TRAUMA SERIES:

ABDOMINAL TRAUMA

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ABSTRACT

Abdominal trauma is one of the most common causes of preventable trauma-related deaths. In order to reduce the incidence of abdominal trauma deaths, medical professionals should strive to educate themselves about the signs and symptoms of these injuries, especially those that are not readily apparent upon physical examination. Medical professionals who have a comprehensive understanding of diagnosis procedures, risk factors, and treatment options greatly improve a patient's recovery time and significantly reduce morbidity associated with abdominal trauma.

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Statement of Need

Initial stabilization of the patient with abdominal trauma requires well-prepared teams to foster the best probability of patient survival. In the initial assessment and management of a seriously injured patient the health team is required to follow a rapid and systematic approach. Nurses and associates are required to practice and be prepared for a systematic approach in order to provide accurate and life-saving interventions for the patient with abdominal trauma. Sound clinical judgment and a well practiced process of emergency interventions demonstrated by all members of the critical care and surgical teams are imperative to provide high quality care for the patient with abdominal trauma.

Course Purpose

This course will provide advanced learning for nurses interested in the management of the individual with abdominal trauma.

Learning Objectives

1. Differentiate between blunt abdominal trauma and penetrating abdominal trauma.
2. Describe common causes of blunt abdominal trauma.
3. Describe common causes of penetrating abdominal trauma.
4. Identify common external signs of abdominal trauma.
5. Explain the procedure for examining a patient with abdominal trauma.
6. Describe the challenges that are unique to abdominal trauma with evisceration.
8. Identify major organs that are at risk in incidents of abdominal trauma.
9. Describe the most common fractures associated with abdominal trauma.
10. Explain the diagnostic tools most commonly used in abdominal trauma cases.
11. Identify the process for stabilizing a patient with abdominal trauma.
12. Describe the factors that indicate a surgical treatment in abdominal trauma cases.

Target Audience

Advanced Practice Registered Nurses, Registered Nurses, Licensed Practical Nurses, and Associates

Course Author & Director Disclosures

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INTRODUCTION

Abdominal trauma is one of the most common causes of preventable trauma related deaths. Due to the complex nature of abdominal injuries and the composition of the abdominal region, it is imperative that medical providers are aware of the various signs and symptoms of abdominal trauma, as many patients will not present with any outward signs of trauma (1). The abdominal region is comprised of a number of organs, both solid and hollow, as well as major arteries, vessels, and tissue (2). Therefore, abdominal injuries can have an impact on a number of areas within the abdominal region, which poses a significant risk to the patient.

Abdominal trauma patients have a greater chance at recovery if problems can be identified early and treated properly (3). A number of assessments are available to determine the extent of injury to the patient and to identify any potential risks. Once a patient has been assessed, treatment will focus on repairing damage and preventing any additional damage. Many abdominal injuries can be life threatening, but with the appropriate evaluation and proper treatment, the patient’s recovery time is greatly improved and morbidity is reduced significantly. This course offers a review of the most important aspects of abdominal trauma, focusing on its work-up and clinical management.

EPIDEMIOLOGY

Abdominal trauma is one of the leading causes of morbidity and mortality in the United States (4). It is often difficult to identify in patients, which can lead to more severe injuries and long-term repercussions. Abdominal trauma is classified as either blunt or penetrating trauma, depending on the cause of the injury. Blunt trauma occurs as the result of blunt force against the patient’s abdominal area. Blunt force abdominal trauma is commonly caused by impact during a motor vehicle accident, sporting event, falls or any other incident that causes blunt force trauma (5). Penetrating abdominal trauma is
caused by penetration to the abdominal area and is often the result of gunshots or stabbing (6).

Blunt abdominal trauma is present in 10% of the patients who are admitted to emergency centers (7). Approximately 75% of blunt trauma injuries are a result of motor vehicle accidents (8). The most common blunt trauma injuries occur in the spleen and the liver. In these cases, the mortality rate is 8.5% (2). Approximately 66% of injuries occur in males between the ages of 14 and 30 (9). Penetrating abdominal injuries occur in 33% of patients admitted to urban trauma centers and 12% of patients admitted to rural trauma centers (10). Gunshot and stab wounds comprise approximately 95% of penetrating abdominal injuries (6). The mortality rate for penetrating abdominal trauma is approximately 12%, but that rate will vary depending on the type and severity of penetration, as well as the cause of injury (11). Stab wounds cause approximately 25% of penetrating abdominal trauma, and approximately 35% of abdominal trauma injuries occur as the result of gunshot wounds (6).

The mortality rate for patients with penetrating abdominal trauma is higher than it is for those with blunt abdominal trauma (10). However, the mortality rate is dependent upon the mechanism of injury. The type and severity of penetrating abdominal injuries vary depending on the cause and location of the injury. However, the most severe morbidities occur as the result of wound site infections and intra abdominal abscesses (4). In the urban trauma center the stab wounds represent approximately the 35% of the injuries and 10% are blunt abdominal trauma (10).

Pediatric abdominal trauma is classified separately from other forms of abdominal trauma. Pediatric patients have different abdominal anatomy than adult patients; therefore, abdominal trauma affects them differently (12). Approximately 10% of pediatric injuries are classified as abdominal trauma. Of those cases, 80% of the cases are caused by blunt trauma (9). A number of pediatric abdominal injuries are caused by abuse and must be monitored and reported accordingly (13).
The Anatomy of the Abdominal Region

The abdominal area includes the major digestive, reproductive, genitourinary, vascular and endocrine systems, and includes a number of major organs. Typically, the abdominal region is considered to be the area between the diaphragm and the pelvic bony structures on the superior and inferior aspects, as well as the flanks along the lateral walls, the abdominal muscles along the anterior, and the vertebrae and back muscles along the posterior cavity wall (10).

The abdominal region is divided into four quadrants, each of which house specific organs, arteries and vessels. The following is a description of the four quadrants of the abdominal region and vital organs:

Right Upper Quadrant (RUQ)

- Colon - the part of the large intestine that extends from the cecum to the rectum.
- Right Kidney - one of a pair of organs situated in the body cavity near the spinal column that excrete waste products. The kidneys are bean-shaped organs that consist chiefly of nephrons by which urine is secreted, collected, and discharged through the ureter to the bladder.
- Pancreas - a large lobulated gland that secretes digestive enzymes and the hormones insulin and glucagon. Only a small portion of the pancreas is located in the RUQ.
- Liver - a large, very vascular, glandular organ that secretes bile and causes important changes in many of the substances contained in the blood.
- Gallbladder - a membranous muscular sac in which bile from the liver is stored.

Left Upper Quadrant (LUQ)

- Colon - see above.
- Left Kidney - see above.
- **Pancreas** - see above for function. Most of the pancreas is located in the LUQ.
- **Spleen** - a highly vascular, ductless organ that is located in the left abdominal region near the stomach or intestine and is concerned with final destruction of red blood cells, filtration and storage of blood, and production of lymphocytes.
- **Stomach** - muscular, distensible, saclike portion of the alimentary tube between the esophagus and the colon.

**Right Lower Quadrant (RLQ)**

- **Ascending Colon** - see above. Ascending means to move upwards.
- **Small Intestine** - the part of the intestine that lies between the stomach and colon; it consists of duodenum, jejunum, and ileum. It secretes digestive enzymes, and is the chief site for the absorption of digested nutrients.
- **Major artery and vein for right leg** - iliac artery and vein.
- **Appendix** - a small sac extending from the large intestine.

**Left Lower Quadrant (LLQ)**

- **Descending Colon** - see above. Descending means to move downwards.
- **Small Intestine** - see above.
- **Major artery and vein for left leg** - iliac artery and vein (14).

In addition to dividing the abdominal region into the quadrants listed above, the following terms are used to define the four areas of the abdominal region:

- **Intrathoracic Region** – This region includes the spleen, stomach, diaphragm, and a portion of the liver. This region extends from the base of the 12 ribs to the diaphragm.
- **Pelvic Abdominal Region** – This region includes the bladder, rectum, small intestine, and female reproductive system. It is located within the space between the pelvic bones and it extends to the superior aspects of the iliac crests.
• Retroperitoneal region – This area includes the kidneys, ureters, pancreas, aorta, and inferior vena cava. It is separated from the pelvic region by connective tissue.
• True Abdominal Region – This area includes the large and small intestines, part of the liver, gravid uterus, distended bladder, and engorged stomach. The true abdominal region is contained within the connective tissue of the peritoneum (15).

The entire abdominal region is comprised of both solid and hollow organs.
• Solid – spleen, liver, pancreas
• Hollow – stomach, intestines, bladder and gallbladder

Solid organs typically bleed when they are injured, while hollow organs tend to spill their contents into the abdominal cavity when injured (16). Most hollow organs (except for the gallbladder and bladder, which do not contain acids, bacteria, or digestive juices) will leak digestive enzymes and bacteria into the peritoneal cavity. The leaking fluids can cause infections and/or peritonitis (9).

The organs within the abdomen expand and contract as part of the digestive process to accommodate food and waste. To accommodate the expansion and contraction, the abdominal cavity includes a number of open spaces (1). During trauma, these spaces often fill with blood, even when no other signs of injury are present. This can result in more severe injury, as the problem is not easily identifiable (17).

Due to the complexity of the abdominal region, the patient may sustain a number of different injuries during a trauma situation. These injuries will range in severity and are not easily identifiable. Therefore, the patient should be fully assessed and evaluated if an abdominal injury is suspected (16).

The abdominal region is different in pediatric patients and must be treated differently than that of an adult patient. Pediatric patients have less protection in the abdominal
region due to thinner muscle walls and less fat (12). In addition, pediatric ribs are more flexible, which increases the potential for the ribs to damage the abdominal organs (9). The organs are also different. In pediatric patients, the solid organs have more surface area, which means more exposure to damage. The increased elasticity of the organ attachments poses a higher risk of tearing and shearing injuries (1). Therefore, pediatric patients require special care during the assessment and treatment of abdominal trauma. The injuries cannot be treated in the same way that they are treated in adults.

TYPES OF ABDOMINAL INJURY

Blunt Abdominal Trauma

Overview

The majority of abdominal injury is caused by blunt trauma (5). Blunt abdominal injury typically occurs when the abdomen is directly compressed by, or against, a fixed object. In many blunt trauma instances, the trauma may cause tears or subscapular hematomas in the viscera of the solid organs, especially the spleen and liver (18). Other injuries may occur as the result of deceleration forces, which can cause tears in the fixed areas of the organs and the blood vessels, especially in the liver and renal arteries (18). Blunt trauma may also cause ruptures in the hollow organs, which often occurs as the result of increased intraluminal pressure (5).

Although the blunt trauma patient may sustain severe injuries throughout the abdominal region, he or she may not show pronounced signs of the injury or injuries. In many instances, a patient will have little to no pain and will not show signs of the injury externally. However, this can be misleading as the patient may be suffering from a life threatening injury (3). It is especially common for a patient with multiple lower rib fractures to have severe intra-abdominal injuries while experiencing no significant pain (5). This may result in a misdiagnosis and could be fatal to the patient.
Causes of Blunt Trauma

Blunt trauma can be caused by any incident that causes a blunt impact to the abdomen. Common causes of blunt abdominal trauma include seat belt impact during a motor vehicle accident, impact from a fall, sports related injuries, abuse, and any other incident that causes blunt trauma to the abdominal region. However, in many instances, the injury will not be immediately apparent, even if the patient has been confirmed as experiencing blunt trauma (3). Therefore, it is important to assess any patient that has experienced trauma to the abdominal region for possible blunt abdominal injuries. While any type of incident that causes blunt trauma can produce blunt abdominal trauma, the three most common causes of blunt abdominal trauma are seat belts, sports, and abuse.

Seat Belts
Seat belts are one of the primary causes of abdominal trauma. Due to the blunt force produced during a motor vehicle accident, an individual often sustains injuries from the compression of the seat belt across the lap and chest (19). To protect an individual from crashing into parts of the vehicle during impact, the seat belt diverts energy from the head to the chest and abdomen (20). During motor vehicle accidents, the risk of an abdominal injury when an individual is not wearing a seat belt is less than 10%. However, when an individual is wearing a seat belt, the risk of abdominal injury increases to 20% (21). In many accidents, a patient will exhibit a “seat belt sign,” which is contusions and abrasions along the abdomen and chest. In patients with a seat belt sign, the risk of abdominal injury increases to 65% (22).

While any area of the abdominal region can suffer damage from a motor vehicle accident, seat belt injuries typically affect a specific set of organs. Patients typically experience injuries in the stomach, small bowel, colon, rectum, liver and spleen (19). In addition, seat belts frequently cause hollow viscus injuries (21). The abdominal injuries caused by seat belts differ from those sustained by an individual who is not wearing a
seat belt (20). Therefore, the evaluating physician must be aware of the seat belt specific injuries so that the patient receives the proper assessment and treatment.

**Sports**
Abdominal injuries are common sports related injuries, especially in high contact sports such as football, rugby and hockey. Sports related abdominal injuries can range in severity, with the most minor injuries being abdominal strains and the most severe injuries being internal bleeding and organ damage (23). Most injuries, regardless of severity, will produce a significant amount of pain (24). Sports related abdominal injuries are some of the most serious injuries sustained during athletic events, and proper assessment and treatment is crucial to a successful outcome (23).

While athletes can experience a variety of different abdominal injuries as the result of sports related accidents, there are a number of injuries that are most common in sports related injuries. Such injuries are discussed in the following section.

**Solar Plexus Injury**
Many athletes experience a blow to their solar plexus, which can result in temporary paralysis of the diaphragm. When this occurs, the patient will experience the common sensation of having the wind knocked out of him or herself. This injury is common in situations such as being hit in the stomach with a shoulder, other body part, or piece of equipment (24). Solar plexus injury can also occur as the result of falling on an object such as a ball or piece of equipment. Common symptoms include substantial pain, acute shortness of breath, and feelings of panic (25). Typically, a solar plexus injury is relatively insignificant. However, in some instances, it can cause extreme discomfort in the patient and will require some amount of treatment to minimize discomfort (23).

**Hernias**
Hernias occur when the intestines protrude through the abdominal wall. Most hernias occur in the femoral ring or the inguinal canal (26). When a hernia occurs in the femoral ring, the intestines will protrude below the inguinal ligament and then come out through
the femoral canal. When a hernia occurs in the inguinal region, the intestines will protrude through the inguinal canal in addition to the spermatic cord (10). Both types of hernia produce an increase in abdominal pressure, which occurs as the result of a muscle contraction or applied external pressure (26). Typical symptoms include tenderness and/or a palpable mass at the site of herniation (23). Immediate treatment is necessary to prevent significant damage to the intestine, which may occur as the result of strangulation of the intestine. Without immediate treatment, the patient may experience tissue necrosis (27).

