TERMINAL LEARNING OBJECTIVE.

1. Given a mission, Commander's guidance and intent, rules of engagement, escalation of force criteria, and a simulated exploded improvised explosive device (IED), while serving as an individual in a small unit, react to an exploded improvised explosive device (IED) to prevent further casualties and resume the mission. (HSS-MCCS-2019)

ENABLING LEARNING OBJECTIVE(S).

1. Without the aid of reference and in writing, identify the five categories of blast effects on the human body, within 80% accuracy per Prehospital Trauma Life Support, Current Military Edition. (HSS-MCCS-2019a)

2. Without the aid of reference and in writing, identify the pattern of injuries from an explosive device, within 80% accuracy per Prehospital Trauma Life Support, Current Military Edition. (HSS-MCCS-2019b)

3. Without the aid of reference and in writing, identify the wounding effects of fragmentation, within 80% accuracy per Prehospital Trauma Life Support, Current Military Edition. (HSS-MCCS-2019c)

4. Without the aid of reference and in writing, identify the wounding effects of blast overpressure, within 80% accuracy per Prehospital Trauma Life Support, Current Military Edition. (HSS-MCCS-2019d)
1. **Identify the Five Categories of Blast Effects**

   a. The term “blast injuries” refers to the general injuries caused by an explosive force.

   b. The five categories of blast injury effects are known as primary, secondary, tertiary, quaternary and quinary. It is important to understand the effects of each, as well as the mechanism of injury and injuries associated with all five.

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<thead>
<tr>
<th>Effect</th>
<th>Impact</th>
<th>Mechanism of Injury</th>
<th>Injuries</th>
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</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Direct blast effects (over- and under-pressurization)</td>
<td>Overpressure; Interaction of blast wave with body; Stress and Sheer Waves</td>
<td>Pulmonary</td>
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<td></td>
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<td>Tympanic Membrane</td>
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<td></td>
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<td>Hollow-viscus Injuries</td>
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<td>Secondary</td>
<td>Projectiles propelled by explosions</td>
<td>Fragments from the exploding weapon as well as from the environment (debris, vehicle metal, rocks etc)</td>
<td>Fragmentation Injuries</td>
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<td></td>
<td></td>
<td>Penetrating Trauma</td>
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<tr>
<td>Tertiary</td>
<td>Body propelled onto hard surface</td>
<td>Displacement of body and structural collapse</td>
<td>Penetrating</td>
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<td>Blunt Trauma</td>
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<td>Crush Injuries</td>
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<td>Quaternary</td>
<td>Heat and Combustion Flames</td>
<td>Burns</td>
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<td>Inhalation Injuries</td>
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<td>Asphyxiation</td>
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<td>Quinary</td>
<td>Additives (Chemicals, Radiation etc)</td>
<td>Contamination</td>
<td>Depends on additive</td>
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2. **Pattern of Injuries**

   a. Casualties from explosions on the battlefield are generally segregated into two categories, military and civilian. While military casualties are predominately young and otherwise healthy, civilian casualties may be very young or very old. A large percentage of those will be in relatively poor health.

   b. Military casualties will be more likely to wear protective gear. Therefore, they will be less likely to suffer injuries to the upper torso and head.
c. Most wounds are non-critical, soft tissue or skeletal injuries. Up to 70% of all mortalities involve head injuries.

3. **Wounding Effects of Fragmentation**

   a. Fragmentation injuries are the most common form of injury in a terrorist bombing. Fragments include debris from the munitions itself, the environment surrounding the explosive (sticks, rocks, trash etc) and, in the case of suicide bombers, human body parts.

   b. Treatment of fragmentation wounds will be based on the body area involved and the extent of the injury.

   c. Limbs are by far the most commonly affected body area, accounting for 70% of the injuries from explosive devices. Primary and secondary effects of the blast may require the patient to receive emergency treatments to prevent exsanguination. As with all war wounds, extremity wounds from explosions will need antibiotics to prevent systemic infection.

   d. While eyes are extremely resistant to primary effects of blasts, they are susceptible to secondary and tertiary effects. Explosions that cause shattering of glass have a high incidence of causing penetrating eye injuries. The majority of eye injuries are caused by inadequate eye protection, such as polycarbonate goggles.

