24 ABDOMINAL TRAUMA

CORE CONCEPTS

- Identify the anatomy and physiology of abdominal organs.
- Assess a casualty with a suspected abdominal injury in a combat environment.
- Treat a casualty with a suspected abdominal injury in a combat environment.

INTRODUCTION

Abdominal injuries are difficult to evaluate in the military treatment facility (MTF) and even more so in the field. Immediate surgical intervention is needed for all penetrating abdominal injuries. Blunt injuries may be more subtle in their presentation but may be just as deadly. Regardless of their cause, abdominal injuries present two life-threatening dangers: infection and hemorrhage. Stay alert to the danger of early shock in casualties with abdominal injuries. Infection can be fatal, but with prompt recognition of abdominal injury and rapid evacuation of the casualty, field intervention will not be required. This lesson will provide an understanding of the anatomy of the abdomen and the types of injuries that may be encountered. You will learn the principles of abdominal injury assessment and casualty stabilization.

ANATOMY AND PHYSIOLOGY

Boundaries

The abdominal cavity is inferior to (below) the thoracic cavity and superior to (above) the pelvic cavity. Its boundaries are pelvic bones, the spinal column, and muscles of the abdomen and flanks. When identifying the source of pain in the abdomen, use the quadrant arrangement.

The four quadrants of the abdomen include the right upper quadrant (RUQ), left upper quadrant (LUQ), right lower quadrant (RLQ), and left lower quadrant (LLQ). The diaphragm is the upper abdominal cavity boundary and, when relaxed, is level with the 4th thoracic vertebrae (T4). Figure 24-1 shows the abdominal quadrants and their associated organs.

Physiology

The liver stores about 10% of a person's total blood volume. It metabolizes carbohydrates (sugars), fat, and protein and stores vitamins and iron. The liver forms various blood-clotting factors, as well as bile, which breaks down fat for digestion and serves as a means for excreting certain waste products from the blood. The liver is also responsible for detoxifying, excreting, and metabolizing many different drugs.

The **gallbladder** stores bile formed by the liver. It empties bile into the **duodenum** (first part of the small intestine). If stones form in the gallbladder, they may obstruct the drainage system (**bile duct**) to the small intestine.

The **pancreas** produces and secretes digestive enzymes into the first part of the small intestine via the **pancreatic duct**. It also produces and secretes hormones (insulin and glucagon) that regulate the blood-sugar (glucose) level into the blood. Insulin promotes glucose entry into most cells of the body, decreasing blood glucose levels. Glucagon increases the release of glucose from the liver into the circulating body fluids, increasing blood glucose levels.

Carbohydrates, proteins, and fats are absorbed in the small intestine, as are ions (sodium, chloride, bicarbonate, calcium, iron, and potassium) and the water that accompanies the ions. However, most water is absorbed in the **colon** (large intestine). Water and electrolytes (up to 7 L/day) are absorbed in the colon. The colon also stores fecal matter until it can be expelled.