Muscle Injury
Since the abdominal muscles are the primary support of the abdominal region, they are especially prone to injury. Most injuries to the abdominal muscles are mild and only cause insignificant damage to the area (23). Mild trauma includes muscle strains and overuse injuries, which are easily treatable (25). While severe contusions are rare, they do occur (26). Therefore, patients must be examined and assessed to ensure that there is not severe damage to the abdominal muscles.

Organ Damage
Organ damage is considered to be the most severe and dangerous sports related abdominal injury (7). Organ damage poses the risk of internal bleeding and organ failure, so it is crucial that the patient receive immediate care (9). While organ damage can be severe, it often produces minimal symptoms. Many patients only experience mild tenderness and present with typical muscle guarding (28). When this occurs, the patient may be treated using an abdominal splint, which can further hide the severity of the injury (27).

In many patients, organ damage, especially hemorrhage, will not become apparent for days or weeks. After this time, the patient may experience systematic dysfunction or organ failure (23). Therefore, it is crucial that patients who present with significant abdominal trauma be examined thoroughly, even when they do not present with any signs of organ damage.
The following is a description of the different organ injuries a patient may experience as part of sports related abdominal trauma:

- **Bladder**
  A small number of athletes may experience a ruptured bladder as the result of a direct blow to a full bladder. However, this is not common, as most athletes do not participate in athletic events with a full bladder. If an athlete does sustain a ruptured bladder, the following symptoms may be present:
  - Hematuria
  - Difficulty with urination
  - Abdominal rigidity

- **Lower Back**
  A direct blow to the lower back can cause significant damage. Athletes who experience this type of trauma are likely to present with kidney or intestinal damage. Some athletes will experience a contused or ruptured kidney, which can cause the following symptoms:
  - Hematuria
  - Muscle guarding
  - Back and flank pain
  - Nausea
  - Vomiting
  - Shock

When a significant force causes the trauma, the patient may suffer severe intestinal damage or a bowel perforation. When this occurs, the patient will experience the following symptoms:
  - Tenderness to the area
  - Changes in bowel function
  - Bloating
  - Systemic symptoms such as temperature or blood pressure changes
• High abdomen
When trauma occurs in the high abdomen, it can cause damage to the liver. This is especially common when the trauma occurs on the right side. Liver damage is especially dangerous as it can often be life threatening. The symptoms of liver damage include:
  o rapid heart rate
  o low blood pressure
  o abdominal pain
  o nausea
  o blood in vomit, feces or urine

• Spleen
Damage to the spleen is common in athletes and is the leading cause of death in athletic injuries. Splenic injuries are often severe and can produce internal bleeding. Patients who have a splenic injury often experience the following symptoms:
  o Shock (clammy, cool, pale skin and weak rapid pulse)
  o Kehr's sign (acute pain in the tip of the left shoulder due to the presence of blood or other irritants in the peritoneal cavity) (26)

Abuse

In this section the focus will be on child abuse because blunt abdominal trauma constitutes a large percentage of injuries to this patient population. Abuse in other vulnerable populations, such as women and elderly, is deserving of a separate focus and discussion of the particular, differing, outcomes of their respective abuse.

Blunt abdominal trauma can occur as the result of child abuse. Therefore, it is important to identify the cause when a child presents with abdominal injuries. Abdominal trauma due to child abuse is often life threatening. In fact, it is the second leading cause of death in child abuse victims (29). Abdominal trauma that occurs from
abuse has a higher rate of mortality and morbidity in children than trauma that occurs from accidents (12). The majority of abuse related abdominal injuries occur in the liver, spleen and bowels (30). In many children, external bruising will be present (31). However, approximately 40% of children with abuse related abdominal trauma show no outward signs (29). In many instances, children who present with abuse related abdominal injuries also have injuries in other areas of the body, especially the head (13).

**Penetrating Abdominal Trauma**

*Overview*

Penetrating abdominal trauma occurs any time an object penetrates the abdomen, which can occur in a variety of incidents including motor vehicle accidents, falls, industrial accidents, military combat, stabbings, and gunshots. However, the primary causes of abdominal trauma are stab wounds and gunshots (6). The extent of the trauma will range in severity depending on a number of factors including the location of the injury, the size of the object, and the amount it has impaled the patient (11). In some instances, the patient will experience full evisceration, while other incidents will produce a small wound.

In penetrating trauma, an object entering the body through the skin and the wall of the abdominal cavity causes damage. Penetrating trauma causes injuries to patients in two different ways:

*First, the object physically damages organ tissues as it penetrates.*
*While passing through organ tissue, the object sends a wave of pressure in all directions, stretching the organs, which can injure adjacent organs, not just the impacted organ. Organs stretch because of their elastic nature and can cause both a temporary and permanent cavity. The greater the speed of a penetrating object, the more kinetic energy is transmitted to the organs, increasing the chance for ricochet off bony objects and for fragmentation (1).*
It is important for healthcare providers to understand the complexity and severity of penetrating abdominal trauma to adequately assess and treat the patient. Abdominal trauma is especially dangerous due to the number of organs located within the abdominal cavity. The number of organs can increase the potential of injury. With penetrating trauma, the injury may be more severe due to the lacerations and wounds caused by the penetrating object (6). Penetrating injuries may or may not penetrate the peritoneum and if they do, they may not cause organ injury (32). Stab wounds are less likely than gunshot wounds to damage intra-abdominal structures (33). The pancreas is the least likely organ to be damaged during penetrating trauma (32). Penetrating wounds to the lower chest may cross the diaphragm and damage abdominal structures (11).

**Causes of Penetrating Trauma**

Penetrating trauma can be caused by any incident that penetrates the abdominal region. Common causes of penetrating abdominal trauma include stab wounds, gunshot wounds, impaling, and any other incident that causes penetrating trauma to the abdominal region. Penetrating abdominal trauma is immediately apparent as it causes an open wound in the skin and abdominal region. While a number of incidents can cause penetrating abdominal trauma, most common causes of penetrating abdominal trauma are stab wounds and gunshot wounds.

**Stab Wounds**

Stab wounds are the most common cause of penetrating abdominal trauma. “*Stab wounds are low-velocity injuries with minimal secondary trauma. Stabbings in the abdomen can result in massive blood loss and may damage organs in both the chest and abdominal cavity. Nearly 5% of trauma patients have been stabbed or cut*” (4). The severity of injury produced by stab wounds will differ depending on the site of injury, the depth of injury, and the type of knife used (34). In many instances, the stab wound will cause trauma through extensive blood loss at the site of the wound (32). However, in
some instances, the stab wound will result in significant organ, muscle and tissue damage in the abdominal region (11). Since damage cannot be seen from the outside, the patient will undergo a thorough assessment, including radiologic imaging, to determine the extent of damage (34).

Patients who experience stab wounds in the anterior abdomen will often require operative care to repair the damage. In fact, anterior abdominal stab wounds have a 30 – 50% chance or resulting in intra-abdominal injuries, which require operative care (33). Patients who do not experience intra-abdominal injury will not require operative care, but they may require other treatment to repair the damage (35). When a patient presents with an anterior abdominal stab wound, the emergency provider will assess the wound using local wound exploration. The primary assessment is used to determine if the patient has damage to the anterior fascia (32). If no damage is detected, the patient will not need extensive care and will typically require minimal treatment to repair the damage. However, if the stab wound has damaged the anterior abdominal fascia, the patient will require continuous monitoring and treatment to ensure that all damage is detected and repaired (34). Common damage includes evisceration of the bowel or omentum (33).

When a patient experiences a stab wound to the back and flank, the chance of intra-abdominal injuries is reduced. In fact, stab wounds to the back and flank only pose a 15% risk of causing intra abdominal injuries (10). Patients with back or flank stab wounds will often require treatment to repair the initial damage to the area and may experience significant blood loss, which can require further treatment (32). In many patients, these types of stab wounds do not produce symptoms, which can result in damage being undetected (34). In some patients, the back and flank stab wound will result in hematuria and blood in the rectum. In these instances, the patient should be monitored and treated for additional damage, as intra abdominal injuries are more likely (11).
Patients who have experienced a stab wound will require a thorough assessment to determine the extent of damage and to provide the appropriate treatment. In many instances, the patient will be able to recover fully. However, when the stab wound causes extensive internal damage, the patient is at risk of long-term damage or death (4). Therefore, all stab wounds should be monitored closely to ensure that the damage in treated properly.

**Gunshot Wounds**

There are approximately 500,000 gunshot wounds per year in the United States, and these wounds typically cause severe damage (36). The amount and severity of injury caused by firearms depends on a number of factors, such as:

- Type of weapon/bullet used
- Distance from weapon
- Location and trajectory/path of injury
- Permanent vs. temporary cavity (37)

All firearm injuries are not the same. Injury and trauma level depends on the type of firearm used. Typically, firearm injuries are categorized as either low velocity injuries or high velocity injuries, and they are classified based on the type of firearm used and the projectile impact that is caused (38). Low velocity injuries are primarily caused by firearms with a muzzle velocity of less than 600 meter per second (m/s). Most low velocity firearm injuries are caused by handguns and are more prevalent than other types of injuries (36). High velocity injuries are caused by firearms with a muzzle velocity of more than 600 meter per second. Most high velocity injuries tend to be caused by military weapons or high-powered hunting rifles (38).

Damage is often dependent on the type of bullet used. Bullets that are encased with hard shells produce deeper penetration and more significant cavitation. Bullets with soft or hollow points typically deform or fragment and often ricochet inside the body (38). This can produce damage to more areas. The actual injuries are influenced by a number of factors, including the point of entry and the distance that the victim is from...
the weapon (39). Some guns, such as shotguns, contain small pellets that spread apart when they are released from the barrel. This produces a blast that spreads over a larger area and will often cause damage to numerous areas of the body rather than one specific point of entry (36). However, these produce less damage when fired from a greater distance (36).

With abdominal gunshot wounds, the patient must be treated appropriately. In many instances the patient may appear stable, but may have extensive hollow or solid organ injury. In many patients, abdominal gunshot wounds will cause extensive hemorrhaging as well as spillage of gastrointestinal contents (40).

Patients who have intra abdominal damage will often present with hypotension, a narrow pulse pressure, and tachycardia. In these instances, the extent of damage is often severe (41). While stab wounds are the most common cause of penetrating abdominal trauma, gunshot wounds are responsible for more fatalities. In fact, gunshot wounds are responsible for 90% of penetrating trauma fatalities (4).

Intra-abdominal injuries from gunshot wounds tend to involve the small bowel (50%), colon (40%), liver (30%) and abdominal vascular structures (25%) (42). Many patients who experience abdominal bleeding as the result of a gunshot abdominal wound will show telltale signs. Patients will often experience pain and present with guarding and rebound tenderness (40). When a patient is unresponsive, the signs of internal abdominal bleeding may include abdominal distension and bruising (35).

Typically, penetrating injuries to the abdomen result in damage to the duodenum, pancreas, kidneys, ureters, bladder, colon, major abdominal vessels and rectum (38). Therefore, the patient must be thoroughly evaluated to identify and treat any hollow or solid organ damage, especially if the patient presents any of the signs above.
SIGNS AND SYMPTOMS

The signs and symptoms of abdominal trauma will vary depending on the type of injury, the cause of injury, the extent of damage and any underlying issues. Therefore, emergency care providers must be familiar with the different signs and symptoms. There are a number of common signs and symptoms that a patient may experience.

General Signs and Symptoms

While the signs and symptoms of abdominal trauma will vary depending on the type, cause and extent of injury, there are a number of common signs and symptoms that will indicate abdominal trauma. These signs and symptoms will be used during the evaluation stage to determine the type of abdominal injury.

_Pain_

Pain will occur in a number of abdominal injuries and will range in severity depending on the type of injury, the location, and the extent of the damage (16). In many instances, the presence of pain will be the only indication of a potential abdominal injury (15). Pain is an important indicator of abdominal injury and should be taken into consideration during an initial evaluation. It is important to identify the type of pain, the severity of the pain, the location of the pain and the consistency of the pain as this information is useful in determining the type and severity of injury.

When an abdominal trauma patient experiences pain and discomfort, it is important to identify the type and location of the pain. The location of the pain is indicative of the underlying cause. In instances where the patient experiences pain in one specific area, the damage is most likely more severe than it would be if the patient experienced generalized pain in the entire abdominal region (43). Therefore, it is important for the provider to fully assess the location, and the type and severity of any pain the patient may be experiencing.
The following components are important considerations when assessing the pain:

- Severity
- Character
- Timing
- Location
- Presence of associated symptoms (43)

The most common symptoms in abdominal trauma patients include:

- Back pain
- Chest pain
- Constipation
- Diarrhea
- Cough
- Breathing difficulty
- Fever
- Nausea
- Vomiting (7)

Most abdominal trauma patients will experience pain in one of the following regions:

- Lower abdominal
- Left lower abdominal
- Right lower abdominal
- Upper abdominal
- Left upper abdominal
- Right upper abdominal (43)

When a patient experiences pain in any of the above areas, the emergency providers will utilize the information to help determine the location and type of injury. However, it is also important to treat the patient and reduce the amount of pain when possible.
**Tenderness**

Many abdominal injuries will cause abdominal tenderness. In fact, abdominal tenderness is regularly associated with abdominal trauma and should be considered a key indicator of abdominal trauma (1). Tenderness is typically identified during the initial evaluation while the emergency provider is conducting the physical evaluation.

Abdominal tenderness is pain that occurs when pressure is applied to the area with the hand (44). Tenderness mostly occurs in one specific area, which is useful in identifying the location of injury, especially during blunt trauma (43). While a number of conditions can cause abdominal pain, very few will cause tenderness (43). Therefore, the presence of tenderness is a key symptom when diagnosing the type of injury.

Some patients may experience *rebound* tenderness, which is pain that occurs with the removal of pressure rather than the application of pressure (9). While rebound tenderness may occur, it is less common than general abdominal tenderness. In most instances, rebound tenderness is caused by a health condition rather than an abdominal injury (18). However, if a trauma patient shows signs of rebound tenderness in the abdominal region, it is important to fully examine the patient to determine if any abdominal trauma has occurred.

