impact care and prognosis of a chemical burn injured patient
5. Management
a. Airway and ventilatory support
b. Circulatory support
c. Pharmacological interventions
d. Non-pharmacological interventions
(1) Acid burn injury management according to local protocol
(2) Alkali burn injury management according to local protocol
(3) Chemical burn injury according to local protocol
(4) Dry chemical burn injury according to local protocol
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies
D. Chemical burn injury of the eye
1. Epidemiology
a. Incidence
(1) Supportive statistics
b. Morbidity/ mortality
(1) Supportive statistics
c. Risk factors
d. Prevention strategies
2. Anatomy and physiology review of the eye
3. Pathophysiology
a. Types of chemicals which cause chemical burn injuries to the eye
(1) Acids
(2) Bases (alkali)
(a) Cement
(3) Dry chemicals
(4) Phenols
(5) Mace/ pepper spray
4. Assessment
a. Mechanism of injury
(1) Industrial accidents most frequent
b. Severity
c. Criteria for determining severity of a eye injury
d. Considerations which impact care and prognosis of a chemical injury to the eye
5. Management
a. Airway and ventilatory support
b. Circulatory support

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c. Pharmacological interventions
d. Non-pharmacological interventions
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

E. Electrical burn injuries
1. Epidemiology
a. Incidence
(1) Supportive statistics
b. Morbidity/ mortality
(1) Supportive statistics
c. Risk factors
d. Prevention strategies
2. Anatomy and physiology review
3. Review of the characteristics of electrical current
4. Pathophysiology
a. External burn injuries
b. Internal burn injuries
c. Musculoskeletal injuries
d. Cardiovascular injuries
e. Respiratory injuries
f. Neurological injuries
g. Myoglobin release and renal involvement
5. Assessment
a. Mechanism of injury
(1) Contact burn injuries
(2) Arc injuries
(3) Flame or flash burn injuries
(a) Welder's flash
(4) Lightning injuries
(a) Direct stroke
(b) Side flash (splash)
(c) Step voltage
b. Depth classification
c. Severity
d. Criteria for determining severity of an electrical burn injury
(1) The adult patient
(2) The pediatric patient
e. Considerations which impact care and prognosis of an electrical burn injured patient
6. Management
a. Airway and ventilatory support
b. Circulatory support
c. Pharmacological interventions
d. Non-pharmacological interventions
(1) Electrical burn injury management according to local protocol

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e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

F. Radiation exposure
1. Epidemiology
a. Incidence
(1) Supportive statistics
b. Morbidity/ mortality
(1) Supportive statistics
c. Risk factors
(1) Accidents associated with the improper handling of radiological materials
d. Prevention strategies
2. Anatomy and physiology review
3. Types of radiation which cause burn injury
a. Alpha radiation
b. Beta radiation
c. Gamma radiation
4. Characteristics of ionizing radiation
a. Alpha radiation
b. Beta radiation
c. Gamma radiation
5. Aspects of exposure
a. Duration of exposure
b. Distance from the source
c. Shielding
6. Other considerations of exposure
a. Direct exposure to ionizing radiation
b. Exposure to contaminants containing small particles of active material
7. Assessment
a. Mechanism of injury
b. Depth classifications
(1) Immediate versus delayed injuries and effects
c. Severity
(1) Immediate versus delayed injuries and effects
d. Criteria for determining severity of a radiation exposure and associated burn injury
(1) The adult patient
(2) The pediatric patient
e. Considerations which impact care and prognosis of a radiation exposure and burn injuries
8. Management
a. Scene safety
b. Airway and ventilatory support
c. Circulatory support
d. Pharmacological interventions

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e. Non-pharmacological interventions
   (1) Injury management according to local protocol
   (2) Management of a radiation accident scene
f. Transport considerations
   (1) Appropriate mode
   (2) Appropriate facility
g. Psychological support/ communication strategies

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UNIT TERMINAL OBJECTIVE

4-4 At the completion of this unit, the EMT-Intermediate student will be able to utilize the assessment findings to formulate a field impression and implement a treatment plan for a patient with a thoracic injury.

COGNITIVE OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-4.1 Describe the incidence, morbidity, and mortality of thoracic injuries in the trauma patient. (C-1)
4-4.2 Discuss the anatomy and physiology of the organs and structures related to thoracic injuries. (C-1)
4-4.3 Predict thoracic injuries based on mechanism of injury. (C-2)
4-4.4 Discuss the types of thoracic injuries. (C-1)
4-4.5 Discuss the pathophysiology of thoracic injuries. (C-1)
4-4.6 Discuss the assessment findings associated with thoracic injuries. (C-1)
4-4.7 Discuss the management of thoracic injuries. (C-1)
4-4.8 Identify the need for rapid intervention and transport of the patient with thoracic injuries. (C-1)
4-4.9 Discuss the epidemiology and pathophysiology of specific chest wall injuries, including: (C-1)
- a. Rib fracture
- b. Flail segment
- c. Sternal fracture

4-4.10 Discuss the assessment findings associated with chest wall injuries. (C-1)
4-4.11 Identify the need for rapid intervention and transport of the patient with chest wall injuries. (C-1)
4-4.12 Discuss the management of chest wall injuries. (C-1)
4-4.13 Discuss the pathophysiology of injury to the lung, including: (C-1)
- a. Simple pneumothorax
- b. Open pneumothorax
- c. Tension pneumothorax
- d. Hemothorax
- e. Hemopneumothorax
- f. Pulmonary contusion