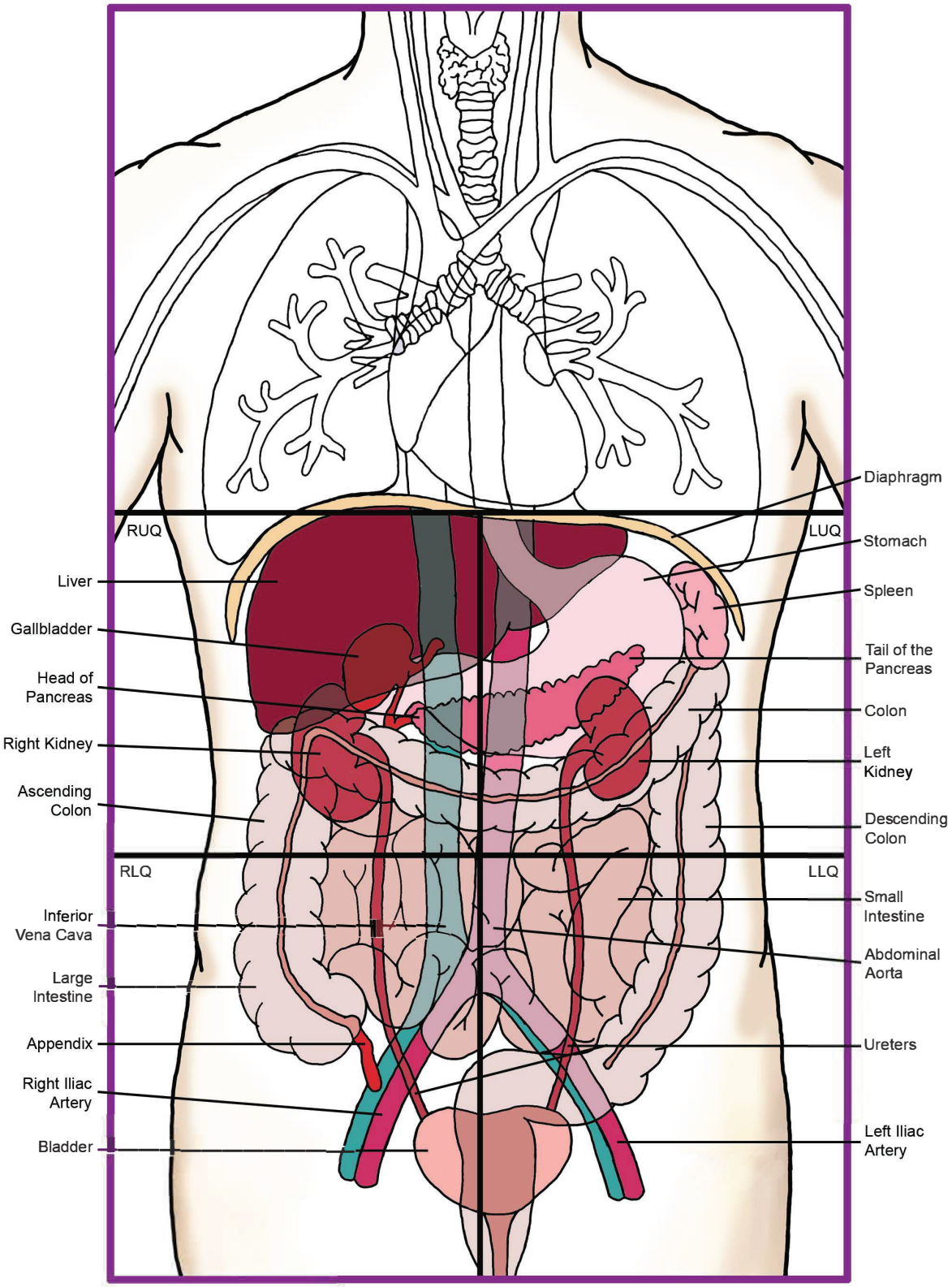

Figure 24-1. Abdominal quadrants and their associated organs.

The stomach stores food until it can be converted into chyme (the semifluid, creamy material produced by digestion of food) and then emptied into the duodenum. It secretes digestive enzymes and is poor at absorption except for highly lipid-soluble substances like alcohol and medications (eg, aspirin).

The **spleen** is an organ of the lymphatic system. It contains the largest amount of lymphatic tissue in the body. It stores red blood cells and platelets and removes ones that are worn out or defective. The spleen carries out immune functions and contains cells involved in fighting infections. It is a highly vascular organ that, if injured, may result in massive hemorrhaging.

Note: The spleen may become inflamed and enlarged in patients with infectious mononucleosis ("mono"). These patients should be advised to avoid contact sports for up to 6 weeks after diagnosis due to a remote possibility of splenic rupture.

Most of the end products of bodily metabolism are excreted by the kidneys via blood filtration and urine formation. The kidneys regulate the water, electrolyte, and acid-base content of the blood.

Solid and Vascular Organs

The liver, spleen, aorta, and vena cava bleed into the abdominal cavity when injured. Blood loss into the peritoneal cavity, regardless of the source, will contribute to hypovolemic shock. A casualty's entire circulating volume can be lost into the abdominal cavity.

