Abdominal trauma, Puncture wounds, and Tetanus

Etiology/Pathophysiology:

1) Abdominal trauma - mechanisms of injury
   a) Blunt trauma: usually occurs with a motor vehicle accident and falls. It's not an open wound and may not show obvious signs of injury. This requires further assessment and diagnostics to see the extent of the injury. The spleen is the most commonly damaged organ. The severity of the injury depends on the estimated velocity on impact, the use of seatbelts, the extent of damage to the car, the victims' location within the car, and internal impact.
      i) Compression injuries involve a direct blow to the abdomen. This is a type of blunt trauma because it doesn't produce an open wound. This type of injury can be caused by a seat belt or steering wheel if in an MVA. The sudden increase in intra-abdominal pressure created by the outward forces can rupture a hollow organ.
         (a) Seat belt syndrome: when a patient is in an MVA, the seat belt can cause trauma. The injury can be a contusion, abrasion, vertebral fracture, rib fracture, or damage to internal organs. Seat belts can produce blunt trauma to abdominal organs by pressing them into the spinal column. Common injuries due to seat belts are bowel perforation, diaphragm rupture, and a tear of the mesentery artery.
      ii) Shearing injuries occur during rapid deceleration when in an MVA, allowing tissues to move forward while other tissues stay unchanged. There is a disruption of the fixed point of attachment for organs and vasculature.
   b) Penetrating trauma: an injury caused by an object that breaks the skin and enters the abdominal cavity. Caused by gunshots, stabbings, and other foreign objects. Impalement of a sharp object is included. The small intestine, colon, and liver are most likely to sustain an injury due to the location and the large surface area.
      i) Gunshot: a projectile at any velocity can fragment after contact with bone and cause additional multiple trajectories and injuries. The severity of the injury depends on the weapon used, distance from the victim when shot, number of shots, and blood loss.
         (a) Close range: more lethal with profound intra-abdominal tissue injury
         (b) Far range: less tissue penetration
      ii) Stab wound: the severity of the injury depends on the number, type and size of the instrument, position of the victim, EBL, and their response to treatment.
2) Organs involved
   a) Liver, pancreas, spleen, and kidneys: bleeding can be severe and can cause hypovolemic shock.
   b) Bladder, stomach, and intestines: bleeding can occur, and contents can spill into the peritoneal cavity which increases the risk for peritonitis and sepsis.
      i) Abdominal compartment syndrome can occur due to bleeding or the contents spilling into the peritoneal cavity. This syndrome is where there are excessively high pressures in the abdomen. When there is an increase in volume in the abdominal cavity, there is an increase in abdominal pressure. This high pressure can cause intra-abdominal hypertension. Due to this pressure, ventilation can be restricted, cardiac output and venous return can be decreased, and perfusion of organs can be decreased. This can lead to multisystem organ failure with high mortality.
   c) Common injuries include lacerated liver, ruptured spleen, mesenteric artery tear, diaphragm rupture, bladder rupture, renal or pancreas injury, and stomach or intestine rupture.
   d) Abdominal injuries are associated with rib fractures, pelvis fractures, spinal injuries, and thoracic injuries.
3) Signs and symptoms_– can be subtle findings to severe shock and coma. If hemodynamically unstable, a physical exam is done throughout the resuscitation.
   a) Blunt trauma: guarding and splinting the abdominal wall, hard and distended abdomen, decreased or absent bowel sounds, abrasions or bruising over the abdomen, abdominal pain, hematemesis or hematuria, rebound tenderness, abdominal rigidity, and nausea and vomiting. If the diaphragm ruptures, bowel sounds will be heard

in the chest if they're present. Abdominal pain may be present at the onset or it can be delayed hours to days later.

i) Cullen's sign: periumbilical ecchymosis. Indicates intra or retroperitoneal hemorrhage. It's described as purple or blueish discoloration of the abdomen around the umbilicus. It can also have swelling and pain associated with it.
ii) Kehr's sign is a classic symptom of a ruptured spleen. It's referred pain in the left shoulder due to the presence of blood in the peritoneal cavity. Irritation of the diaphragm is signaled by the phrenic nerve as pain in the shoulder.

b) Penetrating trauma: abdominal pain, visible truncal injury, bleeding, impaled object, laceration, puncture wound, and evisceration.
c) Hypovolemic shock
   i) Inadequate fluid volume in the intravascular space to support perfusion. Will have decreased cardiac output, impaired cellular metabolism, and decreased tissue perfusion.
   ii) Absolute hypovolemia: external loss of circulating blood/fluid – hemorrhaging from penetrating trauma.
   iii) Relative hypovolemia: third spacing, fluid shifts from vascular to extravascular – internal bleeding.
   iv) Tachypnea, hypotension, tachycardia, diaphoresis, weakness, decreased level of consciousness, confusion, pale and clammy skin, decreased urinary output, and weak thready pulses.
d) Peritonitis
   i) Localized inflammatory process of the peritoneum.
   ii) Abdominal pain, rebound tenderness, muscular rigidity, abdominal distention, fever, tachycardia, tachypnea, and altered bowel habits.