4-4.14 Discuss the assessment findings associated with lung injuries. (C-1)
4-4.15 Discuss the management of lung injuries. (C-1)
4-4.16 Identify the need for rapid intervention and transport of the patient with lung injuries. (C-1)
4-4.17 Discuss the pathophysiology of myocardial injuries, including: (C-1)
- a. Pericardial tamponade
- b. Myocardial contusion

4-4.18 Discuss the assessment findings associated with myocardial injuries. (C-1)
4-4.19 Discuss the management of myocardial injuries. (C-1)
4-4.20 Identify the need for rapid intervention and transport of the patient with myocardial injuries. (C-1)
4-4.21 Discuss the pathophysiology of vascular injuries, including injuries to: (C-1)
- a. Aorta disection/rupture
- b. Vena cava
- c. Pulmonary arteries/ veins

4-4.22 Discuss the assessment findings associated with vascular injuries. (C-1)
4-4.23 Discuss the management of vascular injuries. (C-1)
4-4.24 Discuss the pathophysiology of diaphragmatic injuries. (C-1)
4-4.25 Discuss the assessment findings associated with diaphragmatic injuries. (C-1)
4-4.26 Discuss the management of diaphragmatic injuries. (C-1)
4-4.27 Discuss the pathophysiology of esophageal injuries. (C-1)

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4-4.28 Discuss the assessment findings associated with esophageal injuries. (C-1)
4-4.29 Discuss the management of esophageal injuries. (C-1)
4-4.30 Discuss the pathophysiology of tracheo-bronchial injuries. (C-1)
4-4.31 Discuss the assessment findings associated with tracheo-bronchial injuries. (C-1)
4-4.32 Discuss the management of tracheo-bronchial injuries. (C-1)
4-4.33 Discuss the pathophysiology of traumatic asphyxia. (C-1)
4-4.34 Discuss the assessment findings associated with traumatic asphyxia. (C-1)
4-4.35 Discuss the management of traumatic asphyxia. (C-1)
4-4.36 Differentiate between thoracic injuries based on the assessment and history. (C-3)
4-4.37 Formulate a field impression based on the assessment findings. (C-3)
4-4.38 Develop a patient management plan based on the field impression. (C-3)

AFFECTIVE OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-4.39 Advocate the use of a thorough assessment to determine a differential diagnosis and treatment plan for thoracic trauma. (A-3)
4-4.40 Advocate the use of a thorough scene survey to determine the forces involved in thoracic trauma. (A-3)
4-4.41 Value the implications of failing to properly diagnose thoracic trauma. (A-2)
4-4.42 Value the implications of failing to initiate timely interventions to patients with thoracic trauma. (A-2)

PSYCHOMOTOR OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-4.43 Demonstrate a clinical assessment for a patient with suspected thoracic trauma. (P-1)
4-4.44 Demonstrate the following techniques of management for thoracic injuries: (P-1)
- a. Needle decompression
- b. Fracture stabilization
- c. ECG monitoring
- d. Oxygenation and ventilation

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DECLARATIVE

I. Introduction
- A. Epidemiology
  - 1. Incidence
  - 2. Morbidity/ mortality
  - 3. Risk factors
  - 4. Prevention strategies
    - a. Gun safety education
    - b. Sports training
    - c. Seat belts
    - d. Other
- B. Mechanism of injury
  - 1. Classification
    - a. Blunt thoracic injuries
      - (1) Deceleration
      - (2) Compression
    - b. Penetrating thoracic injuries
  - 2. Injury patterns
    - a. General types
      - (1) Open
      - (2) Closed
    - b. Thoracic cage
    - c. Cardiovascular
    - d. Pleural and pulmonary
    - e. Mediastinal
    - f. Diaphragmatic
    - g. Esophageal
    - h. Penetrating cardiac trauma
  - 3. Blast injury
    - a. Confined spaces
    - b. Shock wave
- C. Anatomy and physiology review of the thorax
  - 1. Anatomy
    - a. Skin
    - b. Bones
      - (1) Thoracic cage
      - (2) Sternum
      - (3) Thoracic spine
    - c. Muscles
      - (1) Intercostal
      - (2) Trapezius
      - (3) Latissimus dorsi
      - (4) Rhomboids
      - (5) Pectoralis major
      - (6) Diaphragm
      - (7) Sternocleidomastoid
    - d. Trachea
    - e. Bronchi

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f. Lungs
   (1) Parenchyma
   (2) Alveoli
   (3) Alveolar - capillary interface
   (4) Pleura
      (a) Visceral
      (b) Parietal
      (c) Serous fluid
   (5) Lobes
g. Vessels
   (1) Arteries
      (a) Aorta
      (b) Carotid
      (c) Subclavian
      (d) Intercostal
      (e) Innominate
      (f) Internal mammary
   (2) Veins
      (a) Superior vena cava
      (b) Inferior vena cava
      (c) Subclavian
      (d) Internal jugular
   (3) Pulmonary
      (a) Arteries
      (b) Veins
h. Heart
   (1) Ventricles
   (2) Atria
   (3) Valves
   (4) Pericardium
i. Esophagus
   (1) Thoracic inlet
   (2) Course through chest
   (3) Esophageal foramen through diaphragm
j. Mediastinum
   (1) Structures located in mediastinum
      (a) Heart
      (b) Trachea
      (c) Vena cava
      (d) Aorta
      (e) Esophagus