Hollow Organs

The intestine, gallbladder, and urinary bladder may spill their contents into the peritoneal cavity and retroperitoneal space upon injury. Release of digestive acids, enzymes, bacteria, and chyme into the peritoneal cavity causes **peritonitis** (inflammation of the peritoneum or lining of the abdominal cavity) and **sepsis** (a massive systemic infection that includes hypotension, decreased urine output, and altered mental status). Bleeding from an intestinal injury is typically minor unless larger vessels of the **mesentery** are damaged.

Due to the proximity of the thoracic and abdominal regions, a wound that started out in the abdomen may end up in the chest, or the other way around. Any penetrating thoracic injury below the nipple line, which is also level with the fourth thoracic vertebrae (T4), may involve abdominal structures (Figure 24-2).

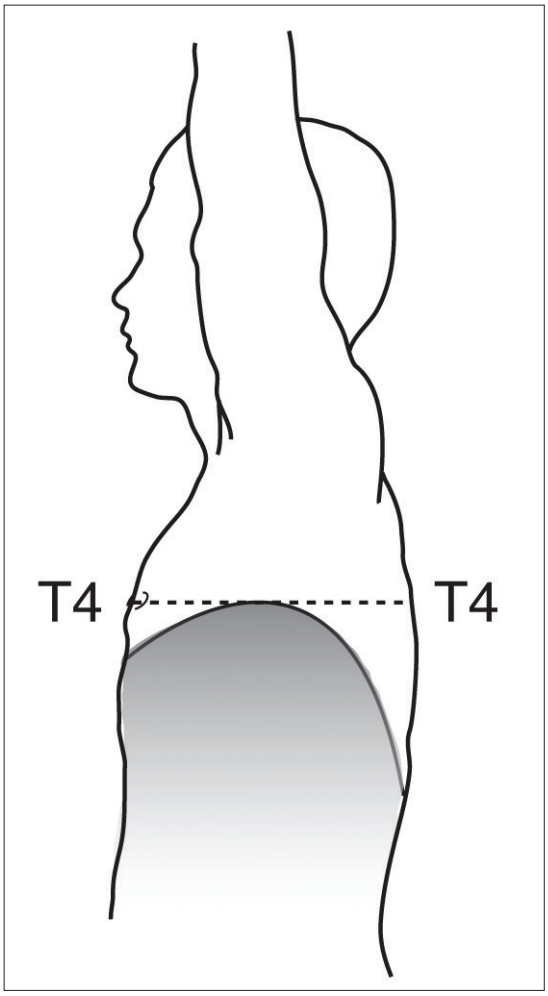

Figure 24-2. Penetrating thoracic injuries below the T4 level (nipple line) have a high probability of involving abdominal structures. Reproduced from Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap IV.4, Fig 4.

ASSESSING ABDOMINAL TRAUMA

Penetrating Trauma

Mentally visualize the path of all penetrating trauma of the abdomen and thorax; never probe penetrating or abdominal wounds with fingers or instruments. Trauma to the thorax or abdomen may continue into a different cavity depending on the position of the diaphragm on impact. Penetrating wounds to the flanks or buttocks may involve organs of the abdominal cavity.

Penetrating trauma in the gluteal area is associated with significant intra-abdominal trauma in up to 50% of cases. In penetrating trauma, the casualty may not initially appear to be in shock unless the object or projectile penetrates a major vessel or organ (Figure 24-3).

Figure 24-3. M16 entry and exit wounds to the abdomen. Reproduced from Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap V.1, Fig 1.

Blunt Trauma

Blunt trauma poses a greater threat to life than penetrating trauma. It is difficult to diagnose, and objective evidence of blunt trauma may not appear on the casualty for hours. The mechanism of injury, such as that depicted in Figure 24-4, and the casualty's complaints of pain may be the only signs of an underlying injury.

