



SOCIETY OF TRAUMA NURSES

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Abdominal Trauma



Objectives

**At the conclusion of this presentation
the participant will be able to:**

- Describe common mechanisms of injury seen in abdominal trauma
- Discuss various injuries of the abdomen
- State appropriate assessment and diagnostic studies for the patient with abdominal trauma
- Describe abdominal compartment syndrome and the importance of early recognition

Epidemiology

Incidence

- Abdominal injuries rank among the top seven causes of death in trauma.
- Accounts for more than 10% of trauma deaths
- Seldom a single system injury

Mechanism of Injury

Blunt



Penetrating



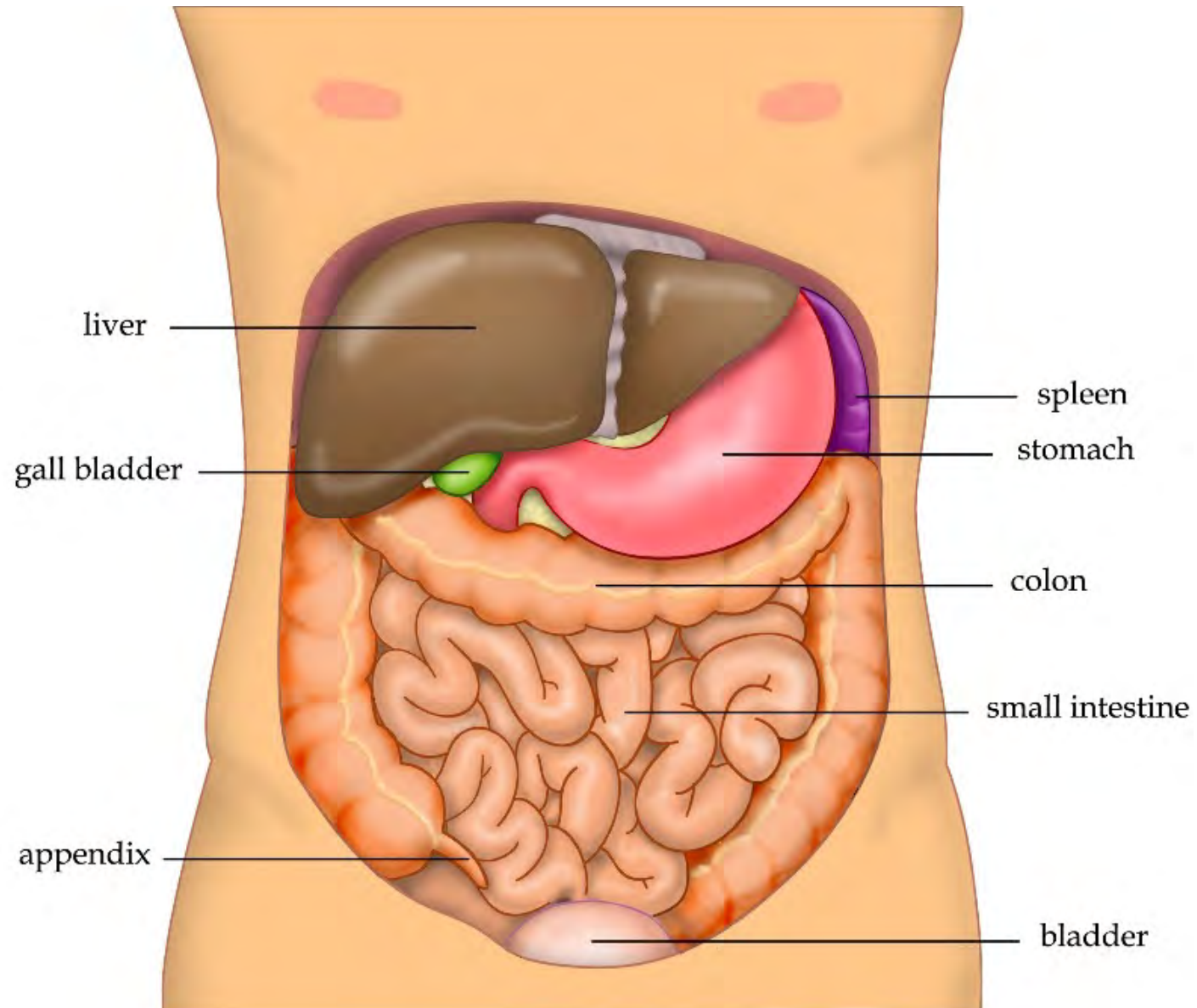
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Mechanism of Injury

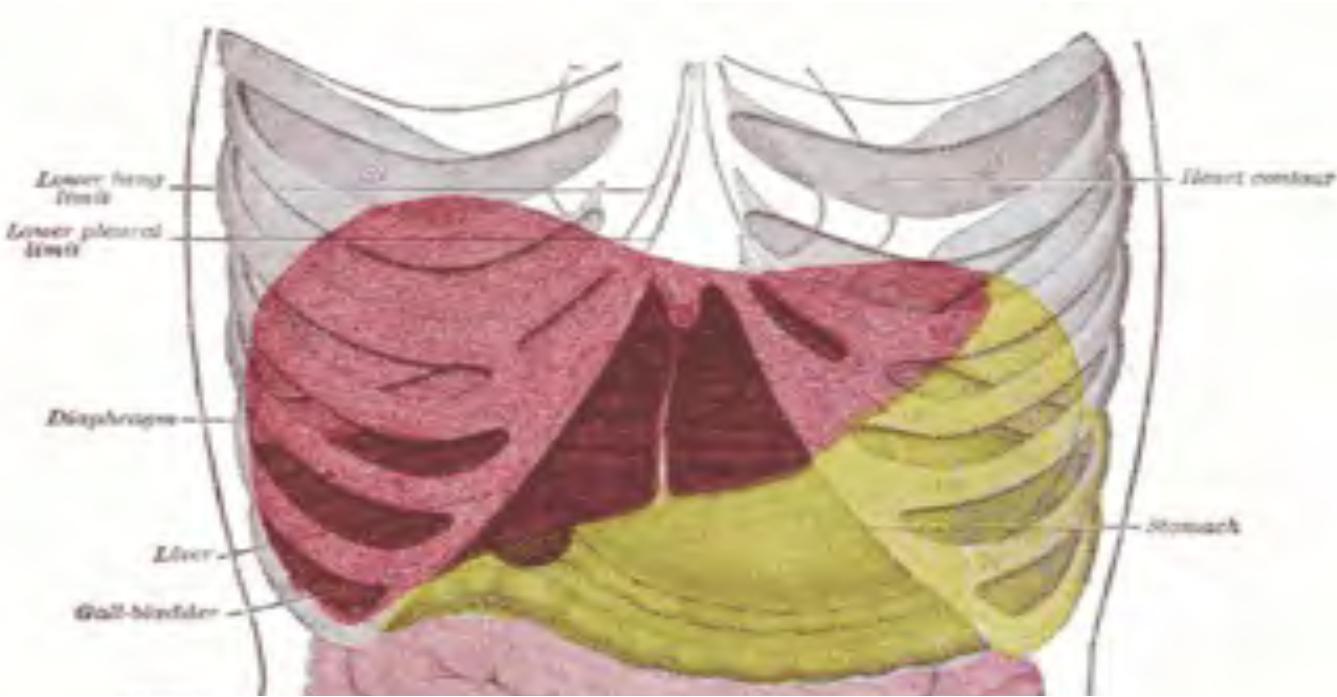
- Heightens suspicion for certain injuries
- Blunt injury and types of forces
- Use of restraint devices
- Penetrating trauma