**Rigidity**

Abdominal rigidity is a stiffness of the muscles in the abdominal region, which occurs when the area is touched or pressed (18). The stiffness occurs in direct response to the contact made to the area. When an area in the abdomen is sore, pressure will cause it to become more severe (16). The patient will often voluntarily or involuntarily stiffen his or her abdominal muscles to prevent the pain from increasing during touch. When a patient experiences fear or nervousness about being touched, and stiffens his or her muscles in anticipation, it is considered *voluntary* rigidity (9). However, in some instances, the muscles will stiffen themselves in response to the touch. When muscles stiffen on their own it is typically caused by a physical condition. This is called *involuntary* rigidity (18).
**Distension**

In some trauma situations, a patient will experience abdominal distension. Abdominal distention occurs when gases or fluids build up in the abdomen causing abnormal expansion that often results in the abdominal region swelling (45). In some patients, the distention will be mild and will result in minor bloating. In other patients, the distention may be severe and can cause extreme distortion to the abdominal region (45). Distention is most often the result of an underlying health condition or digestive problem. However, distention can occur during abdominal trauma situations (9).

Therefore, when a patient shows signs of abdominal distention following an abdominal injury, it is important to identify the cause and treat it accordingly.

**Abrasions**

Many patients will experience abrasions to the abdominal region as the result of abdominal trauma. While abrasions are not typically life threatening, they can be indicative of a more severe problem (22). In some instances, abdominal abrasions will be limited to minor scrapes to the abdominal region. In other instances, the abrasions may be deep and severe. Abrasions will often appear in situations that have the risk of causing severe internal damage and can be used as an indicator of abdominal trauma (1).

**External Bruising**

External bruising is common in blunt abdominal trauma situations. In most instances, the impact caused by the trauma will cause bruising in the external abdominal region. In addition, some internal injuries will produce a bruised appearance in the abdominal region as blood pools under the surface (7). One of the most common external bruises is the “seatbelt sign” that occurs during a motor vehicle accident. Patients who have been involved in motor vehicle accidents will often exhibit the seatbelt sign, which is bruising that occurs in the area that the seatbelt compressed (22). External bruising is not typically dangerous. However, it is important to evaluate any bruising to determine the underlying cause. Most often, the bruise will appear at the site of injury, and can indicate a severe problem.
**Nausea/Vomiting**

Nausea and vomiting is common in patients who experience abdominal trauma and may indicate a severe problem (16). In most instances, patients will experience nausea and vomiting in conjunction with other symptoms. However, some patients may experience nausea and vomiting as the only symptom of trauma. In some patients, nausea and vomiting may be a mild side effect of minor trauma (9). With others, nausea and vomiting can be indicative of a more severe injury. Therefore, providers must consider the presence of nausea and vomiting when assessing the patient.

**Hematuria**

Hematuria, or blood in the urine, can occur as the result of a number of abdominal injuries. It is common in both penetrating and blunt abdominal trauma (46). Hematuria is divided into two categories:

- Gross hematuria – blood that is visible in the urine
- Microscopic hematuria – blood that is only visible through microscopic examination (47)

In trauma situations, patients typically exhibit gross hematuria, which can range in color from faint pink to dark red. Gross hematuria is indicative of injury to the kidney, ureter, or bladder (48). In many patients, hematuria is associated with a renal laceration or hematoma, both of which are dangerous if untreated (46). Therefore, any presence of blood in the urine must be taken seriously. When a patient shows signs of hematuria, a CT scan is recommended to identify any damage (47).

**Reduced/Diminished Bowel Activity**

When an abdominal injury occurs in the bowel region, a patient will experience reduced or diminished bowel activity. While diminished bowel activity may not be associated with a severe injury, there is a chance that the reduced activity is caused by an obstruction from a severe injury (16). Therefore, providers must provide a thorough examination to identify the specific cause of the reduced activity so that treatment can begin.
**Pneumoperitoneum**

Pneumoperitoneum is gas that occurs in the peritoneal cavity. In many instances, pneumoperitoneum occurs as the result of a critical illness. However, it can also occur during instances of abdominal trauma (49). The most common causes of pneumoperitoneum include:

- Perforated duodenal ulcer (the most common cause of rupture in the abdomen; especially of the anterior aspect of the first part of the duodenum)
- Perforated peptic ulcer
- Bowel obstruction
- Ruptured diverticulum
- Penetrating trauma
- Ruptured inflammatory bowel disease (e.g. megacolon)
- After laparotomy
- After laparoscopy
- Breakdown of a surgical anastomosis
- Bowel injury after endoscopy (50)

Due to the fact that pneumoperitoneum can be indicative of both physical illness and abdominal trauma, providers must assess the patient to determine the exact cause.

**Evisceration**

Evisceration is the protrusion of organs through an open wound in the abdomen. Evisceration occurs frequently in abdominal stab wounds, as the patient’s organs will often protrude through the stab wound (6). An evisceration is extremely dangerous and requires immediate attention. It is imperative that the evisceration is immediately treated surgically to ensure that the organs can be salvaged (51).

Emergency personnel should not attempt to reinsert the protruding organs prior to surgical repair, as they require proper cleaning and evaluation. Until a patient can be treated surgically, the abdominal contents should be covered with a sterile dressing that is moistened with sterile saline. The sterile dressing should then be covered with an
occlusive dressing. This will remain in place until the contents can be evaluated, cleaned and surgically repaired (17).

Organ/Injury Specific Signs and Symptoms

The above signs and symptoms can be present in numerous forms of abdominal trauma. However, damage to specific regions will produce some specific signs that can be used to help determine the type of injury and the extent of damage. The following table provides information regarding Organ/Injury specific signs and symptoms.

<table>
<thead>
<tr>
<th>Organ/Area</th>
<th>Description</th>
<th>Signs and Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatic Injuries</td>
<td>Because of its size and location, the liver is frequently injured when force is applied to the abdomen. The friability of liver tissue, the extensive blood supply, and the blood storage capacity cause hepatic injury to result in profuse hemorrhage.</td>
<td>• Upper right quadrant pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Abdominal wall muscle rigidity, spasm, or involuntary guarding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rebound tenderness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hypoactive or absent bowel sounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Signs of hemorrhage and/or hypovolemic shock</td>
</tr>
<tr>
<td>Splenic Injuries</td>
<td>Injury to the spleen is usually associated with blunt trauma, but may also be associated with penetrating trauma. Fractures of the left 10th to 12th ribs are associated with underlying damage to the spleen.</td>
<td>• Signs of hemorrhage or hypovolemic shock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pain in the left shoulder (Kehr's sign)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Tenderness in the upper left quadrant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Abdominal wall muscle rigidity, spasm, or involuntary guarding</td>
</tr>
</tbody>
</table>
| Hollow Organ Injuries | Forces causing trauma to hollow organs may result in either blunt or penetrating injuries.  
\[ \begin{align*} 
& \text{The small bowel is the hollow organ most frequently injured.} \\
& \text{Deceleration may lead to shearing, which causes avulsion or tearing of the small bowel.} \\
& \text{Seat belts causing compression have resulted in rupture of the small bowel or colon.} 
\end{align*} \] | - Peritoneal irritation  
- Evisceration of the small bowel or stomach  
- Diagnostic Peritoneal Lavage (DPL) may show presence of bile, feces, or food fibers |
| Renal Injuries | The most common injury to the kidney is a blunt contusion, Suspect renal injury if there are fractures of the posterior ribs or lumbar vertebrae.  
\[ \begin{align*} 
& \text{Renal parenchyma can be damaged by shearing and} \\
& \text{Ecchymosis over the flank} \\
& \text{Flank or abdominal tenderness elicited during palpation} \\
& \text{Gross or microscopic hematuria—the absence of hematuria does not rule out renal injury} 
\end{align*} \] |
compression forces causing lacerations or contusion.

| Bladder and Urethral Injuries | The majority of bladder injuries are blunt.  
If a distended bladder ruptures are perforated, urine is likely to extravasate into the abdomen.  
Most ruptures of the bladder occur in association with pelvic fractures.  
Urethral trauma is more common in males than females because the male urethra is longer and less protected. |
|---|---|
|  | • Suprapubic pain  
• Urge, but inability to urinate  
• Hematuria (may be microscopic)  
• Blood at the urethral meatus  
• Blood in scrotum  
• Rebound tenderness |

RISKS

Due to the complexity of abdominal trauma, there are a number of risks when a patient sustains an abdominal injury. The abdominal region is comprised of a number of organs, tissue and blood vessels, which increases the chance of severe injury. When a patient receives an abdominal injury, there is a chance that more than one area of the abdominal region will be impacted, which could cause life threatening complications. Like the injuries themselves, the risks associated with abdominal trauma range in severity depending on the type and cause of injury as well as the location of the injury.
Blood Loss

Blood loss is a common risk in abdominal trauma situations, and can occur in instances of blunt and penetrating abdominal trauma (52). Blood loss can result from damage to the organs or abdominal blood vessels (53). Depending upon the underlying structures affected, abdominal injuries can result in significant hemorrhage. For instance, improperly positioned seat belts can cause liver or spleen ruptures that may result in significant internal blood loss (54). In blunt abdominal trauma, the most commonly injured organs are the spleen and the liver. The liver is also frequently injured in penetrating trauma due to its relatively large size (55). It is a very vascular organ and bleeds profusely when it is injured. Blood loss from penetrating trauma occurs because the skin and major vessels are lacerated during penetration (53).

Infection

Infections can occur in patients with abdominal injuries as the result of a number of different factors, depending on the type of injury and treatment provided. In some cases, infections will occur as the result of the injury itself. For example, most hollow organs (except for the gallbladder and bladder, which do not contain acids, bacteria, or digestive juices) will leak digestive enzymes and bacteria into the peritoneal cavity. The leaking fluids can cause infections and/or peritonitis (56). In other situations, infections will occur as the result of medical interventions, especially surgery (57).

Infections pose a high risk for abdominal trauma patients as they are often life threatening. Due to the initial trauma sustained, patients are already compromised. Therefore, their systems are unable to adequately fight off infections (58). Many trauma patients succumb to sepsis. In fact, sepsis is one of the leading causes of late death in trauma patients. Sepsis is especially common following transfusion, hypotension, and prolonged ventilator support (57).

Patients who develop an infection will have to undergo intensive treatment to eliminate the infection and prevent any further infection from developing. The specific treatment
used will vary depending on the type of infection and the patient’s individual physical state (58). However, the following is the standard protocol for infection management in abdominal trauma patients:

**PREVENTION AND PROPHYLAXIS:**

The use of appropriate prophylactic antibiotics in the setting of trauma is a generally accepted practice in specific situations. Antibiotics used in the patient with intra-abdominal injury associated with possible bowel perforation and peritoneal spillage is only an adjunct to drainage and repair. Regimens should be directed at fecal flora.

Given the increase in enterococcal infections, antibiotic regimens that cover this organism may be entertained, but the role of this organism in these patients is unclear. Most authors suggest 1 to 3 days of intravenous antibiotics if a hollow viscous injury is found, although shorter regimens are equally efficacious. Open fractures should receive prophylaxis against Staphylococcus because of the high risk of subsequent osteomyelitis. Twenty-four-hour regimens with a first-generation cephalosporin are as effective as longer treatment periods. Antibiotic prophylaxis with first-generation cephalosporins for facial fractures reduced the risk of infection only in patients with mandibular or compound fractures. Prophylaxis in basilar skull fractures is not effective in decreasing the incidence of meningitis. Lastly, there have been vaccine studies using capsular polysaccharide antigens against common gram-negative rods. These compounds elicit immune responses in trauma patients and could play a role in the prevention of nosocomial infections in the future.

**GENERAL MANAGEMENT OF THE TRAUMA PATIENT:**

Because of the acuteness of their presentation, trauma victims are subjected to many intravenous lines and invasive devices. Fever evaluations should pay close attention to these lines, devices, wounds, and the patient's overall pulmonary status. These patients are typically younger and are usually in good health before injury; therefore, drug doses may need to be increased because of supernormal volumes of distribution and catabolism of these medications. Appropriate discontinuation of
antibiotics should be entertained when no clear source is found. Prospective surveillance of this patient population by an infectious disease practitioner can allow for more rapid diagnosis of infection and more appropriate use of antibiotics. (59)

**Shock**

Shock is common in all trauma situations, including abdominal trauma. Shock occurs when a patient experiences major trauma to one or more areas of the body and it can be extremely dangerous (60). According to the University of Missouri:

*More than 200,000 people die in the United States from septic shock and hemorrhagic shock each year. Shock is defined medically as a condition of abnormally low blood pressure associated with poor blood flow to the tissues. It can result from physical damage (hemorrhagic shock) or from infection (septic shock). In shock, too little blood goes to vital organs, such as liver, kidney, intestine, and brain. This causes cellular damage, loss of function of organs, and, ultimately, death. Hemorrhagic shock is primarily caused by traumatic injury, from automobile accidents, bullet or knife wounds, and falls.* (61)

The different types of shock have been identified to include the following (62):

- **Hypovolemic**
  - Hemorrhagic
  - Non-hemorrhagic

- **Obstructive**
  - Pulmonary embolism
  - Pericardial tamponade
  - Tension pneumothorax
  - Constrictive pericarditis
**Cardiogenic**
- Ischemic
- Arrhythmic
- Mechanical

**Distributive**
- Septic
- Neurogenic
- Anaphylactic
- Adrenal insufficiency

Shock can occur in four different stages. The following table provides information on the four stages of shock:

<table>
<thead>
<tr>
<th>Stage of Shock</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compensated Traumatic Shock</td>
<td>In compensated traumatic shock, an increase in heart rate and vasoconstriction of nonessential and ischemia-tolerant vascular beds will allow prolonged survival and easy recovery once hemostasis is achieved and resuscitation is completed.</td>
</tr>
<tr>
<td>Decompensated Traumatic Shock</td>
<td>Decompensated traumatic shock, also known as progressive shock, is a transitory state in which lack of perfusion is creating cellular damage that will produce toxic effects. Shock is still reversible at this stage.</td>
</tr>
<tr>
<td>Subacute Irreversible Shock</td>
<td>In subacute irreversible shock, the patient is resuscitated to normal vital signs but succumbs at a later time to multiple organ system failure (MOSF) as the result of tissue...</td>
</tr>
<tr>
<td></td>
<td>ischemia and reperfusion.</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Acute Irreversible Shock</strong></td>
<td>Acute irreversible shock is the condition of ongoing hemorrhage, acidosis, and coagulopathy that spirals downward to early death from exsanguination.</td>
</tr>
</tbody>
</table>

When a patient experiences shock, it is important to provide immediate treatment to avoid further complications. In most patients, shock will be treated and managed using the ABCDE (airway, breathing, circulation, disability, exposure/environmental) approach and providing continuous monitoring and circulatory treatment (63).

