Chapter 5: Abdominal Trauma

Objectives:

Upon completion of this topic, the physician will be able to identify the differences in the patterns of abdominal trauma based on injury mechanism, and to establish management priorities accordingly. Specifically, the physician will be able to:

A. Describe the anatomic regions of the abdomen.

B. Discuss the difference between blunt and penetrating abdominal injury patterns.

C. Identify the signs suggesting retroperitoneal, intraperitoneal, and pelvic injury.

D. Outline the diagnostic and therapeutic procedures specific to abdominal trauma.

E. Discuss diagnostic peritoneal lavage and demonstrate the ability to perform this procedure during the surgical practicum.
I. Introduction

A. High index of Suspicion

Unrecognized abdominal injury remains a distressingly frequent cause of preventable death after trauma. Peritoneal signs are often subtle, overshadowed by pain from associated extra-abdominal trauma, or masked by head injury or intoxicants. As many as 20% of patients with acute hemoperitoneum have benign abdominal findings when first examined in the emergency department. Moreover, the peritoneal cavity is a potential reservoir for major occult blood loss. Any patient sustaining significant deceleration injury or a penetrating torso wound must be assumed to have an abdominal visceral injury.

B. Regions of the Abdomen

The abdomen has three distinct anatomic compartments - peritoneal cavity, retroperitoneal space, and pelvis.

The upper abdomen is that portion of the peritoneal cavity covered by the bony thorax, and includes the diaphragm, liver, spleen, stomach, and transverse colon. The diaphragm may rise to the fourth intercostal space with full expiration, rendering the viscera at risk after lower chest trauma - particularly penetrating wounds. Fractures of the lower ribs should increase suspicion for hepatosplenic injury.

The lower abdomen contains the small bowel and remaining portion of the intra-abdominal colon.

The retroperitoneal space contains the aorta, vena cava, pancreas, kidneys, ureters, and portions of the colon and duodenum. Injuries to the retroperitoneal viscera are notoriously difficult to recognize because the area is remove from physical examination and not sampled by peritoneal lavage.

The pelvis contains the rectum, bladder, iliac vessels, and in women, the internal genitalia. Early diagnosis of trauma to these structures is similarly compromised because of anatomic location.

II. Assessment

The primary factor in assessing abdominal trauma is not the accurate diagnosis of a specific type of injury, but rather the determination that an abdominal injury exists.

A. History

Details of the incident are particularly helpful in the initial evaluation of blunt multisystem and penetrating trauma. The patient, if conscious, is best prepared to provide most of this information. However, the prehospital care personnel and police may provide critical insight into timing, mechanism, initial patient presentation, and response to treatment, etc.
B. Physical Examination

The abdominal examination should be conducted in a meticulous, systematic fashion in the standard sequence; ie, inspection, auscultation, percussion, and palpation. These findings, whether positive or negative, should be documented carefully in the medical records.

1. Inspection

The patient must be fully undressed. The anterior and posterior abdomen as well as the lower chest and perineum should be inspected for abrasions, contusions, lacerations, and penetrating wounds. The patient can be cautiously log-rolled to facilitate complete examination. (See Chapter 7, Spine and Spinal Cord Trauma, and Skill Station XI, Immobilization Techniques for Neck and Spinal Trauma.)

2. Auscultation

The abdomen should be auscultated for the presence or absence of bowel sounds. Free intraperitoneal blood or enteric contents may produce ileus, resulting in loss of bowel sounds. However, ileus also may occur from extra-abdominal injuries, ie, rib, spine, and pelvic fractures.

3. Percussion

Percussion of the abdomen after injury is done primarily to elicit subtle rebound tenderness. This maneuver generates slight motion of the peritoneum and produces a response similar to asking the patient to cough.

4. Palpation

Palpation of the abdomen results in subjective as well as objective information. Subjective findings include the patient's assessment of pain location as well as magnitude. Early pain is usually visceral in origin, and therefore, poorly localized. Voluntary tensing of the abdominal musculature results from the fear of pain and may not represent significant injury. Involuntary muscle guarding, on the other hand, is a reliable sign of peritoneal irritation. Similarly, unequivocal rebound tenderness indicates established peritonitis.