Anatomy and Physiology



Abdominal Sections



Henry Vandyke Carter, Public domain, via Wikimedia Commons

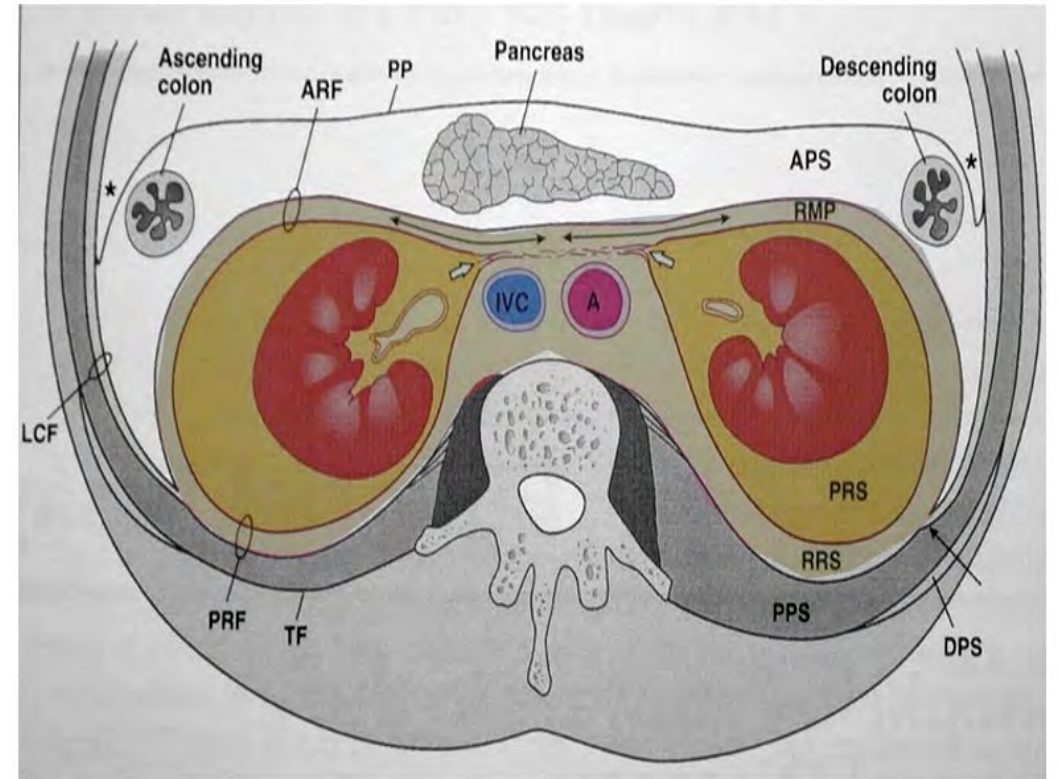


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Abdominal Assessment

- Inspection
- Auscultation
- Percussion
- Palpation



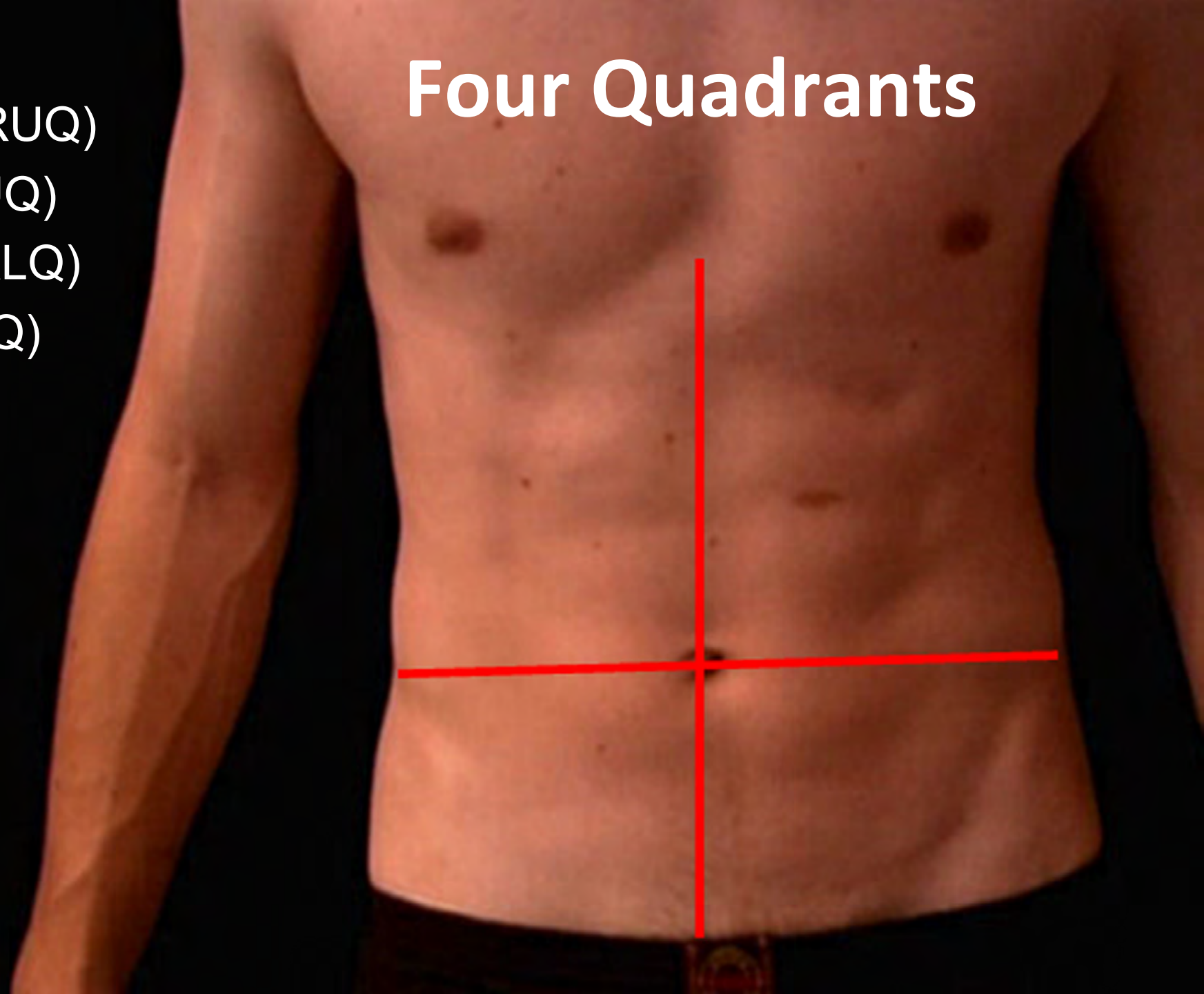
Four Quadrants

Right upper quadrant (RUQ)

Left upper quadrant (LUQ)

Right lower quadrant (RLQ)

Left lower quadrant (LLQ)

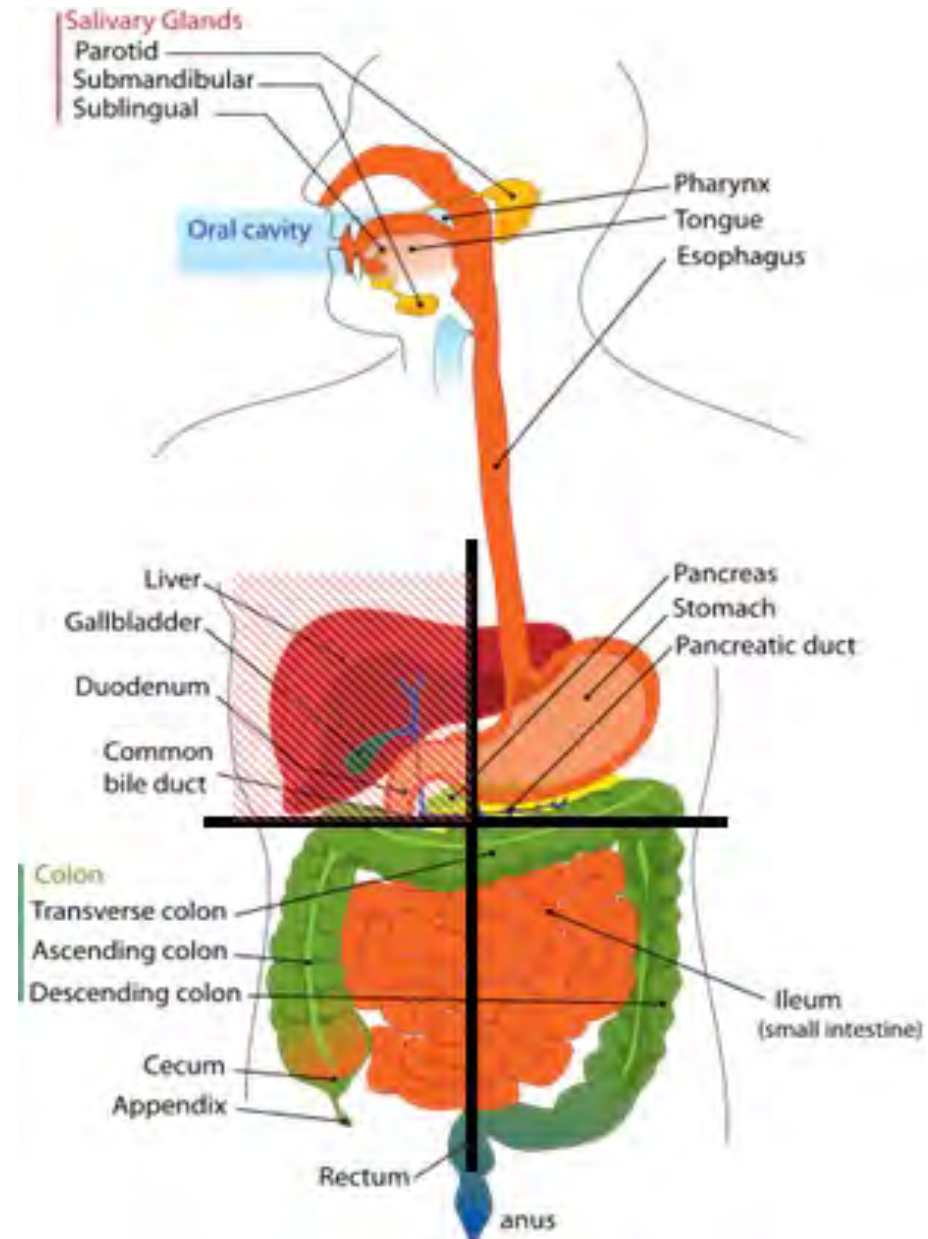


RUQ

- Liver
- Gallbladder with biliary tree
- Duodenum
- Head of pancreas
- Hepatic flexure of colon

LUQ

- Stomach
- Spleen
- Left lobe liver
- Left kidney
- Left adrenal gland
- Splenic flexure of colon
- Parts of transverse and descending colon