**Related Injury**

Trauma to the abdominal region involves a number of organs. In addition, damage can occur to areas just outside of the abdominal region.

**Organ Damage**

The abdominal region is comprised of a number of different organs. Therefore, the patient has a high risk of sustaining organ damage during an abdominal trauma situation. Unlike other organ injuries, abdominal trauma is typically a multiple organ injury due to the composition of the abdominal cavity. Since the abdominal cavity is comprised of a variety of body parts, including solid and hollow organs, tissue, and cavities, there is greater chance of multiple organ injuries (16). In addition, there are both gas filled and fluid filled organs, which further complicates the injury (1).

Unlike other organs, the organs in the abdominal cavity have limited protection from bony structures, which makes them more vulnerable to puncture or pressure related damage (7). The bottom ribs provide some protection to the organs, but they can also cause damage if they are fractured. In these instances, the sharp edges of the ribs can puncture the organs (64).
The following table includes an overview of the different types of organ injury. More in-depth information regarding each organ is included immediately following the table.

<table>
<thead>
<tr>
<th>ORGAN OR TISSUE</th>
<th>COMMON INJURIES</th>
<th>SYMPTOMS</th>
</tr>
</thead>
</table>
| Diaphragm       | • Partially protected by bony structures, diaphragm is most commonly injured by penetrating trauma (particularly gunshot wounds to the lower chest)  
• Automobile deceleration may lead to rapid rise in intra-abdominal pressure and a burst injury  
• Diaphragmatic tear usually indicates multiorgan involvement | • Decreased breath sounds  
• Abdominal peristalsis heard in thorax  
• Acute chest pain and shortness of breath may indicate diaphragmatic tear  
• May be hard to diagnose because of multisystem trauma, or the liver may "plug" the defect and mask it |
| Esophagus       | • Penetrating injury is more common than blunt injury  
• May be caused by knives, bullets, foreign body obstruction  
• May be caused by iatrogenic perforation  
• May be associated with cervical spine injury | • Pain at site of perforation  
• Fever  
• Difficulty swallowing  
• Cervical tenderness  
• Peritoneal irritation |
| Stomach         | • Penetrating injury is more common than blunt injury; in one-third of patients, both the anterior and the posterior walls are penetrated  
• May occur as a complication from cardiopulmonary resuscitation or from gastric dilation | • Epigastric pain  
• Epigastric tenderness  
• Signs of peritonitis  
• Bloody gastric drainage |
| Liver               | • Most commonly injured organ (both blunt and penetrating injuries); blunt injuries (70% of total) usually occur from motor vehicle crashes and steering wheel trauma  
|                    | • Highest mortality from blunt injury (more common in suburban areas); gunshot wounds (more common in urban areas)  
|                    | • Hemorrhage is most common cause of death from liver injury; overall mortality 10%–15%  
|                    | • Persistent hypotension despite adequate fluid resuscitation  
|                    | • Guarding over right upper or lower quadrant; rebound abdominal tenderness  
|                    | • Dullness to percussion  
|                    | • Abdominal distention and peritoneal irritation  
|                    | • Persistent thoracic bleeding  

| Spleen             | • Most commonly injured organ with blunt abdominal trauma  
|                    | • Injured in penetrating trauma of the left upper quadrant  
|                    | • Hypotension, tachycardia, shortness of breath  
|                    | • Peritoneal irritation  
|                    | • Abdominal wall tenderness  
|                    | • Left upper quadrant pain  
|                    | • Fixed dullness to percussion in left flank; dullness to percussion in right flank that disappears with change of position  

| Pancreas            | • Most often penetrating injury (gunshot wounds at close range)  
|                    | • Blunt injury from deceleration; injury from steering wheel  
|                    | • Often associated (40%) with other organ damage (liver, spleen, vessels)  
|                    | • Pain over pancreas  
|                    | • Paralytic ileus  
|                    | • Symptoms may occur late (after 24 hours); epigastric pain radiating to back; nausea, vomiting  
|                    | • Tenderness to deep palpation  

| Small intestines    | • Duodenum, ileum, and jejunum; hollow viscous structure most often  
|                    | • Testicular pain  
|                    | • Referred pain to shoulders,
injured by penetrating trauma
- Gunshot wounds account for 70% of cases
- Incidence of injury is third only to liver and spleen injury
- When small bowel ruptures from blunt injury, rupture occurs most often at proximal jejunum and terminal ileum

<table>
<thead>
<tr>
<th>Large intestines</th>
<th>chest, back</th>
</tr>
</thead>
<tbody>
<tr>
<td>• One of the more lethal injuries because of fecal contamination; occurs in 5% of abdominal injuries</td>
<td>• Mild abdominal pain</td>
</tr>
<tr>
<td>• More than 90% of incidences are penetrating injuries</td>
<td>• Peritoneal irritation</td>
</tr>
<tr>
<td>• Blunt injuries are often from safety restraints in motor vehicle crashes</td>
<td>• Fever, jaundice, intestinal obstruction</td>
</tr>
<tr>
<td>• Pain, muscle rigidity</td>
<td>• Guarding, rebound tenderness</td>
</tr>
<tr>
<td>• Blood on rectal exam</td>
<td>• Tenderness, fever</td>
</tr>
</tbody>
</table>

Liver

The liver is one of the most commonly injured organs in blunt trauma situations. In fact, liver damage occurs in approximately 3 – 10% of all abdominal trauma patients (66). Patients who experience liver trauma have a tendency to sustain injuries to the right lobe more frequently than the left lobe (67). Within the right lobe, it is more common to experience an injury to the poster segment than the anterior segment. Patients rarely present with injuries to the caudate lobe. If injuries do occur, they are often in conjunction with a right or left lobe injury (66).

Blunt hepatic trauma can be life threatening. The mortality rate for these injuries ranges between 8 – 25% (68). Most instances of death occur as the result of uncontrolled hemorrhage (66). With proper management, the damage from hepatic trauma can be
mitigated. A CT is often used in hemodynamically stable patients to determine the extent of the damage, and treatment is determined after the assessment (67). Many individuals with severe damage can be treated without resorting to surgery as long as they are not actively bleeding (66). Hepatic injuries typically take the following forms:

- Laceration
- Intraparenchymal hematoma
- Infarct and subcapsular hematoma (68)

The American Association of Trauma Surgery has published a hepatic injury scale as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Capsular tear, &lt; 1cm parenchymal depth</td>
</tr>
<tr>
<td>II</td>
<td>Parenchymal tear, 1-3cm parenchymal depth</td>
</tr>
<tr>
<td>III</td>
<td>Parenchymal disruption, &gt; 3cm parenchymal depth but &lt; 25% of hepatic lobe</td>
</tr>
<tr>
<td>IV</td>
<td>Parenchymal disruption, 25-50% of hepatic lobe</td>
</tr>
<tr>
<td>V</td>
<td>Parenchymal disruption, &gt; 50% of hepatic lobe</td>
</tr>
<tr>
<td>VI</td>
<td>Hepatic avulsion</td>
</tr>
</tbody>
</table>

(69)

In penetrating trauma situations, the patient will often sustain a liver laceration, as liver lacerations are quite common. However, very few patients will experience biliary tract injuries, as they occur infrequently (10). When biliary tract injuries do occur, they are quite difficult to diagnose (10). Many blunt trauma patients will incur fractures in the 7\(^{th}\) to 9\(^{th}\) ribs overlaying the liver. When these fractures occur, they will produce upper right quadrant tenderness (64). Once the blood has been present in the ribs for two or more hours, the patient will experience peritoneal irritation and will begin showing signs of rebounding sensitivity and guarding (67).

When the patient’s injuries occur in the right lower chest or the right upper abdomen, a liver laceration should be suspected (68). A liver laceration is also a possibility if a blunt
trauma patient experiences upper quadrant tenderness (66). A laceration is easily identified and treated non-operatively using a CT scan in a responsive patient (68). In an unresponsive patient, or a patient who is in shock, a peritoneal lavage will be necessary for confirmation of an intraperitoneal hemorrhage (69). When bile is present on the peritoneal lavage, a biliary tract injury can be confirmed (67). In severe cases, the lacerations will require laparotomy and surgical repair. However, smaller lacerations can be treated and managed non-operatively (68).

Spleen

Splenic injuries are the most common blunt abdominal trauma injuries and they typically produce hemorrhage related hypotension (70). In many instances, a patient will experience a splenic injury when the 9th and 10th ribs on the left side are fractured, as well as when left upper quadrant tenderness and/or tachycardia are present (64). In these instances, the patient will often experience pain in the left shoulder. However, the pain will typically not occur until an hour or two after the trauma occurs. Additionally, rebound sensitivity and guarding may occur, but will not be present until after the blood has begun to irritate the peritoneum (71).

Splenic rupture is the most severe spleen injury and it can be life threatening if not treated properly and immediately (72). When a patient presents with tachycardia or hypotension and upper left quadrant tenderness, a ruptured spleen should be suspected (70). A CT scan or a peritoneal lavage will be used to assess the trauma and identify a potential splenic rupture. A peritoneal lavage is typically used in patients who show signs of a significant hemorrhage, while a CT scan is commonly used in patients who are deemed stable (71). If a patient has small lacerations or injuries, treatment can often be administered in a non-operative format. However, larger injuries and lacerations will typically be treated by oversewing the area or with a splenectomy (71).

Common splenic injuries include:
• Laceration
• Intraspelnic hematoma
• Subcapsular hematoma or infarction (70)

There are a number of splenic injury classification systems. The following system provides a solid set of criteria for classifying splenic injuries and is used frequently in cases of abdominal trauma.

<table>
<thead>
<tr>
<th>Class</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Capsular disruption, subcapsular hematoma</td>
</tr>
<tr>
<td>II</td>
<td>Peripheral laceration, hematoma &lt; 3cm</td>
</tr>
<tr>
<td>III</td>
<td>Fractures extending to the hilum, hematoma &gt; 3cm</td>
</tr>
<tr>
<td>IV</td>
<td>Shattered spleen, vascular disruption</td>
</tr>
</tbody>
</table>

(69)

_Kidneys_

Kidney injuries are most commonly associated with falls and motor vehicle accidents, especially automobile accidents (73). They frequently occur when a patient experiences fractures of the 11th to 12th ribs (64). Approximately 15 – 40% of all abdominal trauma patients experience renal injuries (74). A renal injury should be suspected if a patient presents with flank tenderness or hematuria (75). When a hematuria is present, the source of injury must be identified immediately to prevent any additional damage. Kidney lacerations are especially prone to extensive bleeding, which occurs within the retroperitoneal space and can cause significant damage (73). Some abdominal trauma may result in a ruptured kidney, which requires immediate treatment as it can be life threatening (75). A ruptured kidney should be suspected if the patient shows any of the following signs:

• Pain on inspiration in the abdomen and flank
• CVA tenderness
- Gross hematuria (sometimes only a microscopic hematuria will be present)
- Flank discoloration (late finding - rarely present in emergency department) (74)

It is important to assess the patient when he or she presents with the above symptoms; as these symptoms can also be caused by a contused kidney (73). An IVP examination or a CT scan will be used to determine whether the patient has a ruptured kidney or a contused kidney. In some instances, a contrast study may be used to assess the kidneys (75). This typically occurs when the contrast study is being utilized for a different reason. In the contrast study, the lacerated kidney will show dye leakage while the contused kidney will appear normal or will only show a hint of dye in the stroma. A kidney that cannot be visualized indicates a severe rupture or an avulsion of the renal pedicle (75). While most kidney lacerations can be managed non-operatively, those that show any leakage of dye will have to be treated surgically. A ruptured kidney always requires surgical intervention (74).

Injury to the kidneys can be classified using the following four categories:

<table>
<thead>
<tr>
<th>Class</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Contusions, small corticomedullary lacerations that do not communicate with the collection system</td>
</tr>
<tr>
<td>II</td>
<td>Laceration that communicates with the collection system</td>
</tr>
<tr>
<td>III</td>
<td>Shattered kidney, injury to the vascular pedicle</td>
</tr>
<tr>
<td>IV</td>
<td>UPJ avulsion, laceration of the renal pelvis</td>
</tr>
</tbody>
</table>

(69)

**Bladder**

Bladder injuries are most common with blunt pelvic trauma, pelvic fractures and penetrating injuries (76). The type and severity of the bladder injury depends on the degree of distension of the bladder. Patients who have a distended urinary bladder are more susceptible to injury than those with an empty bladder (77). While some patients
may experience minor bladder injuries, the majority of trauma situations result in a ruptured bladder (76).

A bladder rupture can be either intraperitoneal or extraperitoneal. A direct blow to a distended bladder often causes an intraperitoneal rupture. An extraperitoneal rupture is typically caused by a shear injury at the base of the bladder (78). Bladder ruptures can occur upward into the peritoneal cavity, or they can rupture into the tissues between the pelvic wall and peritoneum (79). In most bladder ruptures, whether intraperitoneal or extraperitoneal, the patient will experience a gross hematuria (80). If a patient presents with blood in the urethral meatus or lower abdominal or pubic area pain, a ruptured bladder should be suspected. A ruptured bladder is typically diagnosed using a retrograde urethrogram and is treated using a foley catheter, which provides drainage (79). Depending on the location and severity of the injury, the rupture may be managed operatively or non-operatively. Patients will also require a urologic consultation (76).

**Ureter**

An injury in the ureter is typically caused by penetrating trauma. However, tears in the urethra can also occur as the result of severe pelvic fractures (81). Most patients will experience a general ureteral injury or a urethral tear (82). The symptoms and subsequent treatment will depend on the specific type of injury. Patients who have sustained a ureteral injury will often have blood in the urine and/or blood and bloody ooze at the end of the ureter (83). Patients who sustain a urethral tear will often have a pelvic fracture and will show one or more of the following signs:

- Tender pubic symphysis
- Perineal or scrotal hematoma
- Tender, mobile, or high prostrate upon rectal exam (81)

A ureteral injury or tear is identified using a retrograde urethrogram (83). Once the specific injury has been identified, treatment can begin. In some patients, a suprapubic cystostomy will be inserted to provide bladder drainage and to monitor fluid output.
Other than drainage, an urologist will manage the injury as ureter injuries and tears are considered low priority injuries (82).