5. Rectal examination

Digital rectal examination is an important component of the abdominal assessment. Major assessment goals for penetrating wounds are to search for blood that may indicate bowel perforation and to ascertain sphincter tone to assess spinal integrity. After blunt trauma, the rectal wall also should be palpated to detect fractured bony elements and prostate position. A high-riding prostate may indicate posterior urethral disruption.

6. Vaginal examination

Laceration of the vagina may occur from penetrating wounds or bony fragments from pelvic fracture(s). The implications of vaginal bleeding in the pregnant patient are reviewed
in Chapter 11, Trauma in Pregnancy.

7. Penile examination

Laceration of the urethra should be suspected if blood is present at the urethral meatus.

A positive physical examination is the most reliable clinical sign of significant intra-abdominal trauma. Conversely, a negative physical examination does not preclude significant intra-abdominal injury. For many patients, abdominal examination may not be diagnostic because of confounding factors or the early absence of clinical signs that may become obvious during subsequent examinations.

C. Intubation

1. Nasogastric tube

Nasogastric intubation is both therapeutic and diagnostic. The primary goal is to remove stomach contents - reducing gastric volume, pressure, and the risk of aspirating gastric contents. The presence of blood in the gastric secretions may suggest upper gastrointestinal tract injury if nasopharyngeal sources are excluded. **Caution:** If severe facial fractures exist, the nasogastric tube should be introduced via the mouth to prevent unintentional intracranial insertion of the tube through a cribriform plate fracture.

2. Bladder catheter

The indwelling urinary catheter serves multiple purposes. The major function is to decompress the bladder and allow for urinary output monitoring as an index of tissue perfusion. Hematuria is an important sign of potential genitourinary trauma, the implications of which are discussed later in this chapter. Consideration also may be given to obtaining a urine drug screen. **Caution:** An examination of the rectum and genitalia should be performed before inserting the urinary catheter, because related findings may contraindicate its placement. A high-riding prostate, blood at the urethral meatus, or scrotal hematoma are contraindications to placing a transurethral bladder catheter until retrograde urethrography confirms an intact urethra.

D. Blood Sampling

Blood should be withdrawn from one of the initial venous access sites and sent to the laboratory for immediate analysis. Blood typing and crossmatching should be performed for the severely injured patient. Laboratory screening for suspected abdominal injury includes a hematocrit, white blood cell count with differential, amylase, urinalysis, pregnancy testing for all females of childbearing age, and alcohol and/or other drugs determinations. These baseline tests are important because subsequent changes may be the first sign of occult injury, particularly in the retroperitoneum.
E. Roentgenographic Studies

1. Screening roentgenograms

Roentgenographic studies must be tailored to the patient's overall status as well as injury mechanism. The crosstable lateral cervical spine, anteroposterior chest, and pelvis films take precedence in multisystem blunt trauma. On occasion, abdominal films also may be helpful in identifying abdominal injury. Free air under the diaphragm or extraluminal air in the retroperitoneum signals hollow visceral disruption, and mandates prompt celiotomy. Loss of psoas shadow may suggest retroperitoneal injury. Such roentgenographic studies also should be viewed for bony injuries associated with abdominal injuries. (See Table 1, Associated Injuries.)

Table 1. Associated injuries

<table>
<thead>
<tr>
<th>Bony Injuries</th>
<th>Associated Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower rib fractures</td>
<td>Liver and/or spleen</td>
</tr>
<tr>
<td>Lower thoracic spine injuries</td>
<td>Pancreas, small bowel</td>
</tr>
<tr>
<td>Lumbar transverse process fractures</td>
<td>Abdominal viscera, kidneys</td>
</tr>
<tr>
<td>Pelvic fractures</td>
<td>Pelvic organ or vessels</td>
</tr>
<tr>
<td></td>
<td>Retroperitoneal</td>
</tr>
</tbody>
</table>