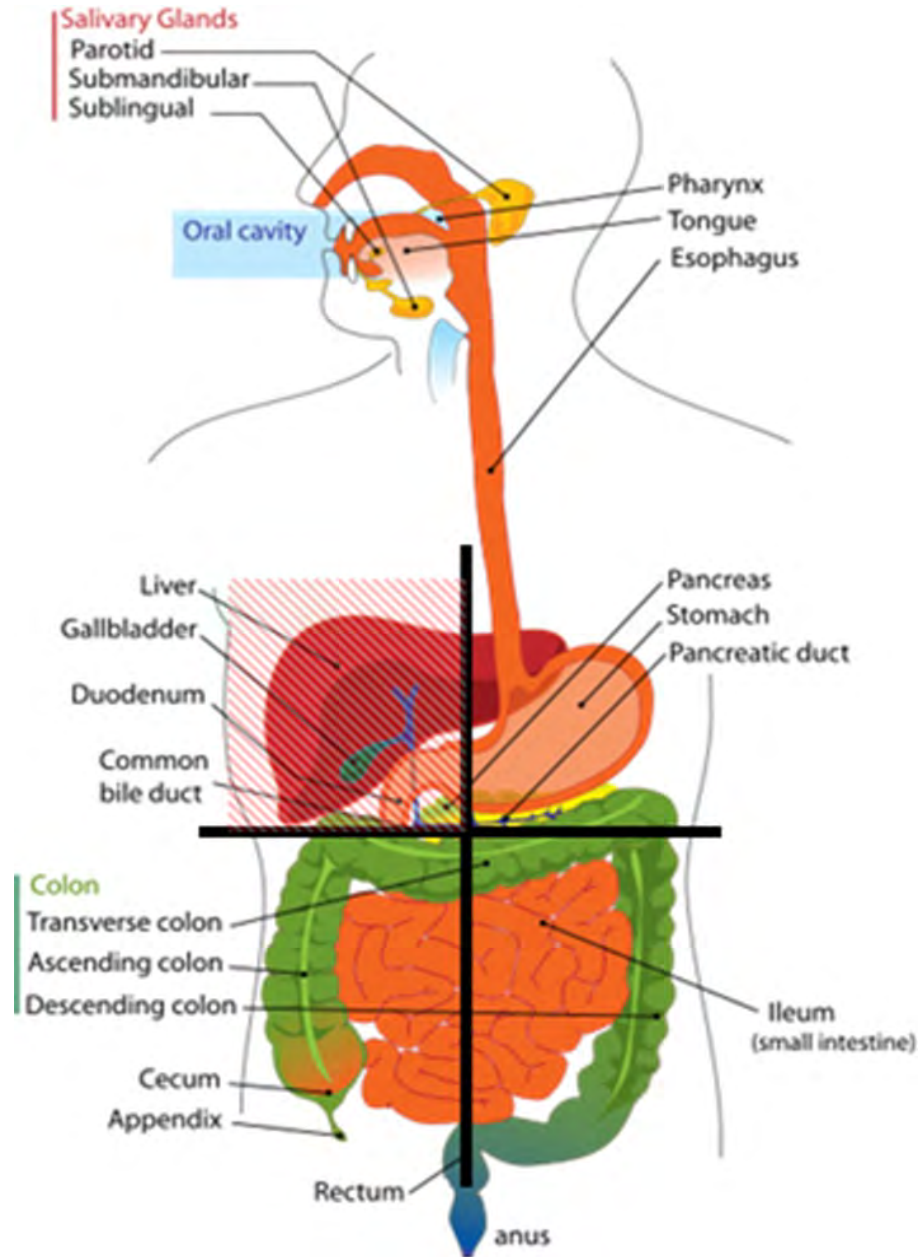


RLQ

- Cecum
- Appendix
- Ascending colon
- Right ovary and fallopian tube
- Right ureter

LLQ

- Descending colon
- Sigmoid colon
- Left ovary and fallopian tube
- Left uterine tube





Ongoing Assessment

- Delayed diagnosis or missed injuries
- Frequent serial and systematic examinations
- Tertiary exam

Diagnostic Labs

Are they necessary?

Reliable?

- Hematocrit
- WBC
- Electrolytes



Diagnostic Labs

- ABGs
- Coagulation studies
- Urinalysis
- Pregnancy
- Pancreatic enzymes
- LFTs



Diagnostic Modalities

- Radiographs
- Diagnostic peritoneal lavage (DPL)
- Ultrasonography (US)
- Computed tomography (CT) scan
- Angiogram
- Diagnostic laparoscopy

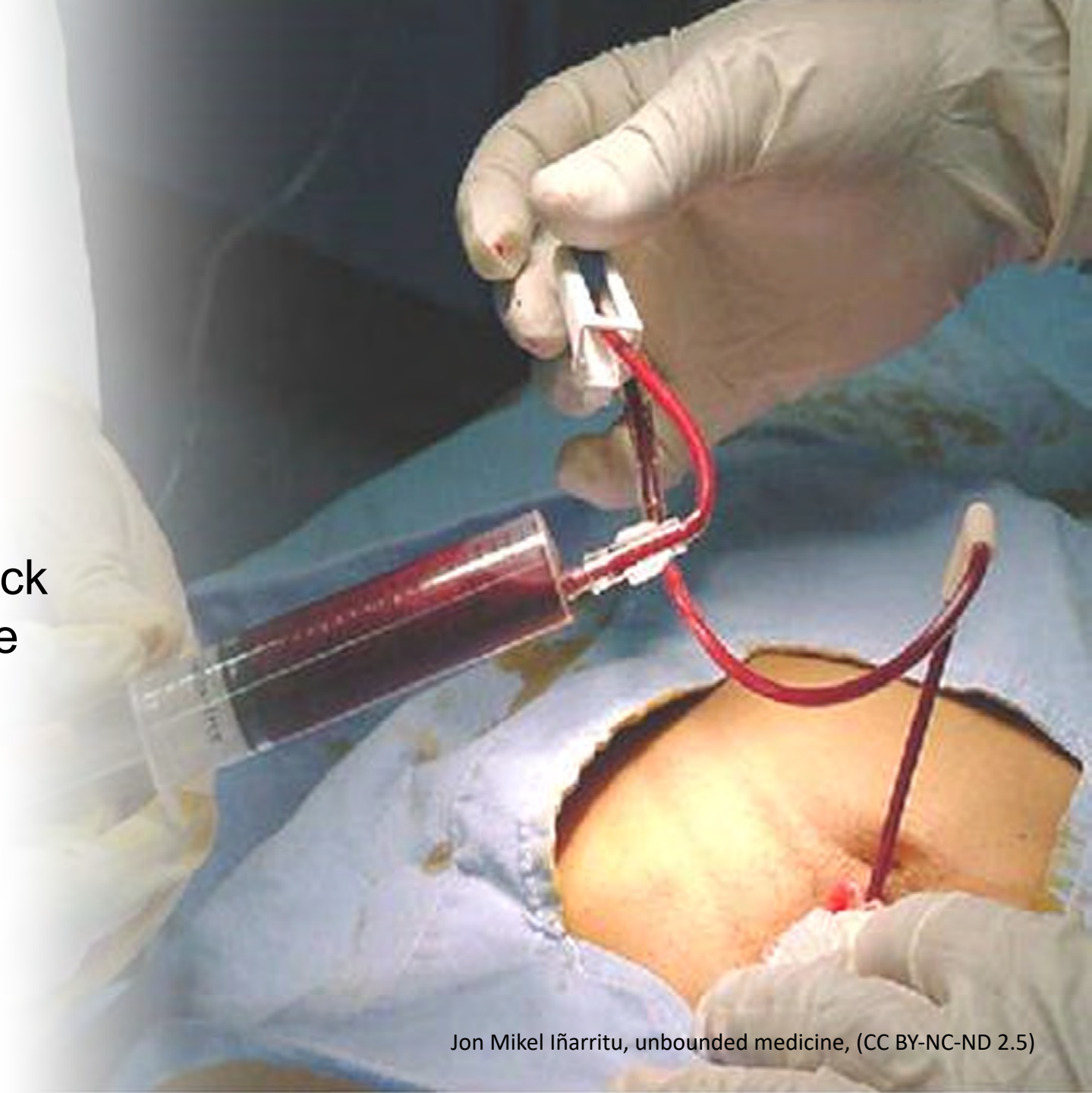


Radiographic Films

- CXR
 - Concomitant pulmonary and cardiac injuries
 - Displacement of abdominal organs
- Pelvis
- Plain abdominal films have limited if any role in the acute resuscitation.
 - AP and lateral films may identify fluid or air.
 - Upright film for free air; may disclose ruptured hollow viscus

Diagnostic Peritoneal Lavage

- Used to diagnose intra-abdominal bleeding
- Indications
 - Unexplained hypotension, decreased hematocrit, or shock
 - CT or ultrasound not available
 - Equivocal abdominal examination
 - Altered mental status
 - Spinal cord injury
 - Distracting injuries



DPL

Advantages

- Quick, simple
- Safe
- Low cost
- Relatively accurate
- Grossly positive result

Disadvantages

- Difficult to perform in some patients
- Invasive procedure
- Can miss certain injuries

Complications: Infection, hematoma, false positives, injury, bleeding, unnecessary laparotomy, failure to recover lavage fluid

Note: A urinary catheter and gastric tube should be in place prior to the procedure.

Ultrasound

FAST

- Focused
- Assessment
- Sonography
- Trauma

Ultrasound probe locations and sequence

- Epigastrium
- RUQ
- LUQ
- Pelvis



Ultrasound

- Reliable, fast, safe
- Noninvasive
- Equipment portable
- Performed simultaneously
- Fast exam detects free fluid
- Serial exams
- Leads to fewer DPL's & CT Scans



Disadvantages of Ultrasound

- Clinician expertise variable
- Lacks specificity & sensitivity
- Reliability is questionable
- May not reveal free fluid if performed too early

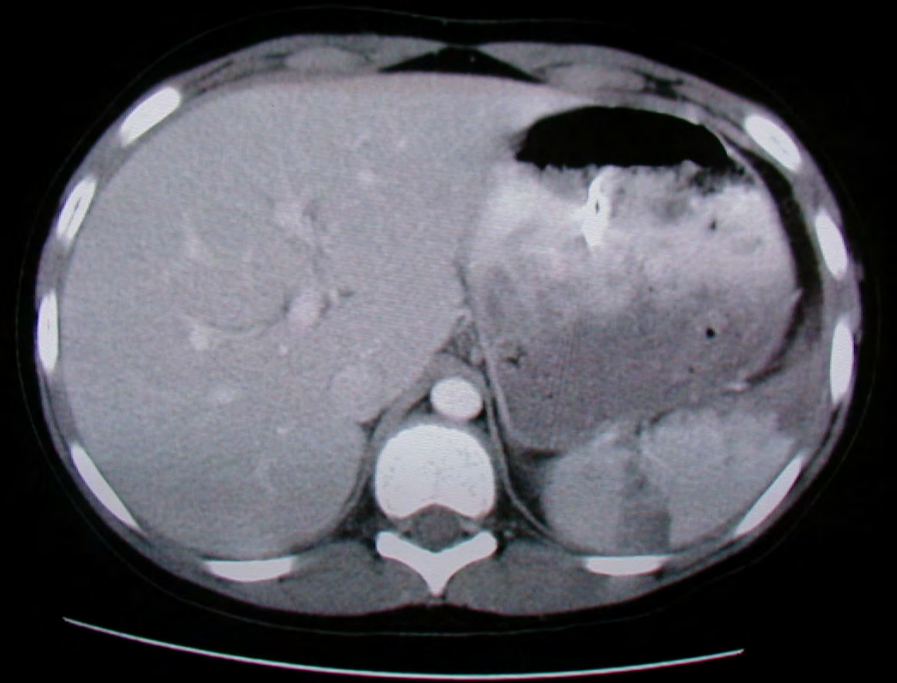
Computed Tomography



- Used for hemodynamically stable patients
- Advantages:
 - Noninvasive procedure
 - Better defines organ injury
 - Estimates amount of blood in spaces
 - Retroperitoneum and vertebrae can be assessed
- Helical scanners