2. Physiology
   a. Ventilation
      (1) Expansion and contraction of thoracic cage
         (a) Bellows system
         (b) Musculoskeletal structure
         (c) Intercostal muscles
         (d) Diaphragm
         (e) Accessory muscles

(f) Changes in intrathoracic pressure
b. Respiration
(1) Neurochemical control
(2) Gas exchange
(a) Alveolar-capillary interface
(b) Capillary-cellular interface
(c) Pulmonary circulation
(d) Cardiac circulation
(e) Acid-base balance
i) Respiratory alkalosis
ii) Respiratory acidosis
iii) Compensation for metabolic acidosis and alkalosis

II. General system pathophysiology, assessment, and management of thoracic trauma
A. Pathophysiology
1. Impairments in cardiac output
a. Blood loss
b. Increased intrapleural pressures
c. Blood in pericardial sac
d. Myocardial valve damage
e. Vascular disruption
2. Impairments in ventilatory efficiency
a. Chest bellow action compromise
(1) Pain restricting chest excursion
(2) Air entering pleural space
(3) Chest wall fails to move in unison
b. Bleeding in pleural space
c. Ineffective diaphragmatic contraction
3. Impairments in gas exchange
a. Atelectasis
b. Contused lung tissue
c. Disruption of respiratory tract
B. Assessment findings
1. Pulse
a. Deficit
b. Tachycardia
c. Bradycardia
2. Blood pressure
a. Narrow pulse pressure
b. Hypertension
c. Hypotension
d. Pulsus paradoxus
3. Respiratory rate and effort
a. Tachypnea
b. Bradypnea
c. Labored
d. Retractions
e. Other evidence of respiratory distress
4. Possible hypothermia

5. Skin
    a. Diaphoresis
    b. Pallor
    c. Cyanosis
    d. Open wounds
    e. Ecchymosis
    f. Other evidence of trauma
6. Hemoptysis
7. Neck
    a. Position of trachea
    b. Subcutaneous emphysema
    c. Jugular venous distention
    d. Penetrating wounds
8. Chest
    a. Contusions
    b. Tenderness
    c. Asymmetry
    d. Lung sounds
        (1) Absent or decreased
            (a) Unilateral
            (b) Bilateral
        (2) Location
        (3) Bowel sounds in hemithorax
    e. Abnormal percussion finding
        (1) Hyperresonance
        (2) Hyporesonance
    f. Heart sounds
        (1) Muffled
        (2) Distant
        (3) Regurgitant murmur
    g. Shift of apical impulse
    h. Open wounds
    i. Impaled object or penetration
    j. Crepitation
    k. Paradoxical movement of chest wall segment
9. Scaphoid abdomen
10. Decreased level of consciousness
11. ECG
    a. ST - T wave elevation or depression
    b. Conduction disturbances
    c. Rhythm disturbances
12. History
    a. Dyspnea
    b. Chest pain
    c. Associated symptoms
        (1) Other areas of pain or discomfort
        (2) Symptoms prior to incident
    d. Past history of cardiorespiratory disease
    e. Use of restraint in motor vehicle crash

C. Management
  1. Airway and ventilatory support
    a. Oxygen therapy
    b. Endotracheal intubation
    c. Positive pressure ventilation
    d. Occlude open wounds
    e. Stabilize chest wall
  2. Circulatory support
    a. Manage cardiac dysrhythmias
    b. Intravenous access
  3. Pharmacological interventions
    a. Analgesics
    b. Antiarrhythmics
  4. Non-pharmacological interventions
    a. Needle thoracostomy
    b. Tube thoracostomy - in hospital management
    c. Pericardiocentesis - in hospital management
  5. Transport considerations
    a. Appropriate mode
    b. Appropriate facility
  6. Psychological support/ communications strategies

III. Chest wall injuries
A. Rib fractures
  1. Epidemiology
    a. Incidence
      (1) Infrequent until adult life
      (2) Most often elderly patients
      (3) Significant force required
    b. Morbidity/ mortality
      (1) Can lead to serious consequences
      (2) Older ribs more brittle and rigid
      (3) Associated underlying pulmonary or cardiovascular injury
      (4) Increases with
        (a) Age
        (b) Number of fractures
        (c) Location of fractures
  2. Anatomy and physiology review
  3. Pathophysiology
    a. Most often caused by blunt trauma, bowing effect with midshaft fracture
    b. Ribs 4 to 9 are most often fractured (thin and poorly protected)
    c. Respiratory restriction due to pain and splinting
      (1) Atelectasis
      (2) Ventilation/ perfusion mismatch
    d. May be associated with underlying lung or cardiac contusion
    e. Intercostal vessel injury
    f. Associated complications
      (1) First and second ribs are injured by severe trauma
        (a) Rupture of aorta

(b) Tracheobronchial tree injury
(c) Vascular injury
(2) Left lower rib injury associated with splenic rupture
(3) Right lower rib injury associated with hepatic injury
(4) Multiple rib fractures
(a) Atelectasis
(b) Hypoventilation
(c) Inadequate cough
(d) Pneumonia
(5) Open rib fracture associated with visceral injury
(6) Posterior rib fracture
(a) Fifth through ninth ribs most frequently injured
(b) Lower ribs associated with spleen and kidney injury