**Pancreas**

Approximately 3 – 10% of all abdominal injuries occur in the pancreas (84). They are typically caused by a forceful blow, which creates compression between the spine and abdominal wall (85). Most patients will experience pancreatic injuries in conjunction with other abdominal injuries (86). However, pancreatic injuries have a higher rate of mortality than some other abdominal injuries (4). Approximately 25% of pancreatic injuries result in death. The majority of pancreatic trauma deaths occur as the result of hypovolemic shock from major visceral hemorrhage (87).

It is difficult to diagnose a pancreatic injury, especially a laceration, as many patients will not show outward signs of injury (84). Therefore, the emergency provider should use a CT scan or surgical exploration to evaluate the patient and identify any pancreatic trauma (88). If a patient is admitted after an incident that involves a localized blow to the midsection, a pancreatic injury should be suspected and the appropriate assessments should be initiated (86).

When a patient does experience symptoms of a pancreatic injury, they often present with vague upper and mid abdominal pain that radiates into the back (85). The following CT scan findings of a general pancreatic injury include:

- Linear hypodensity extending around the pancreatic peranchyma
- Diffuse thickening of Gerota’s fascia
- Retropancreatic fluid anterior to the splenic vein (89)

In some instances, the CT scan will appear normal for approximately 12 hours after the injury occurs. Therefore, it is important to conduct a second CT scan 12 – 14 hours later if a pancreatic injury is still suspected (87).
The treatment of injury to the pancreas will vary depending on the size and severity of the injury. In some cases, the injury can be treated without surgical intervention. However, a consultation with a surgeon should be initiated to make the determination (88).

**Bowel**

Bowel injury during abdominal trauma is less common than other injuries, as it occurs in fewer than 5% of blunt abdominal trauma patients (90). When bowel injuries do occur, they are typically caused by motor vehicle accidents, as most bowel injuries are the result of seat belts (19). The injuries can range in severity from a mild, focal mural hematoma to a more severe complete transaction (91). In most patients, the injury will involve the duodenum, most specifically the second and third sections (92). It is very uncommon for patients to experience an injury in the colon (93). Penetrating trauma affects the bowel differently, as it typically breaks the wall of the bowel. Penetrating trauma is most likely to cause trauma to the small bowel, stomach and large intestine (92).

Bowel injuries are difficult to identify and often require a CT scan (94). Approximately 30% of patients will show signs of a bowel injury, which include tenderness, rigidity, and absent bowel sounds. However, the majority of patients will show no signs at all (92). It is crucial that a bowel injury is diagnosed immediately as an undetected bowel perforation can be fatal if left untreated for 24 hours or more. In fact, the mortality rate for patients with an untreated bowel perforation increases from 5% to 65% after 24 hours (90).

A CT scan specifically looks for the following signs of bowel injury:

- Extraluminal air
- Extravasation of oral contrast
- Thickened or discontinuous bowel wall
- A high-attenuation clot (sentinel clot) adjacent to the involved bowel
- Streaky soft tissue infiltration by fluid (92)
In all bowel ruptures and most other bowel injuries, surgical intervention is necessary. It is uncommon for a patient to be treated non-operatively (90).

**Fractures**

Fractures are a common risk during abdominal trauma, especially in instances of blunt trauma (9). The impact that causes abdominal trauma is significant enough to cause fractures in the bones surrounding the abdominal region. Most fractures occur in the spinal region, the ribs and the pelvis. The fractures themselves pose a risk to the patient, but they also have the potential to create further complications and damage in abdominal region following a trauma situation.

**Rib Fractures**

The ribs cover and protect the chest cavity and the organs that comprise the cavity. The ribs are bone, but are connected by several layers of muscles (64). They attach to the spine to provide stability. While the ribs provide protection to the organs within the chest cavity, they are quite fragile (64). Therefore, rib fractures are very common. Most rib fractures occur upon impact in blunt trauma situations (9). When a rib fracture is non-displaced and occurs in a single rib, it is considered a hairline fracture, or simple fracture (94). When a fracture causes the edges of the ribs to become misaligned or displaced, it is considered a complex fracture and it is more serious than a hairline fracture (64). The most severe form of rib fracture is “flail chest,” which is the term used when a number of connecting ribs are broken in multiple places. This creates a section of the ribs that can move independently and is considered “free floating” (94).

Most rib fractures occur within the 7th – 10th ribs (64). In rare instances, damage may occur within the 1st or 2nd ribs, which is indicative of severe damage to the brachial plexus, the subclavian vessels, or associated with head, facial or thoracic aorta injuries (94). Lower rib fractures frequently occur in conjunction with injuries to the diaphragm, liver, or spleen (95). Rib fractures are especially dangerous for abdominal trauma.
patients as the broken rib pieces can cause additional damage to the organs, tissues and muscles in the region (64).

**Vertebral Fractures**

Vertebral (spinal) fractures often occur in conjunction with abdominal trauma as they share part of the abdominal region. Therefore, patients must be treated as if they have vertebral damage until it has been ruled out (96). In some instances, spinal damage can cause further complications for the patient. However, in most instances, vertebral damage will be addressed separate from the abdominal trauma (97).

The most important consideration regarding vertebral fractures is ensuring that the patient does not suffer more damage as the result of improper handling and treatment. Therefore, each patient must be assessed for vertebral damage upon admission (98). If there is damage, it should be treated immediately. Until damage is ruled out, the patient must be properly stabilized and treated as if damage is present (96).

Dr. George Gohbrial provides the following guidelines (99) for managing vertebral damage in abdominal trauma patients:

**Nonsurgical fracture management:**

*Minor fractures or those with column stability are treated without surgery.*

*Nonoperative management of unstable spinal fractures involves the use of a spinal orthotic vest or brace to prevent rotational movement and bending.*

*Consideration should be given to the stabilization of patients with spinal cord injuries and paraplegia. These patients need to be stabilized sufficiently so that their upper body and axial skeleton are appropriately supported, which allows for effective rehabilitation.*

**Surgical fracture management:**
The goals of operative treatment are decompression of the spinal cord canal and stabilization of the disrupted vertebral column. The following basic approaches are used for surgical management of the thoracolumbar spine:

- **Posterior approach** - Useful for stabilization procedures that involve fixation of the posterior bony elements; the posterior approach is used when early mobilization is considered and decompression of the spinal canal is not a major consideration.
- **Posterolateral approach** - Often used for high thoracic fractures such as T1 through T4; it may be combined with a posterior stabilization procedure when limited ventral exposure is needed.
- **Anterior approach** - Allows access to the vertebral bodies at multiple levels; the anterior approach is most useful for decompression of injuries and spinal canal compromise caused by vertebral body fractures.

The 4 basic types of stabilization procedures are as follows:

- **Posterior lumbar interspinous fusion** - Least-invasive method; involves the use of screws to achieve stability and promote fusion.
- **Posterior rods** - Effective in stabilizing multiple fractures or unstable fractures.
- **Z-plate anterior thoracolumbar plating system** - Has been used for the treatment of burst fractures.
- **Cage**

**Pelvic Fractures**

Pelvic fractures are commonly associated with blunt abdominal trauma (100). In many instances, the pelvic fracture will result in a major hemorrhage due to the amount of bleeding that can occur in the various vessels surrounding the pelvis (101). Typically, a pelvic fracture will cause the patient to show signs of tenderness, crepitus, or hematomas. However, some patients may not show any signs at all (100). If there is no suspicion of a fracture due to the cause of the trauma or other related injuries, the pelvic fracture may remain undiagnosed. Therefore, a patient should be assessed to
rule out a pelvic fracture, even if no signs are present. A pelvic fracture is diagnosed using a standard pelvic X Ray (102).

If a patient is diagnosed with a pelvic fracture, he or she should have a consultation with an orthopedic surgeon for complete treatment. In most cases, initial treatment will involve treatment of any associated hemorrhage and identification of associated injuries (103). The patient should also be assessed for urologic injuries (100).

**DIAGNOSIS**

It is important to properly assess and treat an abdominal trauma patient to ensure initial damage is minimized and any further damage is prevented. The initial abdominal examination will vary depending on the category of injury. If the patient has a potential blunt abdominal injury, a thorough examination is necessary as many blunt injuries can be subtle and may not be immediately apparent (35). In these patients, the abdomen should be examined first for any surgical scars, contusions, or lacerations (104). The abdomen should be palpitated for tenderness or any abnormalities (35). Finally, the treating provider should listen for bowel sounds (105).

When an abdominal trauma patient is admitted to the emergency department, he or she is assessed using a variety or procedures and medical tests. The following table provides an overview of examination and assessment guidelines that should be followed by the emergency care team during interventions for an abdominal trauma patient:

<table>
<thead>
<tr>
<th>EXAMINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial examination:</strong></td>
</tr>
<tr>
<td>- After appropriate primary survey and initiation of resuscitation, focus attention on secondary survey of the abdomen.</td>
</tr>
<tr>
<td>- For life-threatening injuries requiring emergency surgery, comprehensive secondary</td>
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</tbody>
</table>
survey should be delayed until the patient has been stabilized

- Victims of blunt trauma who have a benign abdomen upon initial presentation, should have frequent serial examinations, in conjunction with the appropriate diagnostic studies, such as abdominal CT scan and bedside ultrasonography. This will ensure that occult injuries are picked up quickly.

**Inspection:**

- Examine the abdomen to determine the presence of external signs of injury. Note patterns of abrasion and/or bruising.

- Note injury patterns that predict the potential for intra-abdominal trauma, e.g. lap belt abrasions, steering wheel-shaped contusions. In most studies, lap belt marks have been correlated with rupture of the small intestine and an increased incidence of other intra-abdominal injuries.

- Observe the respiratory pattern, since abdominal breathing may indicate spinal cord injury. Note abdominal distention and any discoloration.

- Bradycardia may indicate the presence of free intraperitoneal blood in a patient with blunt abdominal injuries.

- Cullen’s sign, i.e. periumbilical ecchymosis, may indicate retroperitoneal hemorrhage. However, this symptom usually takes several hours to develop. Flank bruising and swelling may raise suspicion for a retroperitoneal injury.

- Inspect genitals and perineum for soft tissue injuries, bleeding, and hematoma.

**Auscultation:**

- Abdominal bruit may indicate underlying vascular disease or traumatic arteriovenous fistula.

- During auscultation, gently palpate the abdomen while noting the patient's reactions.
Percussion:
- Percussion tenderness constitutes a peritoneal sign.
- Tenderness indicates further evaluation and probably surgical referral is required.

Palpation
- Carefully palpate the entire abdomen while assessing the patient's response. Note abnormal masses, tenderness and deformities.
- Fullness and doughy consistency may indicate intra-abdominal hemorrhage. Crepitation or instability of the lower thoracic cage indicates the potential for splenic or hepatic injuries associated with lower rib injuries.
- Pelvic instability indicates the potential for lower urinary tract injury as well as pelvic and retroperitoneal hematoma. Open pelvic fractures are associated with mortality exceeding 50%.
- Perform rectal and bimanual vaginal pelvic examinations to identify potential bleeding and injury.
- Perform sensory examination of the chest and abdomen to evaluate the potential for spinal cord injury. Spinal cord injury may interfere with the accurate assessment of the abdomen by causing decreased or absent pain perception.
- Abdominal distention may result from gastric dilation secondary to assisted ventilation or swallowing of air.
- Signs of peritonitis, e.g. involuntary guarding or rigidity soon after an injury, suggest leakage of intestinal content. Peritonitis due to intra-abdominal hemorrhage may take several hours to develop.

ASSESSMENT
- Full blood count: normal hemoglobin and hematocrit results do not rule out significant hemorrhage. Do not withhold transfusion in patients who have relatively normal hematocrit
results, but have evidence of clinical shock, serious injuries, e.g. open-book pelvic fracture, or significant ongoing blood loss. Use platelet transfusions to treat patients with thrombocytopenia and ongoing hemorrhage.

- Serum chemistry: most trauma victims are younger than 40 years old and are rarely taking medications that may alter electrolytes. If blood gasses are not routinely obtained, serum glucose and carbon dioxide levels are indicated.

- Rapid bedside blood-glucose determination: this can be obtained with a finger-stick measuring device and is particularly important for patients with altered mental status.

- Liver function studies: LFTs may be useful in the patient with blunt abdominal trauma. However, test findings may be elevated for coincidental reasons, e.g. alcohol abuse.

- Urinalysis: indications for diagnostic urinalysis include significant trauma to the abdomen and/or flank, gross hematuria, microscopic hematuria associated with hypotension and significant deceleration mechanism of injury.

- Serum or urine pregnancy test: obtain this for all females of childbearing age.

- Coagulation profile: obtain PT/aPTT in patients who have a history of blood disorders or those who have synthetic problems, e.g. cirrhosis, or for patients who take anticoagulants.

- Blood type, screen, and crossmatch: screen and type blood from all trauma patients with suspected blunt abdominal injury. If an injury is identified, this greatly reduces the time required for crossmatch. Perform an initial crossmatch of 4-6 units for those patients with clear evidence of abdominal injury and hemodynamic instability. Until crossmatched blood is available use O negative or type-specific blood.

- Arterial blood gas (ABG): ABG may provide important information in major trauma victims. Upon initial investigation suspect metabolic acidemia to result from the lactic acidosis that accompanies shock. A moderate base deficit indicates the need for aggressive resuscitation and determination of the aetiology. ABGs report total hemoglobin more
rapidly than full blood counts do.

- Drug and alcohol screens: these should be performed on trauma patients who have alterations in their level of consciousness.

- Focused abdominal sonography (ultrasound) for trauma (FAST): this can be performed at the bedside and is the investigation of choice in hemodynamically unstable patients. [2] FAST's diagnostic accuracy is generally equal to that of diagnostic peritoneal lavage (DPL) - see below. Free fluid in a hemodynamically unstable patient indicates the need for emergency laparotomy.[3] [4]

- CT scan: although expensive and potentially time-consuming, CT scan often provides the most detailed images of traumatic pathology and may assist in determination of operative intervention.[5] It is the investigation of choice in hemodynamically stable patients.[2] The primary advantage of CT scanning is its high specificity and use for guiding non-operative management of solid organ injuries. CT scanning may miss injuries to the diaphragm and perforations of the GI tract, especially when CT scanning is performed soon after the injury. Pancreatic injuries may not be identified on initial CT scans but generally are found on follow-up examinations performed on high-risk patients. Transport only hemodynamically stable patients to the CT scanner. When performing CT scan, monitor vital signs closely for evidence of decompensation.