4) Puncture wounds: a break through the skin and into the tissue. It's caused by a sharp pointed object or animal bite. Puncture wounds of the foot occur on the plantar surface, from the neck of the metatarsal to the toes. This injury doesn't cause vast tissue destruction or a laceration. These injuries are at risk for infection because they deliver bacteria deep into the body and are difficult to visualize and to clean the full depth of. To aid in optimally treating these wounds if they become infected, they shouldn't be closed. Most infections are caused by gram-positive organisms such as staphylococcus aureus. If the object penetrates the joint capsule, it can produce septic arthritis and puts the patient at risk for developing osteomyelitis. Depending on what caused the wound, the patient can be at risk of getting tetanus.
   a) Tetanus is a severe infection of the nervous system that affects spinal and cranial nerves. The effects are caused by a potent neurotoxin (tetanospasmin) released by anaerobic bacillus clostridium tetani. This neurotoxin binds to motor nerves and enters axons. It can travel to the brain and spinal cord which can stop the release of inhibitory neurotransmitters causing sustained muscle contractions. This neurotoxin can travel via the blood and lymph system causing muscles throughout the body to be affected. It enters the body through a wound that provides a low-oxygen environment for the organism to mature and make the toxin. This is a medical emergency and requires hospitalization. The incidence of tetanus has decreased due to immunizations and wound care.
      i) Risk factors: IV drug use, animal bites, stepping on a nail, gardening injuries, burns, open fractures, and gunshot wounds. Usually occurs because of a deep penetrating wound.
      ii) Incubation period is 4-14 days.
      iii) Generalized tetanus: hallmark features are muscle rigidity and spasms. Other symptoms include muscle soreness, cramping, and difficulty swallowing. Facial muscles are affected first including stiffness of the jaw (trismus). These patients can have a sardonic smile (risus sardonicus) due to muscle contractions.
      iv) Severe: it can progress to the neck, back, abdomen, and extremities. These patients are at risk for continuous tonic seizures occurring with extreme arching of the back and retraction of the head. They can have laryngeal and respiratory spasms which could cause apnea and anoxia.
      v) Localized tetanus: persistent muscle spasms close to the site of injury. Mortality is lower than with generalized. Local can progress to generalized and may reflect partial immunity to tetanospasmin.

vi) Complications: acute respiratory failure from respiratory muscle spasms, laryngospasms, and airway obstruction. Fractures and dislocations can occur. Renal failure can occur due to rhabdomyolysis, dehydration, and sympathetic nervous system hyperactivity. Hyperthermia may result from muscle spasms and sympathetic hyperactivity. Prolonged immobility can lead to deep venous thrombosis and pulmonary embolism.

(a) Autonomic dysfunction is the leading cause of death if they have adequate ventilatory support. Occurs days after the onset of generalized spasms. Disinhibition of the sympathetic nervous system causes dysrhythmias, hypertension, myocarditis, and pulmonary edema. Dysrhythmias and myocardial infarctions are the most common causes of death during this phase.

b) Rabies is a viral disease transmitted through the bite of an animal who has rabies. This virus infects the central nervous system of mammals and causes disease in the brain and death. The animals that transmit this the most are bats, raccoons, skunks, and foxes. It's transmitted from the saliva of the infected animal usually by a bite.

i) Symptoms are flu-like and may last for days. Later signs are fever, headache, nausea, vomiting, agitation, anxiety, hyperactivity, excessive salivation, difficulty swallowing, hallucinations, and partial paralysis.