4. Assessment findings
a. Localized pain
b. Pain that worsens
(1) Movement
(2) Deep breathing
(3) Coughing
c. Point tenderness
d. Crepitus or audible crunch
e. Splinting on respiration
f. Anteroposterior pressure elicits pain

5. Management
a. Airway and ventilatory support
(1) Oxygen therapy
(2) Positive pressure ventilation
(3) Encourage coughing and deep breathing
b. Circulatory support
c. Pharmacological intervention
(1) Analgesics
d. Non-pharmacological intervention
(1) Splint - but avoid circumferential splinting
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

B. Flail segment
1. Epidemiology
a. Incidence
(1) Most common cause is vehicular crash
(2) Falls from heights
(3) Industrial accidents
(4) Assault
(5) Birth trauma
b. Morbidity/ mortality
(1) Significant chest trauma
(2) Mortality rates 20-40% due to associated injuries
(3) Mortality increased with

(a) Advanced age
(b) Seven or more rib fractures
(c) Three or more associated injuries
(d) Shock
(e) Head injuries

2. Pathophysiology
   a. Three or more ribs fractured in two or more places producing a free floating segment of chest wall
   b. Respiratory failure due to
      (1) Underlying pulmonary contusion
      (2) Associated intrathoracic injury
      (3) Inadequate bellow action of chest
   c. Paradoxical movement of the chest
      (1) Minimal because of muscle spasm
      (2) Must be large to compromise ventilation
   d. Pain
      (1) Reduces thoracic expansion
      (2) Decreases ventilation
   e. Pulmonary contusion
      (1) Decreased lung compliance
      (2) Intra-alveolar-capillary hemorrhage
      (3) Alveolar hemorrhage
   f. Decreased ventilation
   g. Impaired venous return with resultant ventilation-perfusion mismatch
   h. Hypercapnia
   i. Hypoxia
3. Assessment findings
   a. Chest wall contusion
   b. Respiratory distress
   c. Paradoxical chest wall movement
   d. Pleuritic chest pain
   e. Crepitus
   f. Pain and splinting of affected side
   g. Tachypnea
   h. Tachycardia
   i. Possible bundle branch block on ECG
4. Management
   a. Airway and ventilatory support
      (1) Positive pressure ventilation as necessary
      (2) Oxygen (high concentration)
      (3) Evaluate the need for endotracheal intubation
      (4) Stabilize flail segment (may be controversial locally)
      (5) Positive end expiratory pressure (PEEP)
   b. Circulatory support
      (1) Restrict fluids
   c. Pharmacological interventions
      (1) Analgesics
   d. Non-pharmacological interventions
      (1) Positioning

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(2) Endotracheal intubation and positive pressure ventilation for internal splinting effect
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

C. Sternal fracture
1. Epidemiology
a. Incidence
(1) 5-8% in blunt chest trauma
(2) Deceleration compression injury
(a) Steering wheel
(b) Dashboard
(3) Blow to chest
(4) Severe hyperflexion of thoracic cage
(5) Occurs at or below the manubriosternal junction
b. Morbidity/ mortality
(1) 25-45% mortality
(2) High association with myocardial or lung injury
(a) Myocardial contusion
(b) Myocardial rupture
(c) Pulmonary contusion
2. Pathophysiology
a. Associated injuries cause morbidity and mortality
(1) Pulmonary and myocardial contusion
(2) Flail chest
(3) Vascular disruption of thoracic vessels
(4) Intra-abdominal injuries
(5) Head injuries
b. Rarely is fracture displaced posteriorly to directly impinge on heart or vessels
3. Assessment findings
a. Localized pain
b. Tenderness over sternum
c. Crepitus
d. Tachypnea
e. ECG changes associated with myocardial contusion
f. History of blunt trauma
4. Management
a. Airway and ventilatory support
b. Circulatory support
(1) Restrict fluids if pulmonary contusion is suspected
c. Pharmacological interventions
(1) Analgesics
d. Non-pharmacological interventions
(1) Allow chest wall self-splinting
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

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IV. Injury to the lung
- A. Simple pneumothorax
  - 1. Epidemiology
    - a. Incidence
      - (1) 10-30% in blunt chest trauma
      - (2) Almost 100% with penetrating chest trauma
    - b. Morbidity/ mortality
      - (1) Extent of atelectasis
      - (2) Associated injuries
  - 2. Pathophysiology
    - a. Lung 1-3 cm away from the chest wall
    - b. May have stable amount of accumulation of air
    - c. Pulmonary function may be good
    - d. Internal wound allows air to enter the pleural space
    - e. Small tears self-seal, larger one may progress
    - f. Paper bag syndrome
    - g. If standing, air will accumulate in the apices - check there first for diminished breath sounds; if supine, air accumulates in the anterior chest
    - h. Trachea may tug towards the affected side
    - i. Ventilation/ perfusion mismatch
  - 3. Assessment findings
    - a. Tachypnea
    - b. Tachycardia
    - c. Respiratory distress
    - d. Absent or decreased breath sounds on affected side
    - e. Hyperresonance
    - f. Decreased chest wall movement
    - g. Dyspnea
    - h. Chest pain referred to shoulder or arm on affected side
    - i. Slight pleuritic chest pain
  - 4. Management
    - a. Airway and ventilatory support
      - (1) Positive pressure ventilation as necessary
      - (2) Monitor for development of tension pneumothorax
    - b. Circulatory support
    - c. Pharmacological interventions
    - d. Non-pharmacological interventions
      - (1) Needle thorocostomy
    - e. Transport considerations
      - (1) Appropriate mode
      - (2) Appropriate facility
    - f. Psychological support/ communication strategies
- B. Open pneumothorax
  - 1. Epidemiology
    - a. Incidence
      - (1) Penetrating trauma
    - b. Morbidity/ mortality
      - (1) Profound hypoventilation could result
      - (2) Death related to delayed management