- Diagnostic peritoneal lavage (DPL): This is used as a method of rapidly determining the presence of intraperitoneal blood. DPL is more sensitive than computed tomography or ultrasound for the detection of hollow viscus injuries, but does not exclude retroperitoneal injury.[6] DPL is particularly useful if the history and abdominal examination of a patient, who is unstable and has multisystem injuries, is either unreliable or equivocal. DPL is also useful for those patients who cannot have serial abdominal examinations. Abdominal exploration always is indicated if approximately 10 ml of blood is aspirated upon insertion of the peritoneal catheter in the unstable patient.

Note: not all patients with a hemoperitoneum need laparotomy and the biggest drawback of diagnostic peritoneal lavage is the resulting high non-therapeutic laparotomy rate of up
Ultrasound has therefore replaced diagnostic peritoneal lavage in Europe and North America as the investigation of choice in hemodynamically unstable patients.[7]

85% penetrating chest injuries do not require thoracotomy. The patient can be treated with simple measures such as airway control. These injuries must take high priority and should be dealt with after securing the airway, obtaining intravenous access and beginning fluid resuscitation.

If the patient is hemodynamically stable, a CXR should confirm the presence of a pneumothorax. A loss of 20% of lung dimension on the CXR corresponds to 50% loss of lung volume. Do not delay draining to first observe a small pneumothorax as increase in size may occur and become life threatening. Draining a major hemothorax or pneumothorax is essential in a patient with chest trauma. This establishes adequate ventilation. Treatment should not be delayed by waiting for a CXR.

Hemothorax and tension pneumothorax require a large-bore chest tube. This should be placed in the mid-axial line, in the fifth or sixth intercostal space. A 20 ml syringe with 1% lidocaine can be used not only to provide local anesthesia, but also to help locate the upper edge of the rib in patients who are obese.

CXR should follow chest tube placement immediately. If the pleural space still contains blood, insert another chest tube.

Rigid sigmoidoscopy is indicated in all patients presenting with injuries in the pelvis or if blood is found on rectal examination.

The above guidelines provide a general overview of the appropriate assessment and management measures for an abdominal trauma patient. The following section will provide an in-depth explanation of the specific procedures and tests administered to abdominal trauma patients.
Radiologic Assessments

Ultrasonography
An abdominal ultrasound is one of the initial tests used to diagnose an abdominal trauma patient. Ultrasound has become a common part of the initial assessment of blunt abdominal trauma (106). Typically, ultrasounds are used as an initial screening assessment because they can detect fluid in the abdomen or pericardium (107). However, while an ultrasound can detect the fluid, it cannot indicate the source (106).

While an ultrasound is primarily suited for initial diagnostic screening, as it is not very sensitive, it does have some advantages that make it a useful screening tool. The following is a list of the advantages of the ultrasound:

- portability (allowing it to be used during resuscitation)
- lack of ionizing radiation exposure
- repeatability (allowing evaluation of changes in patient condition)
- rapidity of the exam (108)

An ultrasound is a solid diagnostic tool, and is commonly used for the detection of solid organ injuries, especially those associated with hemoperitoneum. However, it is not recommended for the detection of bowel or retroperitoneal injuries (106).

When an ultrasound is used, most patients undergo a Focused Assessment with Sonography in Trauma (FAST) assessment, as it is a standard component of trauma diagnosis. The FAST examination screens for intra peritoneal and intra pericardial anechoic material, which is most often blood (109). The following is a description of FAST:

FAST is a quick, sensitive way to detect fluid in the abdominal cavity. FAST can detect as little as 300-500 mL of free fluid. FAST can be accurately performed by properly trained physicians or surgeons. The limitations of FAST are operator dependence; an inability to detect
retroperitoneal blood (e.g., from pelvic fractures); and an inability to differentiate blood from urine, ascites, or other abdominal fluid. (110)

**Computed Tomography (CT scans)**

CT scans are one of the primary diagnostic tools used in abdominal trauma situations. This is due to the fact that CT scans are inexpensive and fast, and they are able to easily identify various trauma related injuries in the patient (111). CT scans are primarily used to identify injuries in the abdomen and pelvis, especially when there are no available patient history or exam findings (112). A CT scan can be used to confirm a suspected pathology (111). The CT scan is also useful in cases where the patient history and exam findings are available, as it will provide more information and help the care provider determine the appropriate treatment (106).

There are a number of general techniques that are utilized during the administration of an abdominal or pelvic CT scan. The following are the two primary techniques used:

- Oral contrast agents containing Barium or Iodine are used to opacify the GI tract. This allows the radiologist to better evaluate the GI tract for pathology and to distinguish bowel from other structures.
- Intravenous (IV) contrast agents are used to opacify blood vessels, to enhance the solid abdominal organs, and to improve image contrast between lesions and normal structures. (113)

There are a number of iodinated contrast agents available for use, and they can be divided into the following two categories:

1) High osmolar contrast agents--"ionics"
2) Low osmolar contrast agents--"non-ionics" (113)

In abdominal trauma situations, both intravenous and oral contrast solutions are used to assess injuries. The intravenous contrast enables the technician to identify injuries in the solid organs (liver, spleen, pancreas, and kidneys) and it is often the most important
assessment as much solid organ damage is undetectable without the contrast solution (111). The oral contrast solution is used to detect bowel injuries and differentiate between unopacified bowel and intrapertoneal blood (113). When an abdominal and pelvic CT scan is performed, it will include various regions of the abdomen, as well as the lower thorax. This enables the technician to detect various injuries: these include fractures of the rib sternum and spine; pneumothorax; hemothorax; lung contusion; aspiration; aortic injury; and malposition of tubes or lines (110). While many of these injuries are not located directly in the abdominal region, they are still important to identify as many patients experience trauma beyond the abdominal region. Chest trauma must be identified and treated prior to evaluating and treating the abdominal region as chest injuries are often immediately life threatening (112).

Although the CT scan is a useful tool for the assessment of abdominal trauma, it does have some limitations. A trained specialist must administer a CT scan and a qualified radiologist must read the results, or the patient may not receive the proper diagnosis (113). While the CT scan is quite sensitive and can easily identify damage to the solid organs, it often fails to identify smaller injuries such as mesenteric tears, bowel injuries, diaphragmatic ruptures and pancreatic injuries (114). Therefore, the CT scan may need to be administered in conjunction with other radiologic and surgical examinations.

X-Ray
X Rays are not used as frequently as other diagnostic tools in the evaluation of abdominal trauma (102). In most abdominal trauma cases, X Rays may be used to identify additional trauma and injuries in the chest and pelvic region, as well as rib fractures (106). However, they are rarely used to identify trauma in the abdominal region, as they cannot detect injury (115).

American College of Radiology Appropriateness Criteria

The different radiologic assessments described above are considered more or less appropriate depending on the type of injury and the patient’s needs. Therefore, the
American College of Radiology has developed a set of appropriateness criteria for blunt abdominal trauma. Patients with penetrating abdominal trauma and pediatric patients are not included in these guidelines.

The Relative Radiation Level (RRL) assignments for some examinations cannot be made since actual patient doses are known to vary based upon certain factors, such as the area of the body exposed to radiation and type of imaging; therefore, the RRLs for some examinations are designated as “varies.”

The following are the American College of Radiology Appropriateness Criteria (ACRAC):

**Major Recommendations**

**Clinical Condition: Blunt Abdominal Trauma**

**Variant 1: Unstable patient.**

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray chest</td>
<td>8</td>
<td>To evaluate for fracture, pneumomediastinum, and abnormal air collection or gas collections, patient condition permitting. Chest radiograph, KUB, and FAST scan are complementary examinations. All are commonly performed in this setting, patient condition permitting.</td>
<td></td>
</tr>
<tr>
<td>US chest abdomen and pelvis (FAST scan)</td>
<td>8</td>
<td>Rapid assessment of free fluid, patient condition permitting. Chest radiograph, KUB, and FAST scan are complementary examinations. All are commonly performed in this setting, patient condition permitting.</td>
<td>O</td>
</tr>
<tr>
<td>X-ray</td>
<td>8</td>
<td>To evaluate for fracture, free intraperitoneal air or</td>
<td>▲▼</td>
</tr>
<tr>
<td>Procedure</td>
<td>Appropriateness Rating</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>abdomen and pelvis (KUB)</td>
<td></td>
<td>abnormal fluid or gas collections. Chest radiograph, KUB, and FAST scan are complementary examinations. All are commonly performed in this setting, patient condition permitting.</td>
<td></td>
</tr>
<tr>
<td>Arteriography with possible embolization abdomen and pelvis</td>
<td>5</td>
<td>Not appropriate as initial imaging modality but may become more appropriate if additional clinical information or imaging suggests possibility of active hemorrhage.</td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>3</td>
<td>Not appropriate for critically unstable patients. Appropriateness rating may increase if clinical condition of patient improves and becomes hemodynamically stable. Would only consider in setting of prior severe contrast reaction or renal failure.</td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>3</td>
<td>Not appropriate for critically unstable patients. Appropriateness rating may increase if clinical condition of patient improves and becomes hemodynamically stable.</td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>3</td>
<td>Not appropriate for critically unstable patients.</td>
<td></td>
</tr>
<tr>
<td>CT chest without contrast</td>
<td>3</td>
<td>Not appropriate for critically unstable patients. Appropriateness rating may increase if clinical condition of patient improves and becomes hemodynamically stable. Would only consider noninfused scanning in setting of prior severe contrast reaction or renal failure.</td>
<td></td>
</tr>
<tr>
<td>Radiologic Procedure</td>
<td>Rating</td>
<td>Comments</td>
<td>RRL</td>
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</tr>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>9</td>
<td>May also consider CT angiography followed by routine portal venous phase sequences if visceral injury (e.g., hepatic, splenic, pancreatic, renal, mesenteric, or vascular injury) suspected clinically or in patients with significant pelvic and/or vertebral fractures.</td>
<td>🌟🌟🌟🌟🌟</td>
</tr>
<tr>
<td>CT chest with contrast</td>
<td>8</td>
<td>May be appropriate for patients who have sustained significant abdominal trauma.</td>
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</tr>
<tr>
<td>Procedure</td>
<td>Score</td>
<td>Description</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
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<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>7</td>
<td>The decision of whether to include infused chest CT should be based on the patient's clinical findings and known mechanism of injury.</td>
<td></td>
</tr>
<tr>
<td>CT chest without and with contrast</td>
<td>7</td>
<td>The decision of whether to include chest CT should be based on the patient's clinical findings and known mechanism of injury.</td>
<td></td>
</tr>
<tr>
<td>X-ray chest</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>CT chest without contrast</td>
<td>6</td>
<td>The decision of whether to include chest CT should be based on the patient's clinical findings and known mechanism of injury. Consider for patients with known severe contrast allergy or renal failure.</td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>6</td>
<td>Consider noninfused CT only if patient has known severe contrast reaction or renal failure (eGFR &lt;40).</td>
<td></td>
</tr>
<tr>
<td>US chest abdomen and pelvis (FAST scan)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray abdomen and pelvis (KUB)</td>
<td>5</td>
<td>May be useful to initially evaluate the patient for free intraperitoneal air and/or fractures of the pelvis and vertebral column.</td>
<td></td>
</tr>
<tr>
<td>Arteriography with</td>
<td>4</td>
<td>Varies</td>
<td></td>
</tr>
</tbody>
</table>
Variant 3: Hematuria >35 RBC/hpf (stable).

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>9</td>
<td>Recommend CT cystogram immediately following CT of abdomen and pelvis in patients with known acute pelvic fractures and/or penetrating injury to the pelvis with hematuria.</td>
<td>⭐⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>CT chest with contrast</td>
<td>8</td>
<td>The decision of whether to include infused chest CT should be based on the patient's clinical findings and known mechanism of injury.</td>
<td>⭐⭐⭐⭐</td>
</tr>
<tr>
<td>X-ray chest</td>
<td>8</td>
<td></td>
<td>⭐⭐⭐⭐</td>
</tr>
<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>7</td>
<td></td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>CT chest without and with contrast</td>
<td>7</td>
<td>The decision of whether to include chest CT should be based on the patient's</td>
<td>⭐⭐⭐⭐</td>
</tr>
</tbody>
</table>

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT chest without contrast</td>
<td>6</td>
<td>The decision of whether to include chest CT should be based on the patient's clinical findings and known mechanism of injury. Consider if patient has known history of severe contrast allergy or renal failure.</td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>6</td>
<td>Consider noninfused CT only if patient has known severe contrast reaction or renal failure (eGFR &lt;40).</td>
</tr>
<tr>
<td>CT pelvis with bladder contrast (CT cystography)</td>
<td>6</td>
<td>Appropriate when performed immediately following CT of abdomen and pelvis. Refer to text for indications.</td>
</tr>
<tr>
<td>X-ray retrograde urethrogramy</td>
<td>6</td>
<td>Appropriate in stable patients following blunt or penetrating trauma demonstrating gross blood coming from urethral meatus. Refer to text for indications.</td>
</tr>
<tr>
<td>X-ray abdomen and pelvis (KUB)</td>
<td>5</td>
<td>May be useful to initially evaluate the patient for free intraperitoneal air and/or fractures of the pelvis and vertebral column.</td>
</tr>
<tr>
<td>X-ray cystography</td>
<td>5</td>
<td>CT cystography preferred to follow initial CT of abdomen and pelvis.</td>
</tr>
<tr>
<td>Arteriography with possible embolization kidney</td>
<td>4</td>
<td>Varies</td>
</tr>
</tbody>
</table>
### Diagnostic Peritoneal Lavage (DPL)

Diagnostic Peritoneal Lavage (DPL) is used in blunt and penetrating trauma situations to identify and evaluate intraperitoneal hemorrhage or a ruptured hollow viscus (69). DPL is considered to be a highly accurate test for the identification of the above conditions, and while it is a fast test, it is also quite invasive (117). DPL was used more frequently in the past to assess abdominal trauma. However, focused abdominal sonography for trauma (FAST) and CT scans have replaced DPL in recent years as the standard methods of evaluation for abdominal trauma patients (111). Yet, there are still instances when DPL is the most appropriate option for abdominal trauma diagnosis. Therefore, all three diagnostic tools should be used when necessary and appropriate.