CT Scan in Trauma

- Visualizes abdominal solid organs and vessels well
- Does NOT see mesenteric injuries, hollow viscus, duodenum, diaphragm, or omentum well
- Whole body scans on all trauma
- Radiation long-term effects



CT Scan Disadvantages

- Takes time to perform
- Cost
- Transport of patient
- Requires stable and cooperative patient
- Less reliable in diagnosing some injuries
- IV contrast
- Radiation exposure



Angiography

- Detects active bleeding in patients with vascular trauma
- Embolizes specific structures within bleeding organs or the pelvis
- Detects A-V fistulas and aneurysms in penetrating trauma



Diagnostic Laparoscopy (DL)

- Screening or diagnostic tool
- Invasive procedure with some limitations
- Used to detect or exclude certain findings
- May reduce the rate of negative laparotomies



Other Diagnostic Procedures

ERCP

- May be indicated in the stable trauma patient suspected of having biliary tract or pancreatic duct injury
- Most accurate test in the patient with hyperamylasemia and in those following pancreatic surgery

Other Diagnostic Procedures

Gastrografin or barium studies

- Helpful in diagnosing injuries to the esophagus, stomach, or bowel
- Contrast enemas are used to diagnose rectal or colonic injury secondary to penetrating trauma

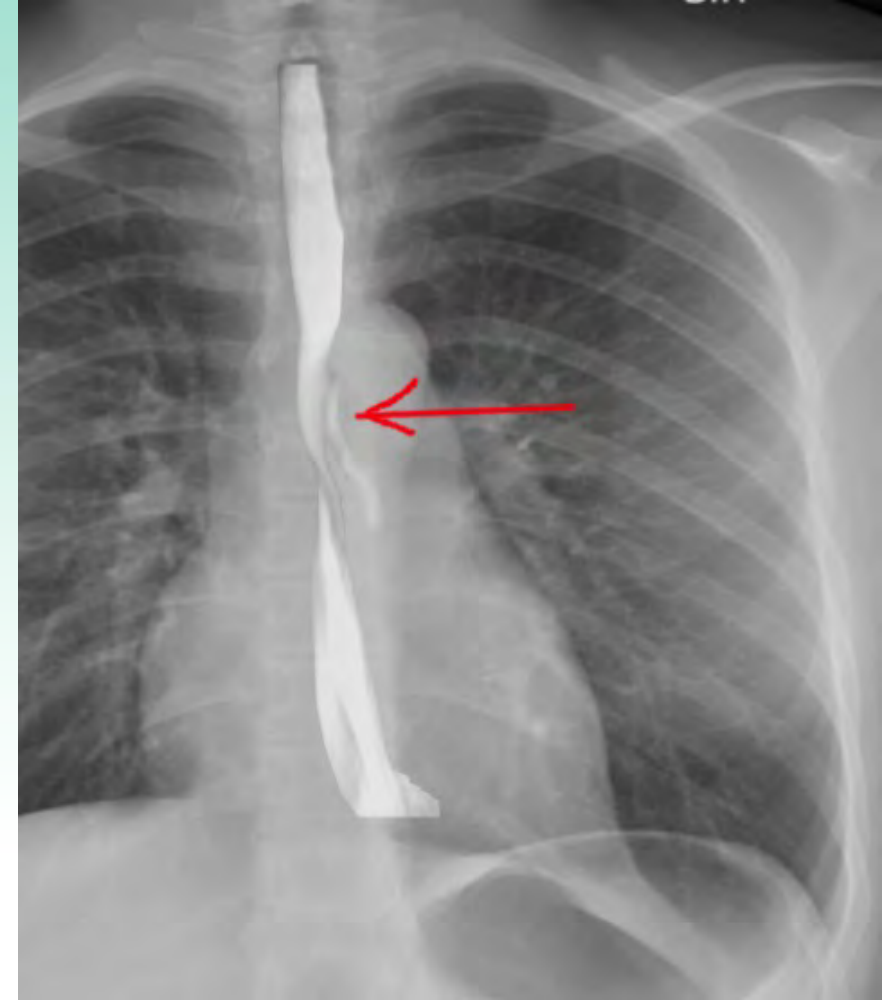


Image courtesy S Bhimji MD, <https://www.statpearls.com/ArticleLibrary/viewarticle/21348>

Specific Injuries





Esophageal Injuries

Esophagus

Anatomy

- Carries food from pharynx to the stomach
- Joins the stomach at the level of T-10
- Posterior surface overlies aorta
- Anterior surface covered by peritoneum

Predisposing Injury Facts

- Narrow at
 - Cricoid cartilage
 - Arch of aorta
 - Esophagogastric junction
- Lacks serosal layer
 - Integrity of anastomoses
 - Possible leak after surgical repair

Esophageal Injury

- Incidence
 - Higher in cervical and thoracic areas
 - Majority are due to penetrating trauma
 - Blunt injury is rare
- Early diagnosis essential
- Can result in high morbidity and mortality

Sequelae

- Respiratory compromise
- Mediastinitis
- Paraesophageal abscess
- Empyema
- Esophageal fistula
- Peritonitis

Esophageal Injury

Assessment

- Symptoms of perforation include pain, fever, and dysphagia
- Symptoms of abdominal esophageal tear include signs of peritoneal irritation followed by dyspnea and pleuritic pain

Diagnostic tests

- Endoscopy/Esophagoscopy
- CT

Esophageal Injury



Management

- Initial assessment complex
- Goal is to minimize the bacterial contamination and enzyme erosion
- Gastric decompression
- Antibiotic coverage
- Drainage of wound
- Surgical repair

Esophageal Injury Management

Continuous monitoring for injury

Complications after repair



Samir धर्म, Public domain, via Wikimedia Commons



Diaphragm

Diaphragmatic Injury

Incidence

- Usually occurs with other injuries
- Seen in < 5% of blunt trauma patients
- Left side greater incidence than right side
- Commonly associated with penetrating trauma
- Injuries from blunt trauma caused by sudden rise in intrathoracic pressure