2. Contrast studies

a. Urethrography

Urethrography should be performed before inserting an indwelling urinary catheter when a urethral tear is suspected. The urethrogram can be performed with a #12-French urinary catheter secured in the meatal fossa by balloon inflation to three milliliters. Undiluted contrast material is instilled with gentle pressure.

c. Cystography

Bladder rupture is established with a gravity flow cystogram. A bulb syringe attached to the indwelling bladder catheter is held 15 cm above the patient, and 250 to 300 mL of water-soluble contrast is allowed to flow into the bladder. Anteroposterior, oblique, and postdrainage views are essential to definitively exclude injury. The order of intravenous pyelogram (IVP) versus cystography is governed by the index of suspicion for upper versus lower tract injury.

c. Excretory urogram

An IVP may be valuable in initial renal evaluation. High-dose intravenous bolus injection should provide evidence of relative kidney function at 5 to 10 minutes. Unilateral nonfunction implies massive parenchymal shattering or vascular pedicle interruption, but may be due to an absent kidney. Nonfunction warrants further surgical evaluation.
In the stable patient, computed tomography (CT) is preferable to the IVP if there is the suspicion of other intra-abdominal and/or retroperitoneal injuries. Intravenous contrast studies should not be performed in the hypotensive, unstable patient.

d. Gastrointestinal

Isolated retroperitoneal gastrointestinal injuries, ie, duodenum, ascending and descending colon, and rectum may not manifest peritoneal signs or abnormalities on diagnostic peritoneal lavage. When these injuries are suspected, specific upper and lower gastrointestinal contrast studies may identify them.

F. Special Diagnostic Studies

If there is early or obvious evidence that the patient will be transferred to another facility, time-consuming tests should not be performed. These tests include contrast urologic and gastrointestinal studies, peritoneal lavage, or computed tomography.

Peritoneal lavage or computed tomography should be done for the multiply injured patient if the abdominal examination is:

a. Equivocal (fractured lower ribs, and pelvic and lumbar spine fracture may obscure findings)

b. Unreliable due to head injury, intoxicants, or paraplegia

c. Impractical because of anticipated lengthy roentgenographic studies (angiography) or general anesthesia for extra-abdominal injuries.

(See Table 2, Diagnostic Peritoneal Lavage versus Computed Tomography.)

1. Diagnostic peritoneal lavage

Peritoneal lavage is an operative procedure that significantly alters subsequent examinations of the patient and is considered 98% sensitive for intraperitoneal bleeding. Ideally, the procedure should be performed by the surgeon caring for the patient.

The necessity for emergent celiotomy in the patient with multisystem trauma may be difficult to establish and must be sequenced properly among other potential life-saving procedures. For this reason, diagnostic peritoneal lavage (DPL) is a critical step in the evaluation of the severely injured trauma patient.

Since the abdomen, without appearing abnormal, may sequestrate large amounts of blood, peritoneal lavage should be performed early to evaluate the hypotensive patient. If gross blood is not found, the cause of the patient's hypotension may be an extra-abdominal injury which redirects the focus of the diagnostic and management processes.

The only absolute contraindication to the procedure is an existing indication for celiotomy. Relative contraindications of a DPL include previous abdominal operations, morbid
obesity, advanced cirrhosis, and established pre-existing coagulopathy. The use of DPL in advanced pregnancy is controversial. If used, the procedure should be performed superior to the enlarged uterus by the open technique.

If a positive DPL will result in the patient's transfer, the procedure should be done by the referring physician. Any lavage fluid obtained should be sent with the patient. Diagnostic peritoneal lavage has a small but real incidence of technical complications and should be performed only by experienced personnel. The open technique is advocated as a rapid and safe method for performing diagnostic peritoneal lavage. However, the method of employing the Seldinger technique is a suitable alternative to be employed by trained physicians.

2. Computed tomography

Diagnostic peritoneal lavage can be performed rapidly and without delay in the emergency department. By comparison, CT requires transport of the patient to the scan area and time to perform the examination. A complete CT examination, usually using both intravenous and oral contrast material, must include the upper abdomen and pelvis. Therefore, the CT scan should be performed only on stable patients in whom there is no apparent indication for immediate operation. The CT scan provides information relative to specific organ injury and its extent, and also can diagnose retroperitoneal and pelvic organ injuries which are difficult to assess by a physical examination or peritoneal lavage.