Compression injuries are a type of blunt trauma in which organs are crushed between solid objects. Shearing injuries occur when tearing forces are exerted against the supporting ligaments of solid organs and vessels. Deceleration injuries are common and may

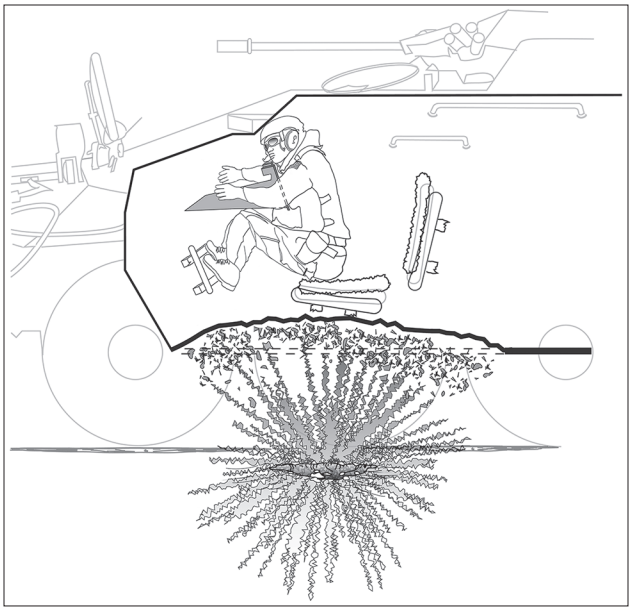

Figure 24-4. How blunt trauma occurs to crewmembers after their armored vehicle is struck by an improvised explosive device.

be caused by restraining devices such as seat belts, gunner's harnesses, and litter straps.

Kinematics

The mechanism of injury and a high index of suspicion play important roles in identifying possible life-threatening abdominal injuries. For example, approximately 15% of stab wounds (low energy) require surgical intervention, whereas approximately 85% of gunshot wounds (medium and high energy) require surgical intervention. Fragmentation wounds are the most common cause of penetrating injuries in combat.

The following are key indicators of abdominal injuries:

- obvious signs of trauma,
- signs of hypovolemic shock without obvious cause,
- degree of shock greater than would be expected by other injuries,
- presence of peritoneal signs, and
- mechanism of injury.

The primary factor in assessing abdominal trauma is not the accurate diagnosis of the injury but rather the determination that an abdominal injury exists. This and the resulting delay of treatment are the major causes of morbidity and mortality in abdominal trauma.

History

When obtaining a casualty's history, there are several key factors to consider. If the individual has been involved in an automobile accident, determine the position of the vehicle, extent of vehicle damage, and position of the casualty within the vehicle. Find out if there was an explosion that threw the victim against immobile objects or transmitted blast pressure to organs inside the abdomen. Keep in mind that overpressure can rupture hollow organs and leave no sign of external injury; ruptured eardrums may signify hollow organ rupture from overpressure. If the injury was caused by a weapon, determine the type of weapon used and the casualty's distance from the weapon. Consider fragmentation wounds. In each case, determine whether safety equipment, such as vehicle seat belts, helmets, or body armor, was used.

Physical Examination

The most reliable indicator of intra-abdominal bleeding is the presence of hypovolemic shock. Look for signs and symptoms of compensated, and later decompensated, shock (see Chapter 8, Shock). Do not waste time auscultating the abdomen in a combat environment; your findings will not alter casualty treatment before reaching the MTF. Inspect for soft-tissue injuries and distention. Soft-tissue injuries due to blunt trauma may not be apparent for hours after the injury; the adult peritoneal cavity can hold up to 1.5 L of fluid before evidence of distention is apparent.

For combat-related abdominal injuries, lightly palpate each quadrant to assess for tenderness and rigidity. Pain or rigidity in any quadrant requires surgical exploration. Avoid deep or aggressive palpation because it may dislodge blood clots, exacerbate existing hemorrhage, and increase spillage of gastrointestinal tract contents. Note any voluntary guarding (ie, the casualty seems to tense up) and involuntary guarding (ie, spasms of the abdominal wall muscles that remain even when the casualty is distracted). Palpate the pelvis for instability in three steps: (1) press posteriorly on the iliac crest, (2) press inward on the iliac crest, and (3) press posteriorly on the symphysis pubis.