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2. Pathophysiology
   a. Open defect in the chest wall
      (1) Allows communication between pleural space and atmosphere
      (2) Prevents development of negative intrapleural pressure
      (3) Produces collapse of ipsilateral lung
      (4) Inability to ventilate affected lung
      (5) Ventilation/ perfusion mismatch
         (a) Shunting
         (b) Hypoventilation
         (c) Hypoxia
         (d) Large functional dead space
   b. Air will enter pleural space during inspiratory phase
   c. Air may exit during exhalation phase
   d. Resistance to air flow through respiratory tract may be greater than through open wound resulting in ineffective respiratory effort
   e. One way flap valve may let air in but not out resulting in built up pressure in pleural space
   f. Direct lung injury may be present
   g. Vena cava kinked from swaying of mediastinum
   h. Preload decreased from knifing of inferior vena cava
3. Assessment findings
   a. To and fro air motion out of defect
   b. Defect in the chest wall
   c. Penetrating injury to the chest which does not seal itself
   d. Sucking sound on inhalation
   e. Tachycardia
   f. Tachypnea
   g. Respiratory distress
   h. Subcutaneous emphysema
   i. Decreased breath sounds on affected side
4. Management
   a. Airway and ventilatory support
      (1) Positive pressure ventilation as necessary
      (2) Monitor for development of tension pneumothorax
   b. Circulatory support
   c. Pharmacological interventions
   d. Non-pharmacological interventions
      (1) Occlude open wound
      (2) Tube thoracostomy - in hospital management
   e. Transport considerations
      (1) Appropriate mode
      (2) Appropriate facility
   f. Psychological support/ communication strategies

C. Tension pneumothorax
1. Epidemiology
   a. Incidence
      (1) Penetrating trauma
      (2) Blunt trauma
   b. Morbidity/ mortality

(1) Profound hypoventilation could result
(2) Death related to delayed management
(3) Immediate life-threatening chest injury

2. Pathophysiology
   a. Defect in airway allowing communication with pleural space
   b. Blunt trauma
      (1) Penetration by rib fracture
      (2) Sudden increase in intrapulmonary pressure
      (3) Bronchial disruption from shear forces
   c. Air trapped in pleural space with build up of pressure
   d. Lung collapse on affected side with mediastinal shift to contralateral side
   e. Lung collapse leads to right-to-left intrapulmonary shunting and hypoxia
   f. Reduction in cardiac output
      (1) Increased intrathoracic pressure
      (2) Deformation of vena cava reducing preload (decreased venous return to heart)
3. Assessment findings
   a. Unilateral decreased or absent breath sounds
   b. Dyspnea
   c. Tachypnea
   d. Respiratory distress
   e. Extreme anxiety
   f. Cyanosis
   g. Bulging of intercostal muscles
   h. Tachycardia
   i. Hypotension
   j. Narrow pulse pressure
   k. Subcutaneous emphysema
   l. Jugular venous distention
   m. Tracheal deviation
   n. Hyperresonance
4. Management
   a. Airway and ventilatory support
      (1) Positive pressure ventilation as necessary
   b. Circulatory support
      (1) Relieve tension pneumothorax to improve cardiac output
   c. Pharmacological interventions
   d. Non-pharmacological interventions
      (1) Occlude open wound
      (2) Needle thoracentesis
         (a) Equipment
         (b) Technique
         (c) Assess the need for a second or third needle insertion
      (3) Tube thoracostomy - in hospital management
   e. Transport considerations
      (1) Appropriate mode
      (2) Appropriate facility
   f. Psychological support/ communication strategies

D. Hemothorax

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1. Epidemiology
   a. Incidence
      (1) Associated with pneumothorax
      (2) Blunt or penetrating trauma
      (3) Rib fractures are frequent cause
   b. Morbidity/ mortality
      (1) Life-threatening injury that frequently requires urgent chest tube and/ or surgery
      (2) Hemothorax associated with great vessel or cardiac injury
         (a) 50% will die immediately
         (b) 25% will live five to ten minutes
         (c) 25% may live 30 minutes or longer
2. Pathophysiology
   a. Accumulation of blood in the pleural space
   b. Bleeding from
      (1) Penetrating or blunt lung injury
      (2) Chest wall vessels
      (3) Intercostal vessels
      (4) Myocardium
   c. Pulmonary parenchyma is low-pressure vascular system
   d. Bleeding from pulmonary contusion generally causes 1,000 to 1,500 ml blood loss
   e. Massive hemothorax indicates great vessel or cardiac injury
   f. Collapse of ipsilateral lung
   g. Respiratory insufficiency dependent on amount of blood
   h. Hypoxia
   i. Hypotension and inadequate perfusion may result from blood loss
   j. Chest cavity can hold 2,000 to 3,000 ml of blood
   k. Classified by amount of blood loss
   l. An intercostal artery can easily bleed 50 ml's per minute
   m. Intrapulmonary hemorrhage
      (1) Bronchus
      (2) Parenchyma
3. Assessment findings
   a. Tachypnea
   b. Tachycardia
   c. Dyspnea
   d. Respiratory distress
   e. Hypotension
   f. Narrow pulse pressure
   g. Pleuritic chest pain
   h. Pale, cool, moist skin
   i. Dullness on percussion
   j. Decreased breath sounds
4. Management
   a. Airway and ventilatory support
      (1) Positive pressure ventilation as necessary
   b. Circulatory support
      (1) Re-expand the affected lung to reduce bleeding