5) On-scene treatment

a) Abdominal trauma

i) Initial: assess airway, breathing, and circulation. Assess HR, BP, O2, and RR. Apply oxygen as needed. Assess for symptoms of blunt or penetrating trauma. Control external bleeding with direct pressure from a sterile pressure dressing. Two large bore IVs with normal saline or lactated ringers running. Remove clothing for better visualization of wounds and to inspect for any other injuries. Administer blood products as needed. Administer TXA if hemorrhaging. Stabilize the impaled object with a bulky dressing. Ask about allergies, medications being taken, preexisting medical conditions, and events immediately leading up to this injury. If abdominal trauma was caused by an MVC, keep the neck and spine immobilized until cleared. Administer analgesics PRN.

ii) Abdominal contents are protruding from the wound: cover with a sterile dressing moistened with 0.9% sodium chloride solution.

b) Puncture wound

i) Initial: assess airway, breathing, and circulation. Assess HR, BP, O2, and RR. Apply oxygen as needed. Control external bleeding with direct pressure from a sterile pressure dressing and cover for transport. 1 IV with normal saline or lactated ringers. Remove clothing if necessary. Assess what object caused this wound. Administer analgesics PRN.

c) Tetanus and rabies

i) Assess airway, breathing, and circulation. Assess HR, BP, O2, and RR. Apply oxygen as needed. Anticipate the need for mechanical ventilation and intubation depending on severity. Administer a sedative and a paralytic if needing intubation. Consider pain management. Insertion of IV access with fluids running. Assess safety concerns regarding hallucinations.

6) ED treatment

a) Abdominal trauma

i) CT scan is the primary diagnostic imaging test for abdominal trauma because it defines the extent of intra-abdominal injury with detailed high-resolution images. MRI isn't appropriate for the acute phase of an abdominal trauma.

ii) Diagnostic peritoneal lavage: an invasive, bedside procedure that provides information about peritoneal penetration and injury to solid organs. Insertion of a catheter into the peritoneal cavity and infusion of fluids to lavage the cavity.

iii) Focused assessment with sonography (FAST): is performed in all multiple-trauma patients and all patients with a suspected abdominal injury. The purpose of a bedside ultrasound is to rapidly identify free fluid in the abdomen. During this ultrasound, they'll exam the Morrison pouch, splenorenal recess, and pouch of

Douglas where blood is likely to accumulate in the intraperitoneal cavity. The thoracic portion of the examination detects pneumothorax, hemothorax, and pericardial effusion/tamponade. Performing this at the bedside is important when the patient is unstable and cannot wait for a CT scan. It's preferred because it can be done simultaneously with evaluation and resuscitation and isn't delaying time for treatment or results. It's safe in pregnant patients and children and requires less radiation than a CT scan.

iv) Nasogastric tube should be inserted in patients who are intubated, have a distended abdomen, and those who have a high concern for stomach injury. This allows decompression of the abdomen, decreased chance of aspiration, and determines whether blood is present. Orogastric tubes are preferred in patients with midface or base skull fractures.

v) Insertion of an indwelling catheter for unconscious patients, those experiencing shock, and those who need strict urine output monitoring.

vi) Prophylactic antibiotics are given to decrease the risk for intra-abdominal sepsis. A single pre-op dose of a broad-spectrum antibiotic such as piperacillin-tazobactam IV is recommended if a perforation injury is present.

vii) Management of stab wounds to the anterior abdomen

(a) Clinical indications for an emergent laparotomy:

- Hemodynamic compromise: the main reason why a patient would be brought to the operating room without preliminary diagnostic studies.
- Peritoneal signs
- Evisceration: will have an exploratory laparotomy.
- Left-sided diaphragmatic injury: diagnose through the observation of stomach/bowel in the left chest on radiographs. This indicates the need for surgical intervention.

➔ If clinical indications for an emergency laparotomy are absent, the next step is to assess the wound tract.

(b) Peritoneal violation: used to establish whether a wound tract is superficial to abdominal cavities. If it is found that the wound is superficial, the patient can be discharged after receiving wound care. If it's inconclusive, assume that a cavity has been violated and further assessments are required.

- Evisceration: clear sign of peritoneal entry.
- Intraperitoneal air: this finding can indicate a bowel perforation and can establish that the object has entered the peritoneal cavity and has drawn air in with it.
- Local wound exploration (LWE): an effective tool in determining if the peritoneal cavity has been penetrated. Superficial wound can be repaired and the patient can be discharged. This tool is ineffective in small puncture wounds, multiple stab wounds, or in obese patients. The wound is infiltrated with a local anesthetic containing epinephrine and then visualized through each layer of tissue.
- Ultrasound: FAST examination can identify peritoneal penetration or injury. The presence of intraperitoneal fluid can preclude the need for LWE and suggest an intra-abdominal injury.
- Laparoscopy" can detect organ injury and simultaneously repair some injuries.