Check on Learning

1. What type of physical examination should be completed on a combat casualty with an abdominal injury?
2. What is the most reliable indicator of intra-abdominal bleeding?
3. Why are soft-tissue injuries a poor indication of intra-abdominal bleeding?

MANAGING ABDOMINAL TRAUMA

Casualty Management

Once an abdominal injury is identified, the casualty should be evacuated to an MTF as soon as possible. Evacuating a casualty to an MTF that does not have surgical capabilities defeats the purpose of rapid evacuation. Categorize these casualties as urgent surgical for evacuation precedence.

Figure 24-5. Simulated casualty presenting with penetrating trauma to the abdomen. The casualty's knees are flexed to relieve pain.

Position the casualty for transport with knees bent when possible (Figure 24-5). Manage conditions associated with hemorrhage, airway, breathing, and circulation (HABCs). Establish vascular access with a saline lock. Follow fluid resuscitation protocols (see Chapter 8, Shock) for combat casualties in hemorrhagic shock. You must achieve the delicate balance of maintaining perfusion to the vital organs without restoring a normal blood pressure that will increase internal bleeding. Provide oral or intravenous antibiotics, depending on availability and the casualty's condition.

Special Considerations

Treatment of abdominal trauma can be complicated by many factors. Some significant considerations are addressed below.

Impaled Objects

Do not move or remove impaled objects; leave that task to the surgeon. Instead, stabilize the object either manually or mechanically with built-up bulky dressing. Apply direct pressure with the flat of the hand to control bleeding around the edges of the wound if necessary. Do not palpate the abdomen (Figure 24-6).

Figure 24-6. A 22-year-old male impaled by a 5-ft iron bar due to a traffic accident. The patient fully recovered after the bar was removed. Photograph by Dr Biplab Mishra. Reproduced with permission from http://www.trauma.org/index.php/main/image/754/. License at https://creativecommons.org/licenses/by-nc-sa/2.5/legalcode

Evisceration

Focus your efforts on protecting the protruding segment of intestine or other organs from further damage. Most abdominal contents require a moist environment. Apply a clean or sterile dressing that has been moistened with saline (normal saline intravenous fluid can be used). Do not attempt to replace the protruding segment in the abdominal cavity. Any action that increases intra-abdominal pressure, such as crying, screaming, coughing, or bearing down, can force more of the organs outward (Figure 24-7).

Figure 24-7. Wound showing evisceration of the small intestine. Reproduced from Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap V.5, Fig 1.

Pregnancy

Until about the 12th week of gestation, the uterus remains protected by the pelvis. Injury to the uterus can include rupture, penetration, **abruptio placentae**, and premature rupture of the membranes. The placenta and uterus are highly vascular and can hemorrhage profusely. Additionally, hemorrhage can be concealed for a period of time within the uterus. A casualty with vaginal bleeding secondary to trauma should be evacuated urgently.

By the third trimester, the mother's heartbeat increases by 15 to 20 beats per minute. By the 36th week of pregnancy, the mother's blood volume has increased by about 50%. Because of increases in cardiac output and blood volume, a pregnant casualty may lose 30% to 35% of total blood volume before showing signs of hypovolemia. Systolic and diastolic blood pressure drop 5 to 15 mmHg during the second trimester but will return to normal by term. Ask the casualty about issues with pregnancy that may complicate your assessment and management.

The best way to ensure the survival of the mother and fetus is to provide the mother with aggressive resuscitation and transport. Treatment and transport of a pregnant casualty are similar to that of any other casualty. First, manage conditions associated with

Figure 24-8. Injury to the kidney. Reproduced from: Nissen SC, Lounsbury DE, Hetz SP, eds. *War Surgery in Afghanistan and Iraq 2003–2007*. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute; 2008: Chap V.4, Fig 2.

HABCs. Then transport the casualty on her left side, tilt the right side of the spine board, and elevate the casualty's right leg or manually displace the uterus to the left to relieve supine hypotension.