Diaphragmatic Injury

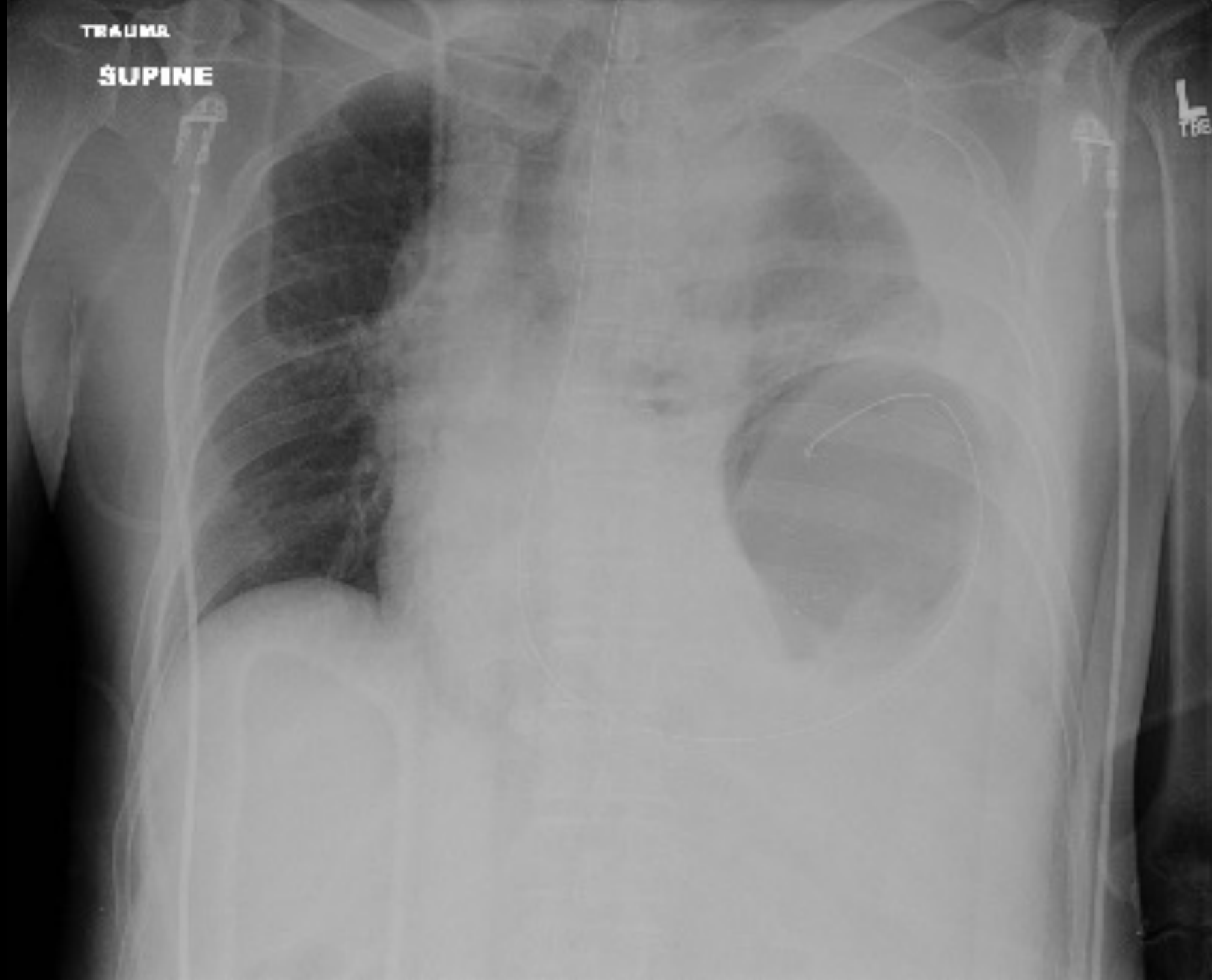
Assessment

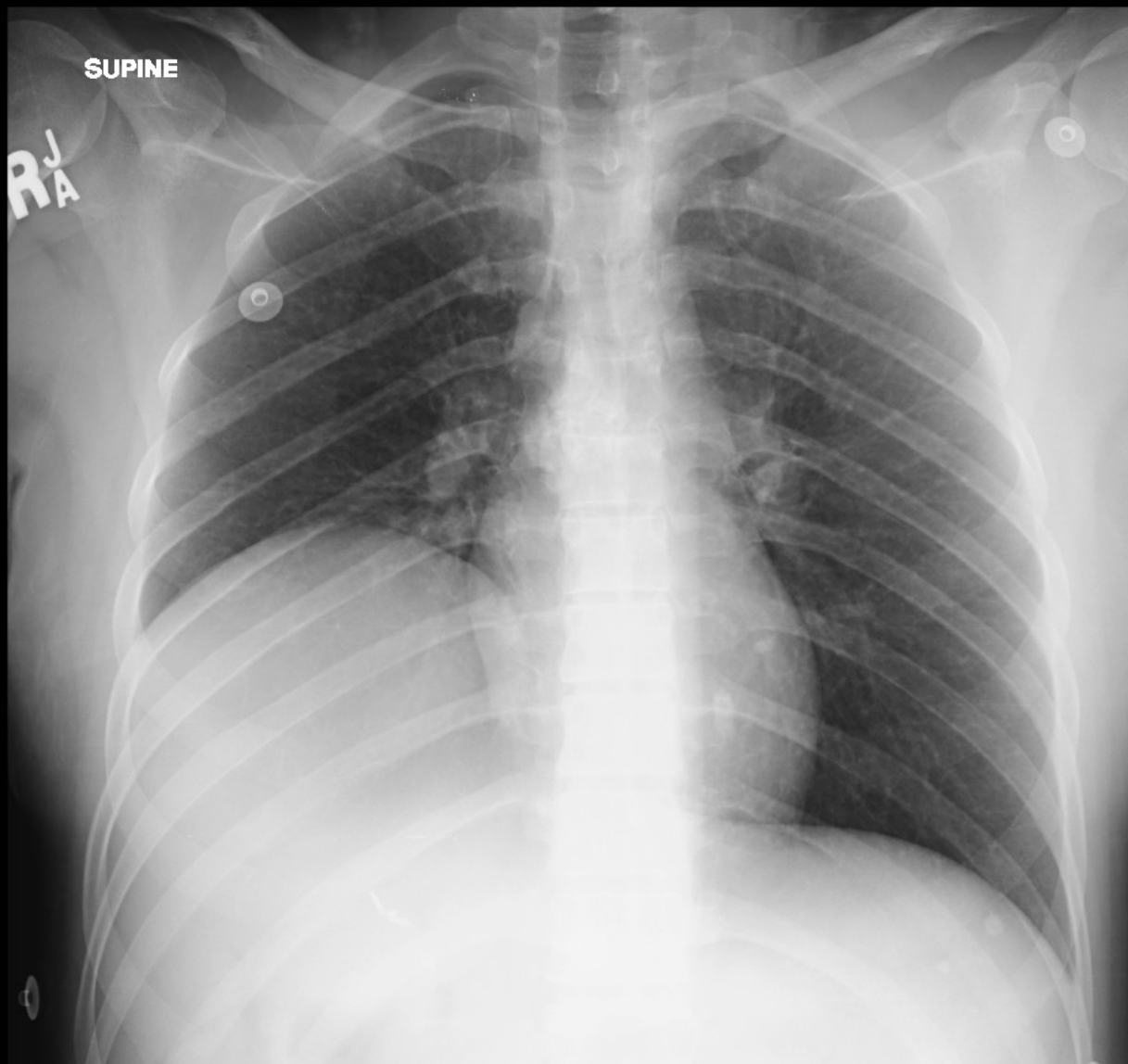
- Auscultation of peristaltic sounds in chest
- Delayed rupture - unexplained chest pain and increased respiratory rate
- CXR is most important diagnostic study
 - Elevation of hemidiaphragm
 - Bowel pattern in the chest
 - Gastric tube curls in chest
 - Hemothorax – associated injury
- Masked by positive pressure ventilation