4. **Wounding Effects of Blast Overpressure**

   a. Physics of Blast Waves

      (1) Stress waves are supersonic, longitudinal pressure waves. These waves create high potential for injuries, especially in gas filled organs such as the lungs, ears and intestines.

      (2) Sheer waves are lower velocity transverse waves with longer duration than stress waves. These waves cause tissue in the body to move back and forth.

   b. The lung is the second-most susceptible organ to primary blast injury. Lung injuries are: possible between 30-40 psi, 50% possible at 80 psi, universally fatal in open-air blasts of over 200 psi. Lung injuries are the most common cause of death related to the primary blast effect.

      (1) Lung overpressure, or “blast lung” is an often-fatal combination of acute respiratory distress (dyspnea/apnea), bradycardia, and hypotension post-blast exposure. Casualties will show signs of hypoxia (inadequate oxygen at the cellular level) and hemoptysis and may require endotracheal intubation. Symptoms may be obvious immediately or may have a delayed onset of 24-48 hours. Intrapulmonary hemorrhage and edema may result in frothy, bloody secretions. Other injuries may include: pneumothorax, hemothorax, and subcutaneous mediastinal emphysema.
(2) Monitor the casualty for respiratory distress. Give oxygen, if available. If fluid administration is necessary prior to evacuation, carefully manage and avoid fluid overload. Continually monitor the casualty for pneumothorax and treat with needle decompression, if necessary. Do not remove impaled objects. Shorten them for transport and wrap them carefully to prevent movement.

c. The auditory system is the site of the most frequently detected blast injury. Perforation of the eardrum is the most common physical finding and may occur at pressures as low as 5-15 psi. The eardrum is the functional structure that can be injured at the lowest pressure by blasts. Therefore, the results of examining the ear drum may assist you in detecting other primary blast effects. The presence of a ruptured eardrum may be used as a marker of primary blast injury, although an intact eardrum does not absolutely rule out lung injuries; absence of a rupture may lower the index of suspicion for primary blast injury. For this reason, it is imperative that all blast injury casualties be examined for possible tympanic membrane rupture. Blast induced deafness may heighten the patient’s anxiety. It may be permanent or spontaneously resolve in a matter of hours.

(1) In some cases, the eardrum is difficult to visualize. Sudden deafness, tinnitus (ringing in the ears), and vertigo (dizziness) may indicate a rupture. Although not a priority for treatment, auditory blast injury should be addressed within 24 hours. The ear canal should be cleaned of all debris. Most ruptured eardrums will heal on their own without treatment. Signs and symptoms of a perforated eardrum from a blast include hearing loss and bleeding from the ears. Avoid irrigating or probing the ear canal. If the canal is full of contaminated debris, administer antibiotic ear-drops.

d. Gastrointestinal Injuries are more likely to occur in patients of blasts detonated inside a building than those exposed to explosions in an open air environment. Of all abdominal blast injuries, intestinal perforation is the most common. Symptoms include pain in the abdomen, rectum and testes. Signs and symptoms may be difficult to appreciate early in the chain of care.

e. Solid Organ injuries are rare in open air blasts but have been reported in underwater blasts.

f. Central Nervous System injuries to include Traumatic Brain Injuries (TBI) are a significant issue associated with blast injuries. Moderate to sever TBI accounts for 71% of the early deaths associated with explosions and 52% of later deaths. Mild TBI is associated with long term issues such as memory loss, irritability and decreased cognitive functions. For this reason ALL PERSONEL INVOLVED IN AN EXPLOSIVE ATTACK SHOULD BE REFERRED TO THE MEDICAL OFFICER FOR DOCUMENTATION AND EVALUATION.

REFERENCES:
Prehospital Trauma Life Support (PHTLS), Current Edition
Blast Related Injuries Review

1. Identify the five categories of blast effects on the human body.

2. Explain the pattern of injury consistent with a blast victim.

3. Identify the wounding effects fragmentation has on different parts of the body.

4. Describe the wounding effects of blast overpressure.