➔ Patients remaining have a presumed peritoneal violation. The next step is to determine whether the injury that exists requires an operative repair.

(c) Injury requiring laparotomy: If a patient reaches this step, they should be observed for 12-24 hours.

- Most patients with a penetrating abdominal injury and peritoneal violated undergo exploratory laparotomy.
- If injury isn't requiring laparotomy: close observation with serial vital signs, repeated abdominal examinations (FAST) and CT scans, and laboratory tests focused on identify new or ongoing hemorrhage or the development of peritonitis.

viii) Management of stab wounds to the flank and back:

(a) CT scans with IV contrast is the method of choice of choice for evaluating these wounds. A negative CT scan with serial examinations over a 24-hour period can rule out the need for serious injury management.

ix) Management of gunshot wounds to the anterior abdomen:
   (a) Emergent laparotomy if the patient is hemodynamically unstable, has peritonitis, or has an unreliable abdominal exam.
   (b) If patient is stable, a CT with IV contrast is helpful to identify the extent and severity of injuries and whether there is active bleeding. They will be admitted for serial examinations.

x) Management of gunshot wounds to the flank and back:
   (a) CT scan is the diagnostic test of choice in a stable patient. Most are then taken to the operating room. If the CT scan showed no signs of injury and the track of the bullet doesn't transverse with any anatomically important structures, a laparoscope or observation can be done.

xi) Management of blunt abdominal trauma
   (a) Immediate laparotomy is reserved for patients with refractory hypotension or peritonitis with a positive FAST examination. Hollow visceral injury requires operative management.
   (b) Hemodynamically stable patients with solid organ injuries from a blunt trauma, mainly can be managed without laparotomy.

xii) Therapeutic angioembolization
   (a) Reserved for unstable patients with blunt trauma. It's used to embolize bleeding vessels. Has also been used for intraperitoneal hemorrhage after a penetrating trauma.

xiii) Penetrating trauma: CT scan or x-ray will be done to see if the foreign object has penetrated an abdominal cavity or has made contact with an abdominal organ.
   (a) If the penetrating object is superficial, they may remove it in the emergency room and provide the patient with intravenous pain medication.
   (b) If not superficial, they will be brought to the operating room to have it surgically removed.
   (c) To prevent contamination and infection, wound irrigation can be done. This removes foreign material, decreases bacterial contamination of the wound, and removes cellular debris from the surface of the wound.
   (d) Povidone-iodine solution is broad, bactericidal, and acts against gram positive and negative bacteria.
   (e) Chlorhexidine is bactericidal against gram positive bacteria.
   (f) Normal saline is the most commonly used.

b) Puncture wound
   i) Plain-film radiographs using soft tissue visualization.
   ii) Antibiotics are indicated for cat and dog bites, some human bites, and some puncture injuries to the foot.
      (a) Cat bites: antibiotic prophylaxis is required especially if the bite is on the hand. These bites are deep puncture wounds and are difficult to irrigate.
      (b) Dog bites: antibiotic prophylaxis may be indicated. Dog bites are more of tearing and avulsions rather than puncture wounds. They are easier to irrigate and debride.
      (c) Cephalexin or dicloxacillin. If MRSA is suspected, sulfamethoxazole-trimethoprim or doxycycline.
   iii) Requires superficial wound cleansing and tetanus prophylaxis as indicated. Low-pressure irrigation will assist in surface cleansing and allow visualization of the entrance site. Debridement is not indicated.
   iv) Rabies:
      (a) Rabies immune globulin (RIG) prevents the virus from infecting the patient after they've been exposed. This is given if the patient hasn't received the vaccine. Administered near where the bite is located. Ideally, it should be administered as soon as possible after the bite.

(b) Rabies vaccinations to help the patients body identify and fight the virus. If the patient hasn't had a rabies vaccine before, they'll get four injections over fourteen days. If they've had the vaccine before, they'll receive two infections over the first three days.