TRAUMA

SUPINE

L
TBE

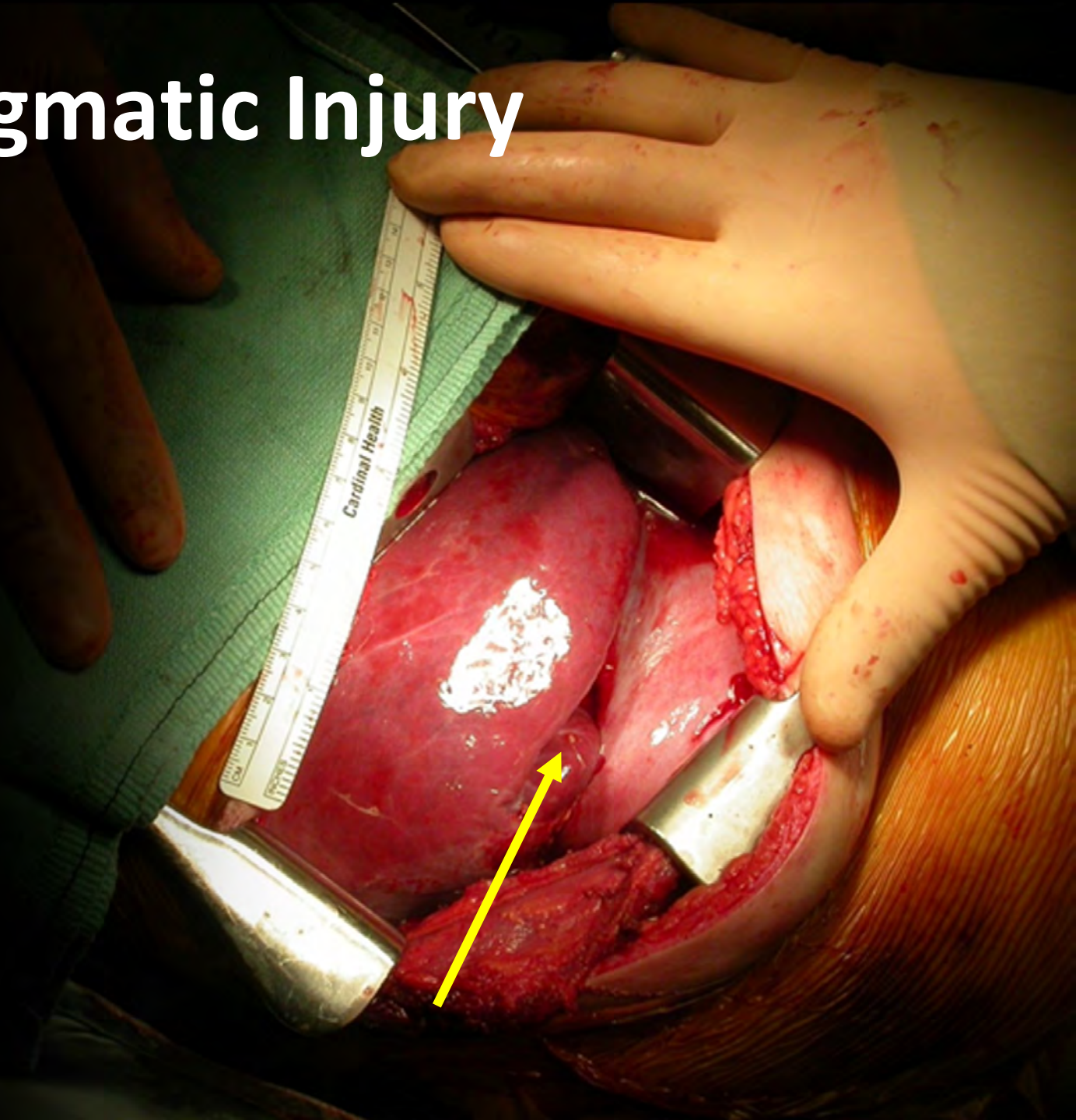


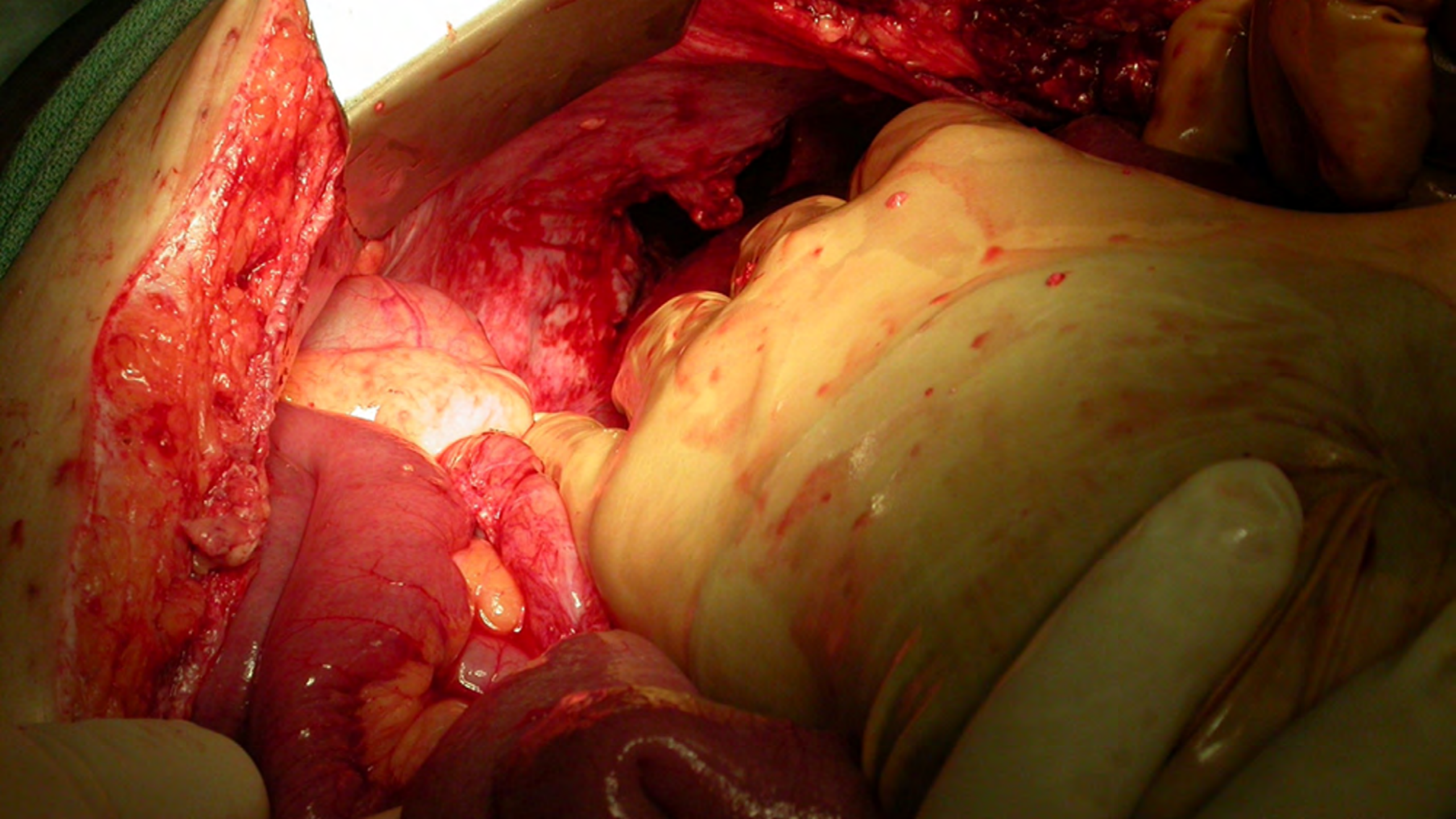


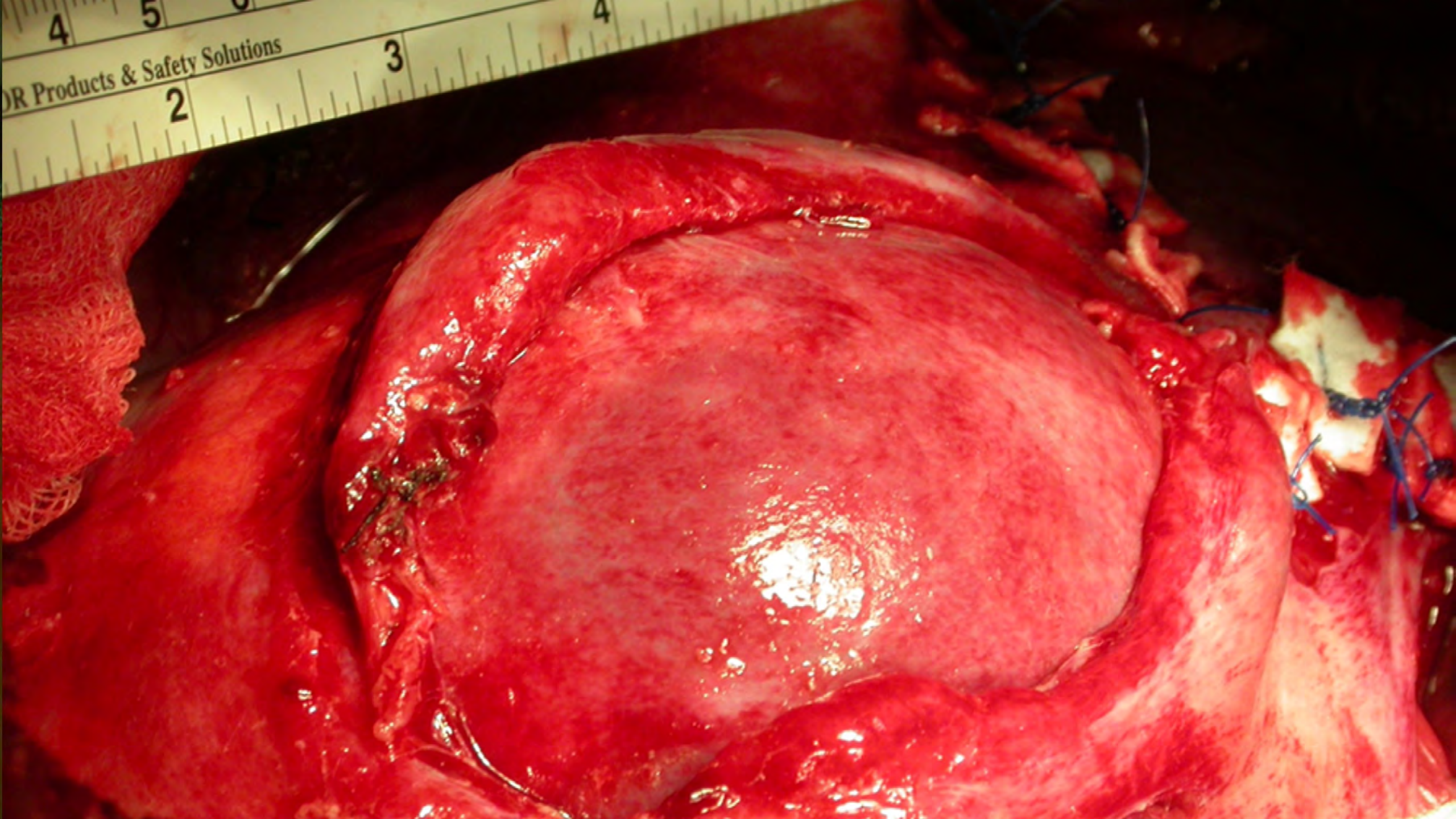
Diaphragmatic Injury

Management

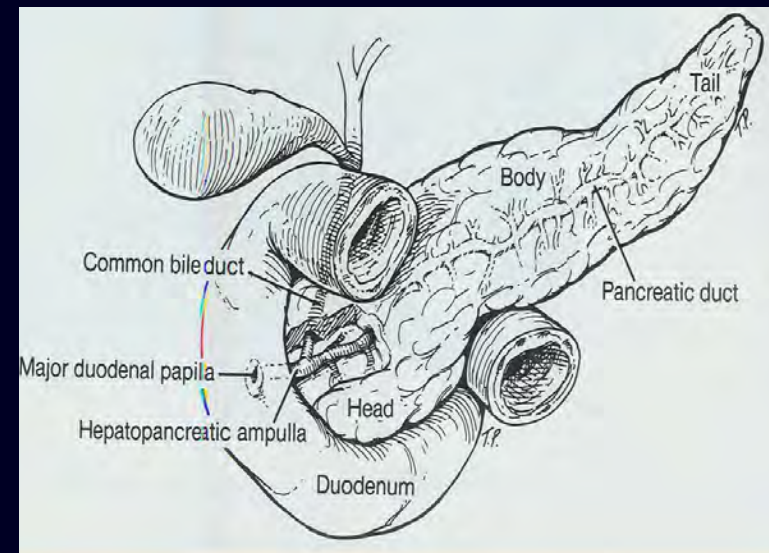
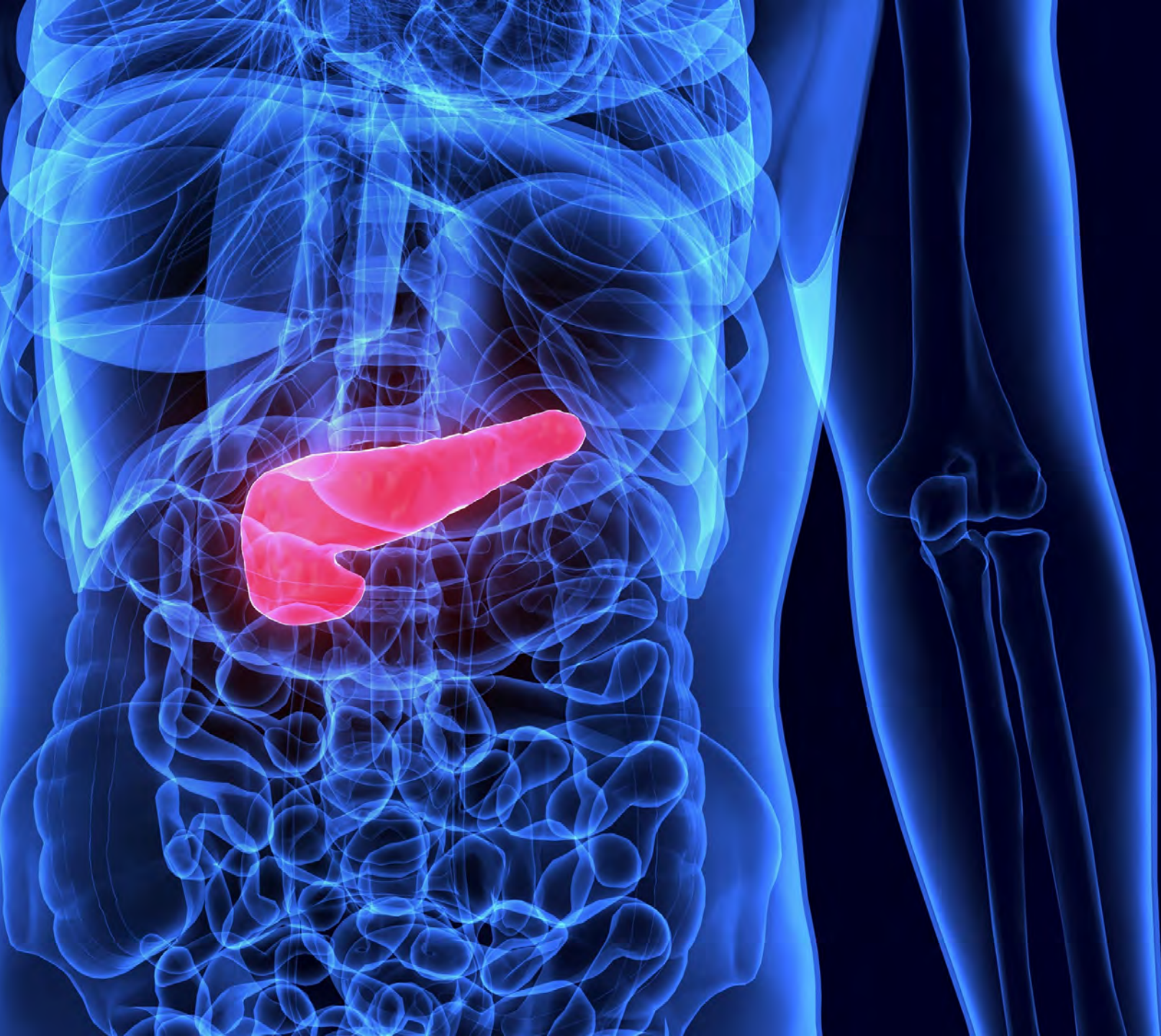
- Exploratory laparotomy
- Diagnostic laparoscopy in penetrating trauma