Genitourinary Injuries

Damage to the kidneys, ureters, and bladder often presents with hematuria, which will not be noted unless the casualty has a urinary catheter (unlikely in a combat environment). Injuries to external genitalia result in soft-tissue hemorrhage, significant pain, and psychological concern. Given the supplies available on the battlefield, control hemorrhage with direct pressure or pressure dressings and manage amputated genital body parts as you would any other amputated body part on the battlefield (Figure 24-8).

Check on Learning

4. What are your options when treating an abdominal evisceration?
5. How should an obviously pregnant female be transported?
6. What is the proper way to manage an impalement?

SUMMARY

Uncontrolled hemorrhage and time are the enemies of the abdominal trauma casualty, and both have immediate consequences to life. You must promptly recognize abdominal injury and the early onset of shock in these casualties. The keys to survival for those suffering from abdominal injuries are early recognition, stabilization, and rapid evacuation.

KEY TERMS

Abruptio placentae. Premature detachment of the placenta.
Bile duct. Any of the intercellular passages that convey bile from the liver to the hepatic duct, which joins the duct from the gallbladder (cystic duct) to form the common bile duct (ductus choledochus) and which enters the duodenum about 3 inches below the pylorus.
Colon. The large intestine from the end of the ileum to the anal canal.
Duodenum. The first part of the small intestine, between the pylorus and the jejunum; it is 8 to 11 inches long. The duodenum receives hepatic and pancreatic secretions through the common bile duct.
Gallbladder. A pear-shaped, gray-blue sac that stores bile from the liver and aids in digestion.
Mesentery. The peritoneal fold that encircles the small intestine and connects it to the posterior abdominal wall.
Pancreas. A compound acinotubular gland that performs multiple functions and is considered both an exocrine and endocrine organ. The exocrine secretions of the pancreas consist of enzymes that digest food in the small intestine. The endocrine cells produce hormones such as glucagon, which raises blood glucose, and insulin, which assists cells of the body to uptake glucose.
Pancreatic duct. The duct that conveys pancreatic juice to the common bile duct and duodenum.
Peritonitis. Inflammation of the serous membrane that lines the abdominal cavity and its viscera.

Sepsis. A systemic inflammatory response to infection, in which there is fever or hypothermia, tachycardia, tachypnea, and evidence of inadequate blood flow to internal organs.

Spleen. A dark red, oval lymphoid organ, located in the left upper abdominal quadrant, that aids in the removal of cell debris; microorganisms; and cells that are old, damaged, abnormal, or coated with antibodies. The spleen also produces white blood cells.

CHECK ON LEARNING ANSWERS

1. What type of physical examination should be completed on a combat casualty with an abdominal injury?

   For combat-related abdominal injuries, lightly palpate each quadrant to assess for tenderness and rigidity. Pain or rigidity in any quadrant of a combat casualty requires surgical exploration. Avoid deep or aggressive palpation because it may dislodge blood clots, promote existing hemorrhage, and increase spillage of contents of the gastrointestinal tract.

2. What is the most reliable indicator of intra-abdominal bleeding?

   The presence of hypovolemic shock from an unexplained source.

3. Why are soft-tissue injuries a poor indication of intra-abdominal bleeding?

   They may not be apparent for hours after the injury.

4. What are your options when treating an abdominal evisceration?

   Focus on protecting the protruding segment of intestine or other organs from further damage. Because most abdominal contents require a moist environment, apply a clean or sterile drssing that has been moistened with saline (eg, normal saline IV fluid). Do not try to replace the protruding segment back into the abdominal cavity.

5. How should an obviously pregnant female be transported?

   Transport the casualty on her left side, tilt the right side of the spine board, and elevate the casualty's right leg or manually displace the uterus to the left to relieve supine hypotension.

6. What is the proper way to manage an impalement?

   Do not move or remove the impaled object. Stabilize it either manually or mechanically with a bulky dressing and apply direct pressure with the flat of your hand to control bleeding around the edges of the wound if necessary.

SOURCES

National Association of Emergency Medical Technicians. *PHTLS: Prehospital Trauma Life Support*, Military Edition. 8th ed. Jones & Bartlett Learning; 2016.

Taber's Cyclopedic Medical Dictionary, 22nd ed. F.A. Davis Co; 2013.