DPL is especially useful in blunt trauma situations, but can only be used if the patient’s condition warrants it (118). DPL is also used when FAST and CT scanning are not available or appropriate (111). When a CT scan is not available, DPL is used for the following patients:

- Patients who are in shock
- Hypotensive patients
- Patients with an unreliable abdominal exam due to altered mental status or spinal cord injury. (117)
DPL is primarily used for the following conditions/situations:

- Equivocal physical exam findings
- Presence of a lap-belt sign
- Injuries to adjacent structures such as the lower ribs, lumbar spine, or pelvis
- Anticipated prolonged loss of contact with the patient (i.e. extra abdominal procedures)
- High clinical suspicion of an intra-abdominal injury. (69)

In penetrating trauma, DPL is primarily used for patients with asymptomatic anterior abdominal stab wounds who show no signs of peritonitis (117). DPL is also used for patients who have anteriorly tracking flank wounds that have had a positive wound exploration (118).

DPL is not typically used in patients who have had prior abdominal surgery as there is a concern that the DPL might injure the intra abdominal organ through the introduction of the catheter of with the development of adhesions from fluid entrance and exit (69). However, the care provider should use clinical judgment to determine if it is safe to perform a DPL on a patient who has had a previous abdominal surgery, as there are situations that warrant the procedure (117). In many instances, DPL can be safely used in patients who have had minimal past abdominal surgeries. However, it is not considered an option for patients who have an extensive history of abdominal surgeries, especially if these patients have a preexisting coagulopathy, advanced cirrhosis, and morbid obesity (118). In addition, patients with pelvic fractures and women who are beyond the first trimester of pregnancy are not candidates for DPL (119).

DPL can be performed using any of the following techniques:

- Open Technique: The open technique utilizes a vertical infraumbilical incision and direct visualization of peritoneal entry with a scalpel.
• Closed Technique: The closed technique relies on percutaneous needle access to the peritoneal cavity, followed by the insertion of a catheter using Seldinger technique.

• Semi-Open Technique: The semi-open technique follows the same principles of the open technique except that the midline fascia is penetrated with a needle and the catheter is advanced using the Seldinger technique. (117)

Any of the techniques listed above can be used with minimal difference in overall outcome or risk of secondary injury. Of the three techniques, the closed method is faster, but there is more potential for technical complications, which include problems with wire placement and inadequate fluid return (69).

The following description explains the process used to administer the DPL, regardless of the technique chosen:

First, the patient is positioned flat in the supine position. A Foley catheter and a nasogastric tube are inserted to decompress the bladder and stomach. The periumbilical area is surgically prepped and draped widely. A combination of local anesthesia and intravenous conscious sedation is used in hemodynamically normal patients. Local anesthesia alone will suffice in a hemodynamically abnormal patient. 1% lidocaine with epinephrine is used for local anesthesia to reduce the amount of cutaneous bleeding, which may lead to a false positive test. (119)

DPL vs. FAST

There is some controversy regarding whether FAST or DPL is more effective in diagnosing abdominal trauma. According to Dr. Mohamed Radwan:

The use of FAST has replaced the use of DPL for detecting intraperitoneal bleeding in the majority of patients. We think that FAST should always be performed before DPL in the Emergency Room because it is non-invasive and takes shorter time. DPL is indicated to diagnose suspected internal abdominal injury when ultrasound machine is not available, there is no trained person to perform FAST, or the results of FAST are equivocal or
difficult to interpret in a hemodynamically unstable patient so the patient can not be shifted to a CT scan room. (111)

DPL is a sensitive technique for detecting intra-abdominal blood. The advantages over FAST include increased sensitivity and the ability to analyze the type of intraperitoneal fluid (e.g., blood, ascites in cirrhotic patients, bowel contents). The disadvantage is that DPL takes longer than FAST and is invasive. DPL is infrequently resorted to with the advent of fast spiral CT scanners (117).

Laparoscopy
While it is not often the first choice, laparoscopy can be a useful tool when diagnosing abdominal trauma and may prevent physicians from having to use the more invasive laparotomy (120). However, laparoscopy is not used solely for diagnostic purposes. It is also used as a form of treatment for abdominal trauma patients. Therefore, laparoscopy can be a useful tool in the assessment and management of abdominal trauma patients when used appropriately (121).

Laparoscopy is most useful with blunt abdominal trauma injuries, especially when other diagnostic tools such as FAST and DPL produce unclear diagnostic results (122). Laparoscopy can be used as another assessment to verify injury type and clarify the diagnosis. Once a laparoscopic examination is conducted, the laparoscopy can be used to repair any of the damage that has been found (121).

With diagnostic laparoscopy, the attending surgeon will make a small cut just below the navel and insert a needle into the area. The needle places carbon dioxide into the abdominal region so that it can be expanded enough to obtain a thorough view of the region. Once the area is expanded, a tube is inserted into the area, and a small video camera (laparoscope) is inserted into the tube. The laparoscope is used to obtain diagnostic images of the pelvic and abdominal region. In some instances, additional cuts may be required for alternate views (123).
While diagnostic laparoscopy can be a useful tool in evaluation of an abdominal trauma patient, especially when other tests are inconclusive, it is not consistently used in abdominal trauma patients for the reasons discussed below:

1) In bleeding, or potentially bleeding patients, timing is of essence. The logistics for laparoscopy set up of theatre still takes longer than for open surgery. Once the operation has started it takes longer to gain access, identify the bleeder and, especially, control it when compared to a trauma laparotomy.

2) In hemodynamically normal patients with spleen injuries a diagnostic laparoscopy may increase the splenectomy rate.

3) The risk of missing injuries (hollow viscus mainly) is high. A literature review reports a 41% to 77% rate of missed injuries when used as a diagnostic tool to perform abdominal exploration (Villavicencio, R. 1999). This is very much operator dependent, but it may carry disastrous outcomes.

4) Logistics wise most traumas happen at night when staff may be less motivated to embark in a time consuming procedure. (124)

Laparoscopy is recommended primarily for patients who are hemodynamically stable and who do not pose a risk of severe bleeding (123). It is not recommended for patients who have an obvious injury that can be identified and diagnosed using an alternate assessment. It is also not recommended for use with patients who experience peritonitis (122). During the initial patient evaluation, these conditions will be assessed and a determination will be made regarding the appropriateness of laparoscopy as a diagnostic tool. In most instances, providers will wait to see how the patient fares with other diagnostic assessment.

**Laparotomy**

An exploratory laparotomy is used in situations when a diagnosis is not available through the standard clinical diagnostic methods. A laparotomy is typically used during the following situations:

- Patients with acute or unexplained abdominal pain
- Patients who have sustained abdominal trauma
- Staging in patients with a malignancy (125)

In the presence of hypotension, a positive FAST or DPL result is an indication for immediate laparotomy (110). In instances where the patient has a potential penetrating abdominal injury, immediate identification is necessary. These patients are typically transferred immediately to the operating room for a laparotomy to identify any potentially life-threatening injuries (104). If the following are present, a laparotomy is administered:

- evisceration
- penetrating injuries caused by firearms or objects
- any injury accompanied by shock, free air under the diaphragm on chest radiographs
- peritoneal signs (104)

With an exploratory laparotomy, a vertical midline incision is made to ensure rapid entry into the peritoneum. The incision can be made in any area of the midline to accommodate specific diagnostic needs. Once the incision has been made, it will be deepened so that it extends through the subcutaneous fat and allows access to the intra-abdominal organs. From this point, the surgeon will exercise caution to ensure that no damage is done to the intraperitoneal contents. The surgeon will then explore the contents of the abdominal region and assess any damage. This is accomplished through careful inspection of each organ. Once the inspection is complete, the patient will be sutured and any damage will be noted (126).

After the injury has been identified, the exploratory laparotomy may continue to be used as a therapeutic procedure or as a means of confirming a diagnosis. In other instances, the laparotomy will be used to provide a specific treatment that has been deemed necessary by the surgeon (125).

The table below provides information regarding the various conditions that laparotomy can be used to identify and/or treat:
<table>
<thead>
<tr>
<th>Condition</th>
<th>Description and Qualifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peritonitis</td>
<td>Patients with clinical features of peritonitis may have pneumoperitoneum on erect chest and abdominal radiographs. They usually have a perforated viscus, most commonly the duodenum, stomach, small intestine, cecum, or sigmoid colon. Exploratory laparotomy is done first to determine the exact cause of pneumoperitoneum, followed by the therapeutic procedure. In the absence of pneumoperitoneum, appendicular perforation and intestinal ischemia are possible diagnoses; a high index of suspicion for possible intestinal ischemia should be maintained.</td>
</tr>
<tr>
<td>Intestinal obstruction</td>
<td>Patients with vomiting, obstipation, and abdominal distention are likely to have intestinal obstruction. Abdominal radiographs in these patients may reveal dilated intestinal loops and air-fluid levels. Hernia, especially an incarcerated inguinal hernia, should be ruled out as a possible cause of the obstruction.</td>
</tr>
</tbody>
</table>
| Intra-abdominal collections        | Patients with pain in the abdomen and fever may have intra-abdominal collections. These are usually detected by means of ultrasonography or computed tomography (CT) and can often be managed percutaneously. A persistently high aspirate or the presence of enteric contents may suggest perforation, and laparotomy may be required to control the source.  

Abdominal trauma with hemoperitoneum and hemodynamic instability.  

Hemodynamically unstable trauma patients with hemoperitoneum should undergo exploratory laparotomy without any delay. They are likely to have intraperitoneal bleeding after injury to the liver, |
spleen, or mesentery. They may also have associated intestinal perforations that call for emergency repair.

In patients with penetrating abdominal trauma (PAT), exploratory laparotomy was conventionally carried out to rule out intra-abdominal injury. The role of laparoscopy has been highlighted in a recent systematic review in patients with PAT.[2] Laparoscopy has been found to be useful in identifying diaphragmatic injury but has been found less sensitive for detecting hollow visceral injuries. It is, however, very good for identifying the need for exploratory laparotomy.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic abdominal pain</td>
<td>Availability of good imaging facilities has restricted the use of exploratory laparotomy in these conditions; however, when limited facilities are available, exploratory laparotomy becomes an important diagnostic tool. These patients may have intra-abdominal adhesions, tuberculosis, or tubo-ovarian pathology</td>
</tr>
<tr>
<td>Obscure gastrointestinal bleeding</td>
<td>The role of exploratory laparotomy has diminished over the last few years with the availability of good imaging, endoscopic techniques, and laparoscopy. However, in centers with limited facilities or when the bleeding is profuse, exploratory laparotomy, with on-table enteroscopy when indicated, can help identify the source of gastrointestinal bleeding.</td>
</tr>
</tbody>
</table>

(127)

Exploratory laparotomy can be used in most patients, with the exception of those that are deemed unfit for general anesthesia. Patients are typically deemed unfit for general anesthesia if they have one of the following conditions:
- Peritonitis with severe sepsis
- Advanced malignancy
- Various comorbid conditions (16)

**TREATMENT**

Due to the potential life threatening complications of abdominal trauma, it is important to begin treating the patient immediately. In some instances, treatment will occur in conjunction with the assessment. However, in other situations, treatment will be postponed until all assessments have been administered (7).

The following table provides a basic overview of the treatment procedures used with abdominal trauma patients:

<table>
<thead>
<tr>
<th>MANAGEMENT</th>
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<tbody>
<tr>
<td>- Perform a rapid primary survey to identify immediate life-threatening problems.</td>
</tr>
<tr>
<td>- Focus close attention on whether the patient can maintain the airway or if a potential threat is present. Secure airway by orotracheal intubation, which is performed with concurrent in-line manual immobilization of the cervical spine. If intubation is required, and if possible, perform and record a brief neurological examination prior to neuromuscular blockade and intubation.</td>
</tr>
<tr>
<td>- Patients who display apnea or hypoventilation require respiratory support, as do those patients with tachypnoea. Provide all patients with supplemental oxygen from a device capable of delivering a high FiO2 (e.g. non-rebreather mask). Decreased or absent breath sounds raise the possibility of hemothorax or pneumothorax; therefore, consider needle decompression or tube thoracostomy, even prior to obtaining a chest radiograph.</td>
</tr>
<tr>
<td>- Identification of hypovolemia and signs of shock necessitate vigorous resuscitation and attempts to identify the source of blood loss. Initiate at least 2 large-bore, eg. 18-gauge</td>
</tr>
</tbody>
</table>
peripheral IV lines. Use central lines, preferably femoral using a large-bore line, and cutdowns, e.g. saphenous, brachial for patients in whom percutaneous peripheral access cannot be established. Administer a rapid bolus of crystalloid.

- Perform physical examination that consists of a complete head-to-toe secondary survey, with attention paid to evidence of the mechanism of injury and potentially injured areas.

- Before the placement of a nasogastric tube and Foley catheter, perform appropriate head, neck, pelvic, perineum and rectal examinations.

- Based on mechanism and physical examination, order initial trauma radiographic studies; trauma suite views include a lateral cervical spine, anterior portable chest, and pelvis radiograph. In-line spinal immobilization must be continued until spinal fractures have been ruled out. Additional radiographs are indicated for other findings in the secondary survey.

- After the primary survey and initial resuscitation have begun, complete the secondary survey to identify all potential and present injuries.

- "Log-roll" the patient to examine the back and palpate the entire spinal column. Investigate for any signs of injury. Perform a rectal examination.

- If signs of shock persist after an initial 2-3 liters of crystalloid infusion, administer blood products. Type O Rh-negative blood typically is given to women of childbearing age. Type O positive blood may be given safely to all other patients including men and postmenopausal women. As soon as available use type-specific or crossmatched blood.

- Bedside ultrasonography using a trauma examination protocol, e.g. FAST, can be used to determine the presence of intraperitoneal hemorrhage.

- Based on stability, mechanism and suspicion of intra-abdominal injury, further investigation may be warranted for patients who are hemodynamically stable after the initial assessment and resuscitation and who have negative or equivocal bedside
ultrasound and/or DPL results.

- Further investigation includes contrast-enhanced CT scans of the abdomen and pelvis or serial examinations and ultrasound.

- Solid organ injury in hemodynamically stable patients can often be managed without surgery.

(15)

**Stabilization**

Patient stabilization is the primary objective when a patient is admitted with abdominal trauma. The emergency team will begin working to stabilize the patient immediately, while assessing the patient and identifying any additional injuries. Once the patient is stabilized, more focused treatment will be administered (128). Abdominal trauma patient stabilization includes three primary components:

1. Airway
2. Circulation
3. Spine

When a patient presents with abdominal trauma, the emergency team will immediately begin working on the three components listed above. It is important to note that these three components of stabilization serve as both assessments and treatment. The three areas are assessed for immediate damage, and any necessary treatment is administered (7).