Pancreatic Injuries

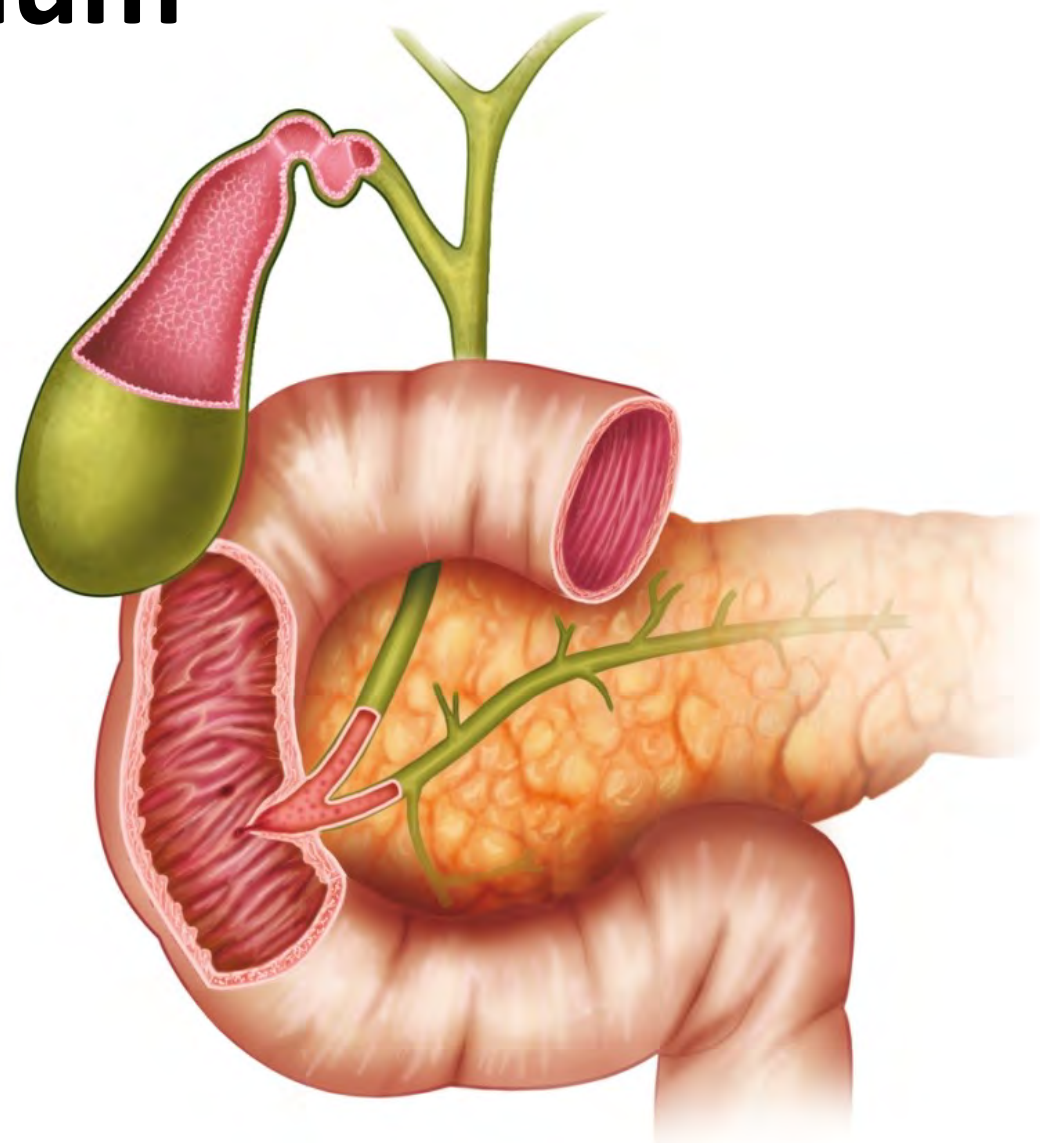
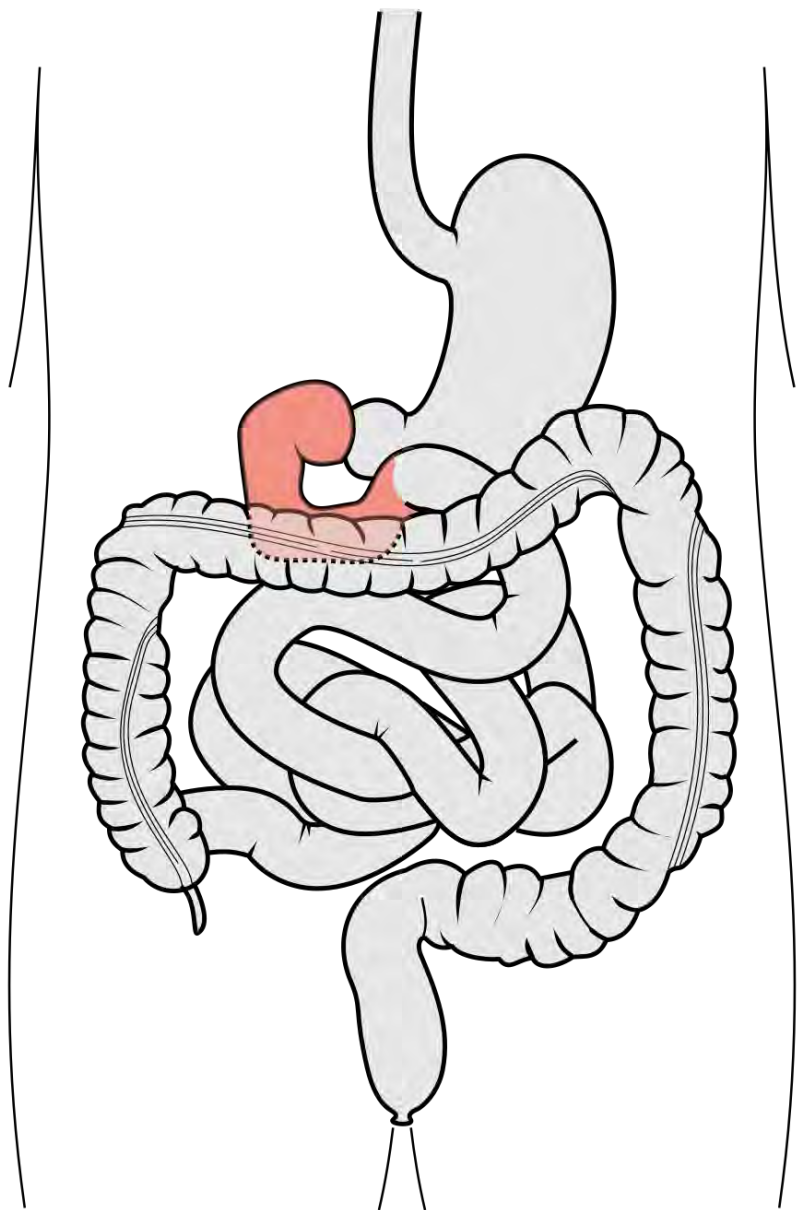


Pancreatic Injuries

Incidence

- Uncommon (0.2% to 12%)
- Associated with other abdominal injuries
- Majority caused by penetrating trauma
- Blunt trauma is usually a direct blow or compression type force
- Mortality is variable
- Pancreatic Injuries graded by severity I-V
- Most grades of III or higher will require OR