Caution: CT may miss some gastrointestinal injuries. In the absence of liver or splenic injuries, the presence of free fluid in the abdominal cavity suggests an injury to the gastrointestinal tract and/or its mesentery, and mandates early surgical intervention.

Table 2. Diagnostic Peritoneal Lavage versus Computed Tomography

<table>
<thead>
<tr>
<th></th>
<th>DPL</th>
<th>CT Scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Faster</td>
<td>Required</td>
</tr>
<tr>
<td>Transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive</td>
<td>Greater</td>
<td>Greater</td>
</tr>
<tr>
<td>Specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe</td>
<td>All patients</td>
<td>Stable patients.</td>
</tr>
</tbody>
</table>

III. Indications for Celiotomy

1. Hypotension with evidence of abdominal injury
   a. Gunshot wounds
   b. Stab wounds
   c. Blunt trauma with gross blood on DPL

2. Peritonitis - early or subsequent

3. Recurrent hypotension despite adequate resuscitation
4. Extraluminal air 

5. Injured diaphragm 

6. Intraperitoneal perforation of urinary bladder on cystography 

7. CT evidence of injury to the pancreas, gastrointestinal tract, and specific injuries to the liver, spleen, and/or kidney 

8. Positive contrast study of upper and lower gastrointestinal tracts 

9. Persistent amylase elevation with abdominal findings. 

IV. Special Problems 

A. Blunt Trauma 

The abdominal injury pattern of blunt trauma is much different from that of penetrating wounds. Blunt vehicular trauma results from rapid changes in speed in which visceral disruption may occur from a direct blow, shear forces, or closed-loop phenomenon. The liver, spleen, and kidney are the organs predominantly involved following blunt trauma, although the relative incidence of hollow visceral perforation and lumbar spinal injuries increases with incorrect seat belt usage. 

Abdominal injury resulting from blunt trauma is difficult to assess and diagnose. The multiplicity of organ systems, alterations in the patient's level of consciousness, and/or variables in prehospital and emergency department care can mask or alter the physical findings of abdominal injuries. Physical findings are often subtle and require a high index of suspicion based on the mechanism of injury. The abdominal examination should be conducted in a meticulous, systematic fashion as previously described. Some injuries are visible on physical examination, others may require more specific studies to be identified. 

1. Diaphragm 

Blunt tears may occur in any portion of either diaphragm and may involve the pericardium. The most common injury is 5 to 10 cm in length, involving the posterolateral left hemidiaphragm. Abnormalities on the initial chest roentgenogram are usually nonspecific but may be heralded by hemothorax. The position of the nasogastric tube may identify an otherwise occult left-sided tear; a tube above the diaphragm is pathognomonic. 

2. Duodenum 

Duodenal rupture is classically encountered in the intoxicated, unrestrained driver involved in a frontal-impact motor vehicular accident or by a blow to the abdomen by bicycle handlebars. A bloody nasogastric aspirate or retroperitoneal air should raise one's suspicion. Duodenal "C-loop" diatrizoate meglumine (Gastrografin) studies or double-contrast CT is indicated for the high-risk patient.
3. Pancreas

Pancreatic injury most often results from a direct epigastric blow compressing the organ against the vertebral column. A normal serum amylase level does not exclude major pancreatic trauma; conversely, the amylase level may be elevated from nonpancreatic sources. Even double-contrast CT may not identify significant pancreatic trauma in the immediate postinjury period.