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c. Pharmacological interventions
d. Non-pharmacological interventions
(1) Needle chest decompression
(2) Tube thoracostomy - in hospital management
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

E. Hemopneumothorax
1. Pathophysiology
a. Pneumothorax with bleeding in pleural space
2. Assessment
a. Findings and management same as hemothorax
3. Management
a. Management is the same as a hemothorax

F. Pulmonary contusion
1. Epidemiology
a. Incidence
(1) Blunt trauma to chest
(a) Most common injury from blunt thoracic trauma
(b) 30-75% with blunt trauma have pulmonary contusion
(2) Associated commonly with rib fracture
(3) High energy shock waves from explosion
(4) High velocity missile wounds
(5) Rapid deceleration
(6) High incidence of extrathoracic injuries
(7) Low velocity (e.g., ice pick)
b. Morbidity/ mortality
(1) Missed due to high incidence of other associated injuries
(2) Mortality between 14-20%
2. Pathophysiology
a. Three physical mechanisms
(1) Implosion effect
(a) Overexpansion of air in lungs secondary to positive-pressure concussive wave
(b) Rapid excessive stretching and tearing of alveoli
(2) Inertial effect
(a) Strips alveoli from heavier bronchial structures when accelerated at varying rates by concussive wave
(3) Spalding effect
(a) Liquid-gas interface is disrupted by shock-wave
(b) Wave releases energy
(c) Differential transmission of energy causes disruption of tissue
b. Alveolar and capillary damage with interstitial and intraalveolar extravasation of blood
c. Interstitial edema
d. Increased capillary membrane permeability
e. Gas exchange disturbances
f. Hypoxemia and carbon dioxide retention

g. Hypoxia causes reflex thickening of mucous secretions
(1) Bronchiolar obstruction
(2) Atelectasis
h. Blood is shunted away from unventilated alveoli leading to further hypoxemia
3. Assessment findings
a. Tachypnea
b. Tachycardia
c. Cough
d. Hemoptysis
e. Apprehension
f. Respiratory distress
g. Dyspnea
h. Evidence of blunt chest trauma
i. Cyanosis
4. Management
a. Airway and ventilatory support
(1) Positive pressure ventilation as necessary
b. Circulatory support
(1) Restrict intravenous fluids (use caution restricting fluids in hypovolemic patients)
c. Pharmacological interventions
d. Non-pharmacological interventions
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

V. Myocardial injuries
A. Pericardial tamponade
1. Epidemiology
a. Incidence
(1) Rare in blunt trauma
(2) Penetrating trauma
(3) Occurs in less than 2% of chest trauma
b. Morbidity/ mortality
(1) Gunshot wounds carry higher mortality than stab wounds
(2) Lower mortality rate if isolated tamponade is present
2. Anatomy and physiology
a. Pericardium
(1) Tough fibrous sac
(2) Encloses heart
(3) Attaches to great vessels at the base of heart
(4) Two layers
(a) Visceral forms epicardium
(b) Parietal regarded as sac itself
(5) Purpose
(a) Anchors heart
(b) Restricts excess movement
(c) Prevents kinking of great vessels

(6) Parietal layer is acutely nondispensable but can slowly distend by as much as 1,000 to 1,500 ml
(7) Space between visceral and parietal layer is "potential space"
(8) Space normally filled with 30-50 ml of straw-colored fluid secreted by visceral layer
(a) Lubrication
(b) Lymphatic drainage
(c) Immunologic protection for heart

3. Pathophysiology
a. Rapid accumulation of fluid over a period of minutes to hours leads to increases in intrapericardial pressure
b. Increased intrapericardial pressure
(1) Compresses heart and decreases cardiac output due to restricted diastolic expansion and filling
(2) Hampers venous return
c. Myocardial perfusion decreases due to pressure effects on walls of heart and decreased diastolic pressures
d. Ischemic dysfunction may result in infarction
e. Removal of as little as 20 ml of blood may drastically improve cardiac output

4. Assessment findings
a. Tachycardia
b. Respiratory distress
c. Narrow pulse pressure
d. Pulsus paradoxus
e. Cyanosis
(1) Head
(2) Neck
(3) Upper extremities
f. Beck’s triad - advanced stage seen in only 30% of patients
(1) Hypotension
(2) Neck vein distention
(3) Muffled heart tones
g. Kussmual's sign
h. ECG changes

5. Management
a. Airway and ventilatory support
b. Circulatory support
(1) Fluid challenge
c. Pharmacological interventions
d. Non-pharmacological interventions
(1) Pericardiocentesis - in hospital management
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

B. Myocardial contusion (blunt myocardial injury)

1. Epidemiology
a. Incidence
(1) 16-76% of blunt trauma

b. Morbidity/ mortality
(1) Significant cause of morbidity and mortality in the blunt trauma patient