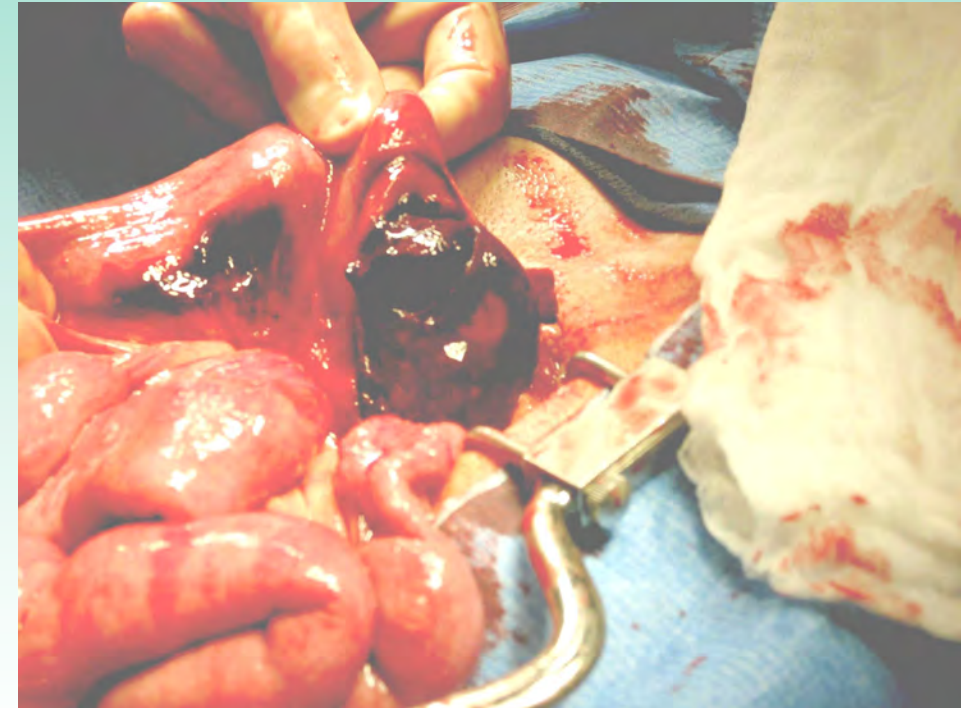
Duodenum



Duodenal Injuries

Incidence

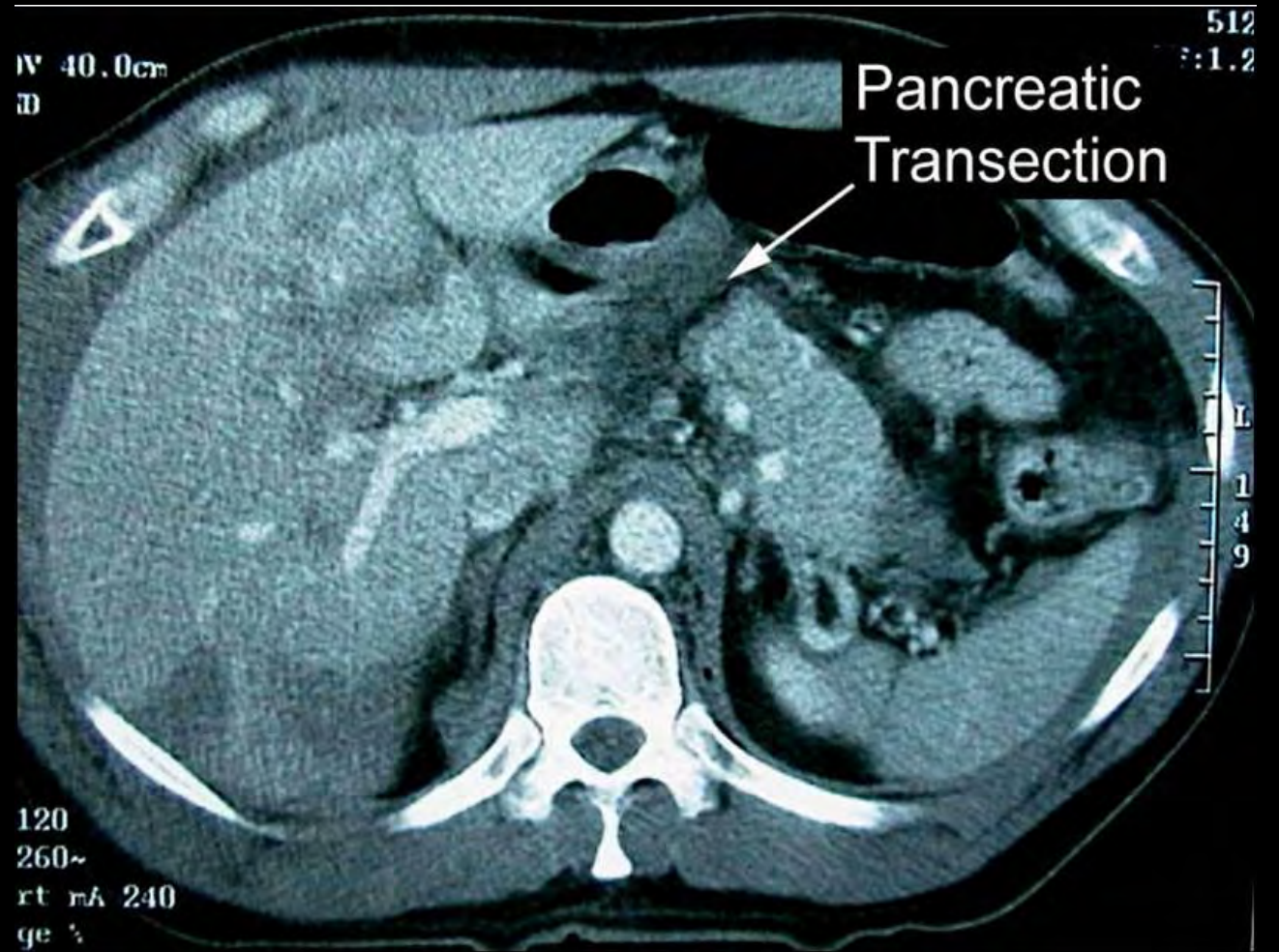
- Majority caused by penetrating trauma
- Blunt trauma is usually compression type
- Mortality is variable
- Multi-organ injuries



Pancreatic and Duodenal Injuries

Assessment

- Peritoneal symptoms not evident but appear later
- CT scan is the exam of choice
- Injury usually found intraoperatively





Pancreatic and Duodenal Injuries

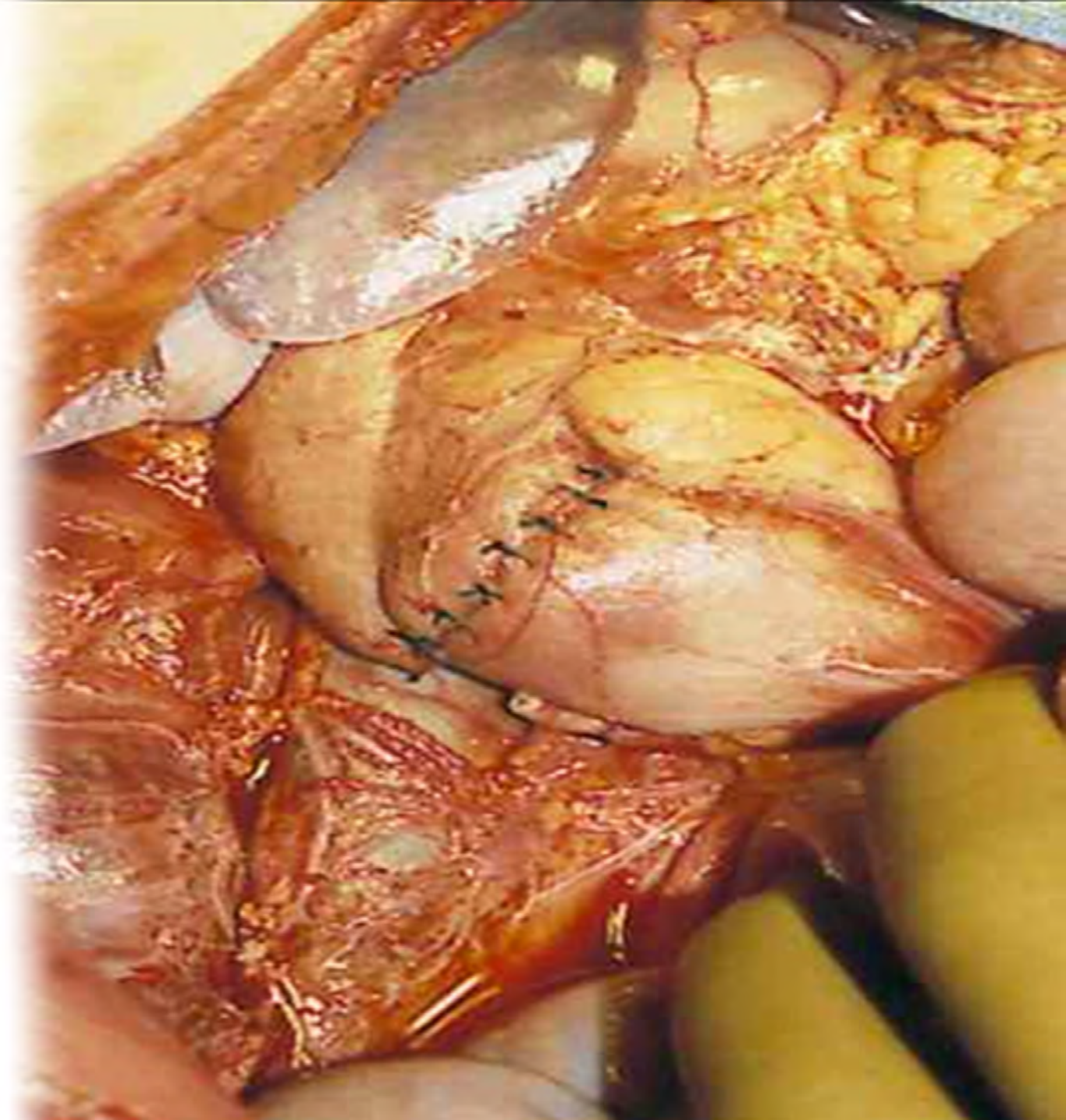
Assessment

- Blunt injury to duodenum can produce intramural hematoma
- Perforation causes contamination

Pancreatic and Duodenal Injuries

Management

- Options depend on site and severity
- Primary closure
- Simple external closed drainage
- Distal pancreatectomy
- Pancreatic duodenectomy



Pancreatic and Duodenal Injuries

Duodenal Management

- Debridement and primary repair
- Surgical procedure depends on hemodynamic stability and duct involvement
- Nonoperative management requires close observation

Pancreatic Management

- Primary cause of death is hemorrhage
- Late deaths are due to sepsis, ARDS, multiple organ failure
- Observe for complications

Injuries to the Stomach and Intestines



Stomach Injury

Incidence

- Rare; more common in children
- Commonly involves adjacent organs
- Protected by location and mobility
- Most common cause is penetrating injury



Stomach Injury



Assessment

- Symptoms variable and nonspecific
- May include severe epigastric or abdominal pain, tenderness, signs of peritonitis
- Clouded by associated injuries
- Bloody output from NG tube
- Free air on radiograph
- Findings on CT or DPL

Stomach Injury