c) Tetanus
   i) There are no laboratory tests to confirm or exclude the diagnosis. A CT scan can help assess for intracranial disease.
   ii) Spatula test: touching the oropharynx with a tongue blade. If the test is negative, the patient will gag and expel the tongue blade. If it is positive, the patient has reflex masseter muscle spasms and bites the spatula.
   iii) Supportive care: controlling muscle spasms. Benzodiazepines for symptomatic therapy.
   iv) Immunization with human tetanus immune globulin (HTIG)and active immunization with Td. HTIG neutralizes the circulating toxin. It doesn't neutralize what is already in the nervous system and doesn't help with the symptoms already present.
   v) Prevent further toxin production by eliminating the C. tetani infection. Wound debridement and antibiotic administration should be delayed until after the HTIG is administered to prevent a transient release of tetanospasmin. Metronidazole is the antibiotic of choice.
   vi) ICU: Should be considered for early tracheostomy to decrease reflex spasms. Sympathetic hyperactivity can be treated with combined alpha- and beta-adrenergic antagonist such as propranolol. Morphine, magnesium sulfate, spinal anesthesia, and intrathecal baclofen improves autonomic dysfunction. Diuretics should be avoided for blood pressure control due to worsening autonomic instability. Patients can have dysrhythmias that should be treated with temporary pacing.

7) Role of the ED nurse
   a) Abdominal trauma
      i) Monitor vital signs, level of consciousness, oxygen, and urinary output.
      ii) Assess for allergies, medications, and previous medical history if appropriate.
      iii) Laboratory testing: Hemoglobin and hematocrit to provide a baseline and to show the extent of and time from hemorrhage. H+H will be normal because fluids are lost at the same rate as red blood cells. Therefore, the deficiencies will be present with fluid resuscitation. White blood cells to assess infection, inflammation, and organ involvement. Platelets, red blood cells, liver enzymes, and pancreatic enzymes
      . Type and crossmatch for the potential of blood administration and obtain coagulation studies. Serum bicarbonate and lactate levels should be drawn to identify metabolic acidosis and could suggest the presence of hemorrhagic shock. Women of child-bearing age should receive a pregnancy test. BUN and creatinine to assess for kidney damage.
      iv) Obtain a urinalysis. Blood in the urine can indicate bladder or kidney damage.
      v) Perform an abdominal assessment
         (a) Inspection: distention, contusions, lacerations, bleeding, and penetrating wounds. Assess for seat belt syndrome. Auscultate for bowel sounds and abdominal bruits.
         (b) Percussion will provide information regarding abdominal organs. This can help identify if there is a buildup of air or fluid within the abdominal cavity.
         (c) Palpation: guarding, tenderness, rigidity, and pain.
      vi) Use warm blankets, IV fluids, and humidified oxygen.
      vii) Administer blood products PRN.
      viii) Administer vasopressors and IV fluids.
      ix) Prepare patient for transport to CT.
      x) Prepare patient for the operating room. Educate if appropriate.
      xi) Administer pain medications PRN.
      xii) Insert nasogastric tube and indwelling catheter if appropriate.
   b) Puncture wound

i) Perform wound care and dressing changes. Education on wound care when appropriate.
ii) Administer antibiotics as ordered.
iii) Assess whether patient has had previous rabies vaccines and if they've received their Tdap.
iv) Rabies: Safety considerations due to hallucinations and partial paralysis. Keep patient NPO due to difficulty swallowing. Perform an ANA blood test – fluorescent antinuclear antibody test to test for rabies. Administer rabies vaccinations as ordered.
v) Tetanus: decrease stimulation. Administer benzodiazepines PRN (lorazepam, diazepam). Administer dantrolene for muscle relaxation. Anticipate need for mechanical ventilation and intubation. Anticipate administration of a sedative and a neuromuscular blockade agent. Administer magnesium sulfate as ordered. - ICU care: Sedation holiday daily to assess patient's status.

8) Discharge/prevention instructions
   a) Abdominal trauma
      i) Educate on post-operative limitations and when to seek treatment again. Educate on pain management post-operative. Educate on importance of deep breathing and coughing post-op to prevent complications. Educate on wound care instructions. Signs and symptoms of infection.
   b) Puncture wound
      i) Wound care instructions. Ways to prevent this type of injury in the future. When to seek treatment again. Signs and symptoms of infection.
      ii) Tetanus: immediate thorough cleaning of wounds is important for prevention. Adults should receive a series of three tetanus toxoid doses if immunization status is unknown and should receive a booster every 10 years. Vaccination provides close to 100% protection if three doses are received. Immunity starts to decrease between 5-10 years after vaccination.
      iii) Rabies: vaccinate your pets against rabies. Keep your pets inside and supervise them when outside. Don't approach wild animals. Consider receiving a rabies vaccine if you're traveling to developing countries or going to be around animals that may have rabies. Seek immediate assistance if you're bitten by any animal. If a bat is near a person that cannot report a bite, assume the person has been bitten and seek assistance.

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