2. Pathophysiology
a. Hemorrhage with edema and fragmented myocardial fibers
b. Cellular injury
c. Vascular damage may occur
d. Hemopericardium may occur from lacerated epicardium or endocardium
e. Fibrinous reaction at contusion site may lead to
(1) Delayed rupture
(2) Ventricular aneurysm
f. Areas of damage are well demarcated
g. Conduction defects

3. Assessment findings
a. Associated injuries
(1) One to three rib fractures
(2) Sternal fracture
b. Retrosternal chest pain
c. ECG changes
(1) Persistent tachycardia
(2) ST elevation, T wave inversion
(3) Right bundle branch block
(4) Atrial flutter, fibrillation
(5) Premature ventricular contractions
(6) Premature atrial contractions
d. New cardiac murmur
e. Pericardial friction rub (late)

4. Management
a. Airway and ventilatory support
(1) Oxygen therapy
b. Circulatory support
(1) Intravenous fluid volume
c. Pharmacological interventions
(1) Antiarrhythmics
(2) Vasopressors
d. Non-pharmacological interventions
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

VI. Vascular injuries
A. Aortic dissection/ rupture
1. Epidemiology
a. Incidence
(1) Blunt trauma
(a) Motor vehicle crash
(b) Falls
(2) 15% of all blunt trauma deaths

2. Morbidity/ mortality

a. 85-95% die instantaneously
b. 10-15% survive to arrive at hospital
(1) 33% of survivors die within six hours
(2) 33% of survivors die within twenty-four hours
(3) 33% survive three days or longer

3. Pathophysiology
a. Shear injury
b. Separation of the aortic intima and media
c. Blood enters media through a small intima tear
d. Tear due to effect of high speed deceleration on portions of the aorta at points of relative fixation
e. Increased intraluminal pressure results from impact
f. Thinned out layer may rupture
g. Descending aorta at the isthmus just distal to left subclavian artery is most common site of rupture (ligamentum arteriosom)
h. Ruptures of ascending aorta much less common

4. Assessment findings
a. Retrosternal or interscapular pain
b. Dyspnea
c. Dysphagia
d. Ischemic pain of the extremities
e. Upper extremity hypertension with absent or decreased amplitude of femoral pulses
f. Harsh systolic murmur over precordium or interscapular region

5. Management
a. Airway and ventilatory support
b. Circulatory support
(1) Do not over hydrate
c. Pharmacological interventions
d. Non-pharmacological interventions
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies

B. Penetrating wounds of the great vessels

1. Usually involve
a. Chest
b. Abdomen
c. Neck

2. Wounds are accompanied by
a. Massive hemothorax
b. Hypovolemic shock
c. Cardiac tamponade
d. Enlarging hematomas

3. Hematomas may cause compression of any structure
a. Vena cava
b. Trachea
c. Esophagus
d. Great vessels

e. Heart
4. Management
a. Manage hypovolemia
(1) PASG not recommended
b. Relief of tamponade if present
c. Expeditious transport

VII. Other thoracic injuries
A. Diaphragmatic injury
1. Epidemiology
a. Incidence
(1) Blunt trauma
(2) Penetrating trauma
(3) Frequently encountered injury
b. Morbidity/ mortality
(1) Could be life-threatening
2. Pathophysiology
a. High-pressure compression to abdomen with resultant intra-abdominal pressure increase
b. Can produce very subtle signs and symptoms
c. Bowel obstruction and strangulation
d. Restriction of lung expansion
(1) Hypoventilation
(2) Hypoxia
e. Mediastinal shift
(1) Cardiac compromise
(2) Respiratory compromise
3. Assessment findings
a. Tachypnea
b. Tachycardia
c. Respiratory distress
d. Dullness to percussion
e. Scaphoid abdomen
f. Bowel sounds in affected hemithorax
g. Decreased breath sounds
4. Management
a. Airway and ventilatory support
(1) Positive pressure ventilation as necessary
(2) Caution - IPPB may worsen the injury
b. Circulatory support
c. Pharmacological interventions
d. Non-pharmacological interventions
(1) Do not place patient in Trendelenburg position
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies
B. Esophageal injury
1. Epidemiology

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a. Incidence
(1) Penetrating trauma most frequent cause
(2) Rare in blunt trauma
b. Morbidity/ mortality
(1) Could be life-threatening if missed
2. Pathophysiology
a. Missile and knife wounds penetrate esophagus
b. Can perforate spontaneously
(1) Violent emesis
(2) Carcinoma
(3) Anatomic distortions produced by diverticulae or gastric reflux
3. Assessment findings
a. Pain
b. Fever
c. Hoarseness
d. Dysphagia
e. Respiratory distress
f. Cervical esophageal perforation
(1) Local tenderness
(2) Subcutaneous emphysema
(3) Resistance of neck on passive motion
g. Intrathoracic esophageal perforation
(1) Mediastinal emphysema
(2) Mediastinitis
(3) Subcutaneous emphysema
(4) Mediastinal crunch
(5) Splinting of chest wall
h. Respiratory distress
i. Shock
4. Management
a. Airway and ventilatory support
b. Circulatory support
c. Pharmacological interventions
d. Non-pharmacological interventions
e. Transport considerations
(1) Appropriate mode
(2) Appropriate facility
f. Psychological support/ communication strategies
C. Tracheo-bronchial injuries
1. Epidemiology
a. Incidence
(1) Rare injury - less than 3% of chest trauma
(2) Penetrating trauma
(3) Blunt trauma
b. Morbidity/ mortality
(1) High mortality rate - greater than 30%
2. Pathophysiology
a. Majority occur within 3 cm of carina
b. Tear can occur anywhere along tracheal/ bronchial tree

c. Rapid movement of air into pleural space
d. Tension pneumothorax refractory to needle decompression
e. Continuous flow of air from needle of decompressed chest
f. Severe hypoxia