4. Genitourinary

Direct blows to the back or flank resulting in contusions, hematomas, or ecchymosis are markers of potential underlying renal injury. Fractures of posterior lower ribs or spinal transverse processes increase this probability. Similarly, perineal hematomas and anterior pelvic fractures suggest bladder or urethral trauma. Blood at the urethral meatus or the inability to void are overt signs of lower urinary tract injury. Urethral disruptions are divided into those above (posterior) or below (anterior) the urogenital diaphragm. Posterior urethral trauma usually occurs in patients with multisystem injuries and pelvic fracture(s). Anterior urethral injury is due to a straddle impact and may be an isolated injury. Blunt renal artery thrombosis is infrequent and renal pedicle disruption is rare; both lesions may not produce hematuria. In the conscious patient they are associated with severe abdominal pain.

5. Small bowel

Blunt injury to the intestines generally results from sudden deceleration with subsequent tearing near a fixed point of attachment, especially if the patient's seat belt was applied incorrectly. The appearance of transverse, linear ecchymosis on the abdominal wall (seat belt sign) or the presence of an anterior lumbar compression fracture on roentgenogram should alert the physician to the possibility of intestinal injury. Diagnosis may be difficult, especially since minimal bleeding may result from torn intestinal organs. CT is often not diagnostic.

B. Penetrating Trauma

Penetrating injuries may involve indirect effects, such as blast or cavitation, as well as the injury incurred as a result of the anatomic course of the weapon or object inflicting the wound. The injury pattern correlates with the relative size of the abdominal viscera and their proximity to the entrance site. As expected, liver, small bowel, colon, and stomach are commonly involved. Stab injuries traverse adjacent structures, whereas gunshot wounds may have a circuitous trajectory, injuring multiple noncontiguous organs.

Valuable facts in the assessment of penetrating injuries include time of injury, type of weapon, distance from the assailant (particularly for shotgun wounds), number of stab attempts or shots taken, and the amount of blood at the scene. The patient, if conscious, is best prepared to provide most of this information, but police also may glean these data from their preliminary investigation.

Penetrating wounds, particularly gunshot wounds, to the back, flank, or pelvis may produce occult urologic or colon injury. Some perforations of the ureter and bladder may not
exhibit hematuria.

1. Lower chest wounds

The lower chest is defined as the area between the fourth intercostal space anteriorly (nipple line), the seventh intercostal space posteriorly (scapular tip), and the costal margins. Because the diaphragm rises to the fourth intercostal space during full expiration, penetrating wounds to this region may involve the underlying abdominal viscera. The safest policy may be celiotomy for lower chest gunshot wounds, while some surgeons may manage stab wounds nonoperatively.

2. Flank and back wounds

Penetrating injuries in the retroperitoneum are particularly difficult to evaluate because of their secluded anatomic location. An overlooked colon perforation can be fatal. The risk of visceral injury following back or flank penetration is significant.

C. Pelvic Fractures and Associated Injuries

Most severe pelvic injuries result from auto-pedestrian, motorcycle, or high-fall incidents. Mortality rates from open pelvic fractures may exceed 50%.

Major hemorrhage from pelvic fractures is an extremely difficult management problem. The large bones of the pelvis have a generous blood supply, and the fractured bone bleeds. The major muscle groups surrounding these bones also are very vascular and may bleed when the pelvis is fractured. Numerous large veins attend the pelvis and are at high risk for disruption. Major arterial injury from pelvic trauma can lead to exsanguinating hemorrhage.

Physical examination should include careful inspection of the perineum for ecchymosis or open wounds, and systematic compression of the bony pelvis. Rectal and genitourinary injuries must be suspected and excluded in all patients with pelvic fractures. Sacral plexus injuries are common. Major hemorrhage usually is associated with posterior pelvic disruption. Single roentgenographic views of the pelvis may underestimate the extent of these injuries, particularly of the posterior elements.

**Hypotension in the patient with pelvic fracture represents a difficult problem.** The pelvic fracture is rarely an isolated phenomenon. The hypotension may be associated with extrapelvic injury. The patient's hypotension should be the focus of the diagnostic and treatment processes. Causes for blood loss may include:

1. Intra-abdominal from organ or visceral injuries
2. Life-threatening thoracic injuries
3. Retroperitoneal or pelvic vascular injuries
4. Hemorrhage associated with fractured pelvic bones.