As soon as the patient arrives in the emergency department, he or she will receive a rapid primary survey to assess and identify any immediate problems (62). The first area to receive treatment is the airway. If a patient requires intubation, it is initiated immediately. Typically, nasotrachael or endotracheal intubation is used with abdominal trauma patients. Once an airway has been established, patients who require breathing assistance will receive the appropriate treatment (129).
The next stage in patient care involves the circulatory system. An initial assessment of the circulatory system is conducted to determine if the patient has experienced a circulatory collapse (130). This can be caused by hypovolemia from hemorrhage. Immediate treatment is necessary to prevent further blood loss and assist with patient resuscitation (131).

While the airway and circulation are the two primary areas of focus for the assessment and treatment of abdominal trauma patients, providers have begun using the ABCDE approach instead. The goal remains the same, but this approach provides a more thorough assessment of the patient (132). The ABCDE approach expands the original treatment protocol to provide more in-depth assessment and treatment of the abdominal trauma patient. Therefore, this section includes detailed information about the ABCDE approach. Since the airway and circulatory assessments and treatment are part of the ABCDE approach, they are discussed more fully in this section.

**ABCDE (Airway-Breathing-Circulation-Disability-Exposure/Environmental)**

This approach can be used in any type of clinical emergency to assess the patient and determine the necessary treatment needs (110). Using the ABCDE approach is highly recommended by most medical professionals as it is considered an effective means of improving patient outcomes through the early identification and treatment of life threatening injuries and complications (133). Skilled professionals, in an acute setting, best use the ABCDE approach, as it requires a basic understanding and common knowledge of early identification and treatment (132). If a team is providing the treatment, it is important that all team members understand and employ the ABCDE approach to ensure consistent assessment and consistent identification and treatment (133). Emergency personnel and treatment team members should receive adequate training in the ABCDE approach prior to working with trauma patients.

The goals of the ABCDE approach include the following:

- to provide life-saving treatment
- to break down complex clinical situations into more manageable parts
• to serve as an assessment and treatment algorithm
• to establish common situational awareness among all treatment providers
• to buy time to establish a final diagnosis and treatment. (133)

The ABCDE approach is promoted as an effective tool for diagnosing and treating critically ill or injured patients and is widely used in emergency care setting. Most often, it is emergency technicians, critical care specialists, and traumatologists that utilize the ABCDE approach (130). Using the ABCDE approach in conjunction with other emergency treatment protocol has proven to increase the patient survival rate and decrease the long-term impact of the injuries (131).

The ABCDE approach can be used with all patients, regardless of age or medical status. Regardless of the cause, the clinical signs of various critical conditions are similar. Therefore, the ABCDE approach can be used to identify clinical issues even if the cause is unknown. In fact, it is not necessary for emergency personnel to know the underlying cause of the conditions when initiating the ABCDE approach (132). Ultimately, the ABCDE approach should be used in any situation in which a critical injury is present, as it is a useful tool for determining the presence of critical conditions, especially when those conditions are not immediately apparent or identifiable (130).

The ABCDE approach provides efficiency in the identification and treatment of the patient as the initial assessment and the treatment are performed in conjunction with each other (133). In situations where the cause is not apparent, immediate treatment may be necessary for any life threatening injuries or conditions. In these instances, treatment will be initiated prior to making a definitive diagnosis. The ABCDE approach provides a means for initiating treatment without knowing the exact diagnosis (132).

The ABCDE approach follows a standard process that follows the words indicated by the ABCDE. First, life-threatening airway problems are assessed and treated; second, life threatening breathing problems are assessed and treated, etc. This approach enables the treatment team to quickly identify issues and treat them accordingly. The ABCDE approach also helps determine which services are needed and what level of
assistance is required. In many emergency situations, additional care may be needed from other emergency responders, specialists, and other hospital departments. This approach helps quickly determine the level of assistance required and the specific departments that are needed for treatment and assistance (134). This identification helps increase the speed and efficiency of treatment, thereby improving the outcome.

The ABCDE assessment should be conducted as soon as possible to begin the treatment process (130). In addition, the assessment should be repeated in regular intervals until the patient is stable as a means of determining the effectiveness of various treatments (135). If a patient shows signs of deterioration, additional treatment may be needed. The patient should be reassessed after each treatment or intervention to assess the outcome (134).

The following table includes the description and recommendation for using the ABCDE approach with trauma patients:

<table>
<thead>
<tr>
<th>A – Airway: is the airway patent?</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the patient responds in a normal voice, then the airway is patent. Airway obstruction can be partial or complete. Signs of a partially obstructed airway include a changed voice, noisy breathing (e.g., stridor), and an increased breathing effort. With a completely obstructed airway, there is no respiration despite great effort (i.e., paradox respiration, or “see-saw” sign). A reduced level of consciousness is a common cause of airway obstruction, partial or complete. A common sign of partial airway obstruction in the unconscious state is snoring.</td>
</tr>
</tbody>
</table>

Untreated airway obstruction can rapidly lead to cardiac arrest. All health care professionals, regardless of the setting, can assess the airway as described and use a head-tilt and chin-lift maneuver to open the airway. With the proper equipment, suction of the airways to remove obstructions, for example, blood or vomit, is recommended. If possible, foreign bodies causing airway obstruction should be removed. In the event of a complete airway obstruction, treatment should be given according to current guidelines. In brief, to conscious patients give five back blows alternating with five abdominal thrusts until the obstruction is relieved. If the victim becomes unconscious, call for help and start cardiopulmonary resuscitation according to guidelines.
Importantly, high-flow oxygen should be provided to all critically ill persons as soon as possible.

**B – Breathing: is the breathing sufficient?**

In all settings, it is possible to determine the respiratory rate, inspect movements of the thoracic wall for symmetry and use of auxiliary respiratory muscles, and percuss the chest for unilateral dullness or resonance. Cyanosis, distended neck veins, and lateralization of the trachea can be identified. If a stethoscope is available, lung auscultation should be performed and, if possible, a pulse oximeter should be applied.

Tension pneumothorax must be relieved immediately by inserting a chest tube cannula where the second intercostal space crosses the midclavicular line (needle thoracocentesis). Bronchospasm should be treated with inhalations.

If breathing is insufficient, assisted ventilation must be performed, by giving rescue breaths with or without a barrier device. Trained personnel should use a bag mask if available.

**C – Circulation: is the circulation sufficient?**

The capillary refill time and pulse rate can be assessed in any setting. Inspection of the skin gives clues to circulatory problems. Color changes, sweating, and a decreased level of consciousness are signs of decreased perfusion. If a stethoscope is available, heart auscultation should be performed. Electrocardiography monitoring and blood pressure measurements should also be performed as soon as possible. Hypotension is an important adverse clinical sign. The effects of hypovolemia can be alleviated by placing the patient in the supine position and elevating the patient's legs. An intravenous access should be obtained as soon as possible and saline should be infused.

**D – Disability: what is the level of consciousness?**

The level of consciousness can be rapidly assessed using the AVPU method, where the patient is graded as alert (A), voice responsive (V), pain responsive (P), or unresponsive (U). Alternatively, the Glasgow Coma Score can be used. 16 Limb movements should be inspected to evaluate potential signs of lateralization. The best immediate treatment for patients with a primary cerebral condition is stabilization of the airway, breathing, and
circulation. In particular, when the patient is only pain responsive or unresponsive, airway patency must be ensured, by placing the patient in the recovery position, and summoning personnel qualified to secure the airway. Ultimately, intubation may be required. Pupillary light reflexes should be evaluated and blood glucose measured. A decreased level of consciousness due to low blood glucose can be corrected quickly with oral or infused glucose.

E – Exposure: any clues to the patient’s condition?

Signs of trauma, bleeding, skin reactions (rashes), needle marks, etc, must be observed. Bearing the dignity of the patient in mind, clothing should be removed to allow a thorough physical examination to be performed. Body temperature can be estimated by feeling the skin or using a thermometer when available.

Spine

Patients who experience abdominal trauma may also have spinal damage. Therefore, initial treatment will be administered to stabilize any potential damage. Until a spinal injury has been ruled out, the patient will be treated as if one is present (136). Therefore, the patient will often be placed on a stabilization board and will be required to maintain spinal stabilization until an injury is ruled out (137).

The following fact sheet, obtained from www.trauma.org, provides thorough information regarding the care and treatment of patients with a suspected spinal injury:

The spine should be protected at all times during the management of the multiply injured patient. The ideal position is with the whole spine immobilized in a neutral position on a firm surface. This may be achieved manually or with a combination of semi-rigid cervical collar, side head supports and strapping. Strapping should be applied to the shoulders and pelvis as well as the head to prevent the neck becoming the centre of rotation of the body.
Prehospital

Manual spinal protection should be instituted immediately. The application of definitive immobilization devices should not take precedence over life-saving procedures.

If the neck is not in the neutral position, an attempt should be made to achieve alignment. If the patient is awake and co-operative, they should actively move their neck into line. If unconscious or unable to co-operate this is done passively. If there is any pain, neurological deterioration or resistance to movement the procedure should be abandoned and the neck splinted in the current position.

Long spine (rescue) boards are valuable primarily for extrication from vehicles. Repeated transfers to and from the board may compromise spinal protection and induce a significant amount of spinal movement. Patients may also be transferred on a scoop stretcher and/or vacuum mattress. There is little place for the short spine board or spinal extrication devices in the prehospital environment.

In-hospital

The spine board should be removed as soon as possible once the patient is on a firm trolley. Prolonged use of spine boards can rapidly lead to pressure injuries. Full immobilization should be maintained. Manual protection should be reinstated if restraints have to be removed for examination or procedures (e.g. intubation).

The log-roll is the standard maneuver to allow examination of the back and transfer on and off back boards. Four people are required, one holding the head and coordinating the roll, and three to roll the chest, pelvis and limbs. The number and degree of rolls should be kept to an absolute minimum. Rigid transfer slides (e.g., Patslide) are useful for transferring the patient from one surface to another (e.g. CT scanner, operating table).

Patients who are agitated or restless due to shock, hypoxia, head injury or intoxication may be impossible to immobilize adequately. Forced restraints or manual fixation of the head may risk further injury to the spine. It may be necessary to remove immobilization devices and allow the patient to move unhindered.

Anesthesia may be necessary to allow adequate diagnosis and therapy. Intubation of the
trauma victim is best achieved via rapid sequence induction of anesthesia and orotracheal intubation, though the technique used should ultimately depend on the skills of the operator. The collar should be removed and manual, in-line protection re-instituted for the maneuver. The routine use of a gum elastic bougie is recommended, minimizing cervical movement by allowing intubation with minimal visualization of the larynx.

Spinal immobilization is a priority in multiple trauma situations, whereas spinal clearance is not.

Transfer to Secondary Units
Patients may require transfer to other units for definitive care of other injuries such as head or pelvic trauma. There should be no unnecessary delays in the transport of these patients. Transfer should not wait for unnecessary diagnostic procedures that will not alter management. This includes radiological imaging of the spine.

The spine should be immobilized and protected for the transfer. Split-scoop stretchers and vacuum mattresses are more appropriate for transfer than rigid spinal (rescue) boards, which should be reserved for primary extrication from vehicles, rather than as devices for transporting patients.

Surgery
In recent years, more abdominal injuries sustained during abdominal trauma situations are repaired in a non-operative format (139). However, there are still a number of injuries that will require surgical intervention. Due to the number of organs present in the abdomen and the complexity of the damage that can occur, many patients will require a variety of treatment mechanisms to repair the damage. Surgery is one of the treatment options used. Surgery is used to repair intra-abdominal damage that cannot be repaired by other means (140). Some common abdominal surgeries include:

- Appendectomy
- Drainage of abdominal and pelvic abscesses
• Small bowel anastomosis
• Colostomy
• Herniorraphy (140)

In most instances, surgery is used to repair organ damage or extensive damage to the tissue or muscles (141). The specific surgical procedures used will depend on the type and location of injury.

SUMMARY

Abdominal trauma is one of the leading causes of preventable trauma-related deaths. In order to reduce the incidence of abdominal trauma deaths, medical professionals should be aware of the signs and symptoms of these injuries, especially those that are not readily apparent upon physical examination. Abdominal trauma is complex in nature and requires a comprehensive approach to assessment and treatment. The abdominal region is comprised of a number of organs, both solid and hollow, as well as major arteries, vessels, and tissue. Therefore, abdominal injuries can have an impact on a number of areas within the abdominal region, which poses a significant risk to the patient. It is imperative that patients with trauma related abdominal injuries receive immediate care and treatment in order to reduce the likelihood of long term damage or death.

Abdominal trauma patients have a greater chance at recovery if problems can be identified early and treated properly. A number of assessments are available to determine the extent of injury to the patient and to identify any potential risks. Once a patient has been assessed, treatment will focus on repairing damage and preventing any additional damage. Many abdominal injuries can be life threatening, but with the appropriate evaluation and proper treatment, the patient’s recovery time is greatly improved and morbidity is reduced significantly. Medical professionals who have a comprehensive understanding of diagnosis procedures, risk factors, and treatment options greatly improve a patient’s recovery time and significantly reduce morbidity associated with abdominal trauma.
References:

   http://www.emsworld.com/article/10319768/abdominal-trauma
   http://www.operationalmedicine.org/TextbookFiles/FMST_20008/FMST_1408.htm
   http://www.patient.co.uk/doctor/abdominal-trauma


50. Chao CM, Tsai TC, Lai CC. Signs of pneumoperitoneum. QJM, 2013; 106(2), 199-199.


79. Mundy AR, Andrich DE. Pelvic fracture- related injuries of the bladder neck and prostate: their nature, cause and management. BJU international, 2010; 105(9), 1302-1308.


100. Young, B. (2010). Pelvic Trauma. ABC of Imaging in Trauma, 35.


120. Lee PC, Lo C, Wu JM, Lin KL, Lin HF, Ko WJ. Laparoscopy Decreases the Laparotomy Rate in Hemodynamically Stable Patients With Blunt Abdominal Trauma. 2013; Surgical innovation.

121. Amin PB, Magnotti LJ, Fabian TC, Croce MA. The role of laparoscopy in abdominal trauma. Trauma. 2011; 13(2): 137-143.


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