3. Assessment
   a. Tachypnea
   b. Tachycardia
   c. Massive subcutaneous emphysema
   d. Dyspnea
   e. Respiratory distress
   f. Hemoptysis
   g. Signs of tension pneumothorax that don't respond to needle decompression
4. Management
   a. Airway and ventilatory support
   b. Circulatory support
   c. Pharmacological interventions
   d. Non-pharmacological interventions
   e. Transport considerations
      (1) Appropriate mode
      (2) Appropriate facility
   f. Psychological support/ communications strategies

D. Traumatic asphyxia
1. Epidemiology
   a. Incidence
   b. Morbidity/ mortality
2. Pathophysiology
   a. Sudden compressional force squeezes the chest
   b. Blood backs up into the head and neck
   c. Jugular veins engorge, capillaries rupture
3. Assessment
   a. Cyanosis to the face and upper neck
   b. Jugular venous distention
   c. Swelling or hemorrhage of the conjunctiva
   d. Skin below area remains pink
   e. Hypotension when pressure released
4. Management
   a. Airway and ventilatory support
   b. Circulatory support
      (1) Expect hypotension once compression is released
   c. Pharmacological interventions
      (1) Sodium bicarbonate should be guided by ABG's in hospital
   d. Non-pharmacological interventions
   e. Transport considerations
      (1) Appropriate mode
      (2) Appropriate facility
   f. Psychological support/ communications strategies

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UNIT TERMINAL OBJECTIVE

4-5 At the completion of this unit, the EMT-Intermediate student will be able to demonstrate the practical skills of managing trauma patients.

COGNITIVE OBJECTIVES

None identified for this unit.

AFFECTIVE OBJECTIVES

None identified for this unit.

PSYCHOMOTOR OBJECTIVES

At the completion of this unit, the EMT-Intermediate student will be able to:

4-5.1 Demonstrate the assessment of a patient with signs and symptoms of hypovolemic shock. (P-2)
4-5.2 Demonstrate the management of a patient with signs and symptoms of hypovolemic shock. (P-2)
4-5.3 Demonstrate the assessment of a patient with signs and symptoms of compensated shock. (P-2)
4-5.4 Demonstrate the management of a patient with signs and symptoms of compensated shock. (P-2)
4-5.5 Demonstrate the assessment of a patient with signs and symptoms of decompensated shock. (P-2)
4-5.6 Demonstrate the management of a patient with signs and symptoms of decompensated shock. (P-2)
4-5.7 Demonstrate the assessment of a patient with signs and symptoms of external hemorrhage. (P-2)
4-5.8 Demonstrate the management of a patient with signs and symptoms of external hemorrhage. (P-2)
4-5.9 Demonstrate the assessment of a patient with signs and symptoms of internal hemorrhage. (P-2)
4-5.10 Demonstrate the management of a patient with signs and symptoms of internal hemorrhage. (P-2)
4-5.11 Demonstrate a clinical assessment for a patient with suspected thoracic trauma. (P-1)
4-5.12 Demonstrate the following techniques of management for thoracic injuries: (P-1)
- a. Needle decompression
- b. Fracture stabilization
- c. ECG monitoring
- d. Oxygenation and ventilation

4-5.13 Demonstrate a clinical assessment to determine the proper treatment plan for a patient with a suspected musculoskeletal injury. (P-1)
4-5.14 Demonstrate the proper use of fixation, soft and traction splints for a patient with a suspected fracture. (P-1)
4-5.15 Demonstrate the assessment and management of a patient with signs and symptoms of soft tissue injury, including: (P-2)
- a. Contusion
- b. Hematoma
- c. Crushing
- d. Abrasion
- e. Laceration
- f. Avulsion
- g. Amputation
- h. Impaled object
- i. Penetration/ puncture
- j. Blast

4-5.16 Demonstrate a clinical assessment to determine the proper management modality for a patient with a suspected traumatic spinal injury. (P-1)
4-5.17 Demonstrate a clinical assessment to determine the proper management modality for a patient with a

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suspected non-traumatic spinal injury. (P-1)

4-5.18 Demonstrate immobilization of the urgent and non-urgent patient with assessment findings of spinal injury from the following presentations: (P-1)
- a. Supine
- b. Prone
- c. Semi-prone
- d. Sitting
- e. Standing

4-5.19 Demonstrate preferred methods for stabilization of a helmet from a potentially spine injured patient. (P-1)

4-5.20 Demonstrate helmet removal techniques. (P-1)

4-5.21 Demonstrate alternative methods for stabilization of a helmet from a potentially spine injured patient. (P-1)

4-5.22 Demonstrate documentation of assessment before spinal immobilization. (P-1)

4-5.23 Demonstrate documentation of assessment during spinal immobilization. (P-1)

4-5.24 Demonstrate documentation of assessment after spinal immobilization. (P-1)

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