Initial management priorities in the hypotensive patient with a fractured pelvis include adequate volume replacement, careful hemodynamic monitoring, and a complete patient evaluation to exclude extrapelvic sources of blood loss. Peritoneal lavage should be performed
above the umbilicus to avoid the hematoma that frequently extends from the pelvis into the lower anterior abdominal wall. The free flow of gross blood indicates an intraperitoneal injury requiring emergency celiotomy. A positive diagnostic lavage RBC count must be interpreted cautiously. Approximately 15% of these patients may not have intraperitoneal injuries, but rather leakage from the retroperitoneal hematoma. If properly performed, negative peritoneal lavage reliably excludes serious intraperitoneal bleeding. If the pelvis is unstable, consultation should be obtained for concurrent orthopedic care. Once intraperitoneal bleeding has been controlled, pelvic stabilization, often with an external fixator, can be done without delay.

If significant intraperitoneal bleeding can be excluded by the absence of gross blood on peritoneal lavage, if no distant bleeding source is present (chest, extremities, etc), and if the patient's hemodynamic stability is not restored by fluid resuscitation, it can be assumed that continuing blood loss is from the retroperitoneal pelvic injury. In the vast majority of cases, this is due to low-pressure bleeding from either the fracture site, adjacent soft tissue, or venous injuries. This bleeding is most effectively controlled by stabilizing the pelvis and allowing the closed retroperitoneal space to tamponade. External pelvic fixation is the currently favored method of rapidly stabilizing a mechanically unstable pelvic ring. Until external pelvic fixation can be achieved in the hemodynamically unstable patient, a pneumatic antishock garment may be the best alternative, for temporary, emergent splinting of the pelvic ring. Should pelvic stabilization fail to control continuing blood loss, prompt arteriography is indicated. In a small percentage of all patients with pelvic fracture (<10%), continuing arterial bleeding is identified and may be controlled by embolization of the involved vessel.

In the hemodynamically stable patient, there is less urgency for fixation of the disrupted pelvis. External fixation alone often does not adequately maintain alignment of displaced posterior pelvic ring injuries, and internal fixation is required. Open pelvic fractures require the evaluation described previously, thorough wound debridement, appropriate pelvic stabilization, and a diverting colostomy.

Management of these serious problems, especially in the persistently hypotensive patient, requires a multidisciplinary approach for optimal patient outcome. This often requires transferring the patient to a facility capable of managing the patient's complex problems.

V. Summary

Two major types of abdominal trauma occur: blunt and penetrating. In either case, early patient evaluation by a surgeon is essential.

A. Blunt Trauma

Intra-abdominal visceral damage must be strongly suspected following blunt trauma to the abdomen, especially because evidence is frequently subtle and misleading. Diagnosis of such injuries is often difficult, and an aggressive approach is mandatory. Multiple injuries are common, and common signs and symptoms guide the diagnostic process. Assessment of the mechanisms of injury may provide some insight. If clinical findings are absent of obscured by other injuries, special techniques must be applied. Peritoneal lavage, properly
performed, is a valuable diagnostic tool for these patients. A specific organ injury diagnosis is not necessary - only the finding of an acute abdominal injury.

B. Penetrating Trauma

A surgeon must evaluate all penetrating injuries of the abdomen. Penetrating trauma to the flanks, buttocks, and lower chest may produce intra-abdominal injuries as well and should be regarded with a high degree of suspicion.

C. Management

Management of blunt and penetrating trauma to the abdomen includes:

1. Re-establishing vital functions and optimizing oxygenation and tissue perfusion.

2. Delineating the injury mechanism.

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

4. Repeating a meticulous physical examination, assessing for changes.

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

Skill Station VIII: Diagnostic Peritoneal Lavage

This surgical procedure, if performed on a live, anesthetized animal, must be conducted in a USDA Registered Animal Laboratory facility. (See ATLS Instructor Manual, Section II, Chapter 9 - Policies, Procedures, and Protocols for Surgical Skill Practicum.)

Resources and Equipment

This list is the recommended equipment to conduct this skill session in accordance with the stated objectives for and intent of the procedures outlined. Additional equipment may be used providing it does not detract from the stated objectives and intent of this skill, or from performing the procedure in a safe method as described and recommended by the ACS Committee on Trauma.

1. Live, anesthetized animals.

2. Licensed veterinarian (see guidelines referenced above).

3. Animal intubation equipment
   a. Endotracheal tubes
   b. Laryngoscope blade and handle
   c. Respirator with 15 mm adapter.

5. Electric shears with #40 blade.

6. Tables or instrument stands.

7. Needles/syringes:
   a. 6-mL syringes with #21- or #25-gauge needles
   b. 12-mL syringes.


9. Surgical instruments:
   a. Disposable scalpels with #10 and #11 blades
   b. Tissue forceps
   c. Allis clamps
   d. Hemostats.

10. Antiseptic swabs.

11. 500- or 1000-mL Ringer's lactate/normal saline with macrodrip and extension tubing.
12. Lidocaine with epinephrine.

13. Surgical drapes (optional).

14. Surgical garb (gloves, shoe covers, and scrub suits or cover gowns).

**Objectives**

1. Upon completion of this station, the participant will be able to discuss the indications and contraindications of peritoneal lavage.

2. Upon completion of this station, the participant will be able to describe the procedure for peritoneal lavage.

3. Performance at this station will allow the participant to practice and demonstrate the technique of peritoneal lavage.

4. Upon completion of this station, the participant will be able to discuss complications of this procedure.

   **The skill procedure for peritoneal lavage is performed via the open-technique method to avoid injury to underlying structures as may occur with the use of the trocar technique. However, the method of employing the Seldinger technique is a suitable alternative to be employed by trained physicians.**
Skill Procedure: Diagnostic Peritoneal Lavage

Note: Universal precautions are required whenever caring for the trauma patient.

I. Peritoneal Lavage Technique: Open Technique

A. Decompress the urinary bladder by inserting a urinary catheter.

B. Decompress the stomach by inserting a nasogastric tube.

C. Surgically prepare the abdomen (eg, costal margin to the pubic area and flank to flank, anteriorly).

D. Inject local anesthetic midline and one third the distance from the umbilicus to the symphysis pubis. Use lidocaine with epinephrine to avoid blood contamination from skin and subcutaneous tissue.

E. Vertically incise the skin and subcutaneous tissue to the fascia.

F. Grasp the fascial edges with clamps, elevate, and incise the peritoneum.

G. Insert a peritoneal dialysis catheter into the peritoneal cavity.

H. After inserting the catheter into the peritoneum, advance the catheter into the pelvis.

I. Connect the dialysis catheter to a syringe and aspirate.

J. If gross blood is not obtained, instill 10 mL/kg (body weight) of warmed Ringer's lactate/normal saline (up to 1 liter) into the peritoneum through the intravenous tubing attached to the dialysis catheter.

K. Gentle agitation of the abdomen distributes the fluid throughout the peritoneal cavity and increases mixing with the blood.

L. If the patient's condition is stable, allow the fluid to remain 5 to 10 minutes before allowing it to drain. This is done by putting the Ringer's lactate/normal saline container on the floor and allowing the peritoneal fluid to drain from the abdomen. Make sure the container is vented to promote flow of the fluid from the abdomen.

M. After the fluid has returned, send a sample to the laboratory for erythrocyte and leukocyte counts (unspun). A positive test and the need for surgical intervention are indicated by 100,000 RBCs/mm$^3$ or more and greater than 500 WBCs/mm$^3$.

N. A negative lavage, however, does not exclude retroperitoneal injuries, ie, pancreas or duodenum, isolated hollow visceral perforation, or diaphragmatic tears.
Complications of Peritoneal Lavage

1. Hemorrhage, secondary to injection of local anesthetic, incision of the skin, or subcutaneous tissues providing a false-positive study.

2. Peritonitis due to intestinal perforation from the catheter.

3. Laceration of urinary bladder (if bladder not evacuated prior to procedure).

4. Injury to other abdominal and retroperitoneal structures requiring operative care.

5. Wound infection at the lavage site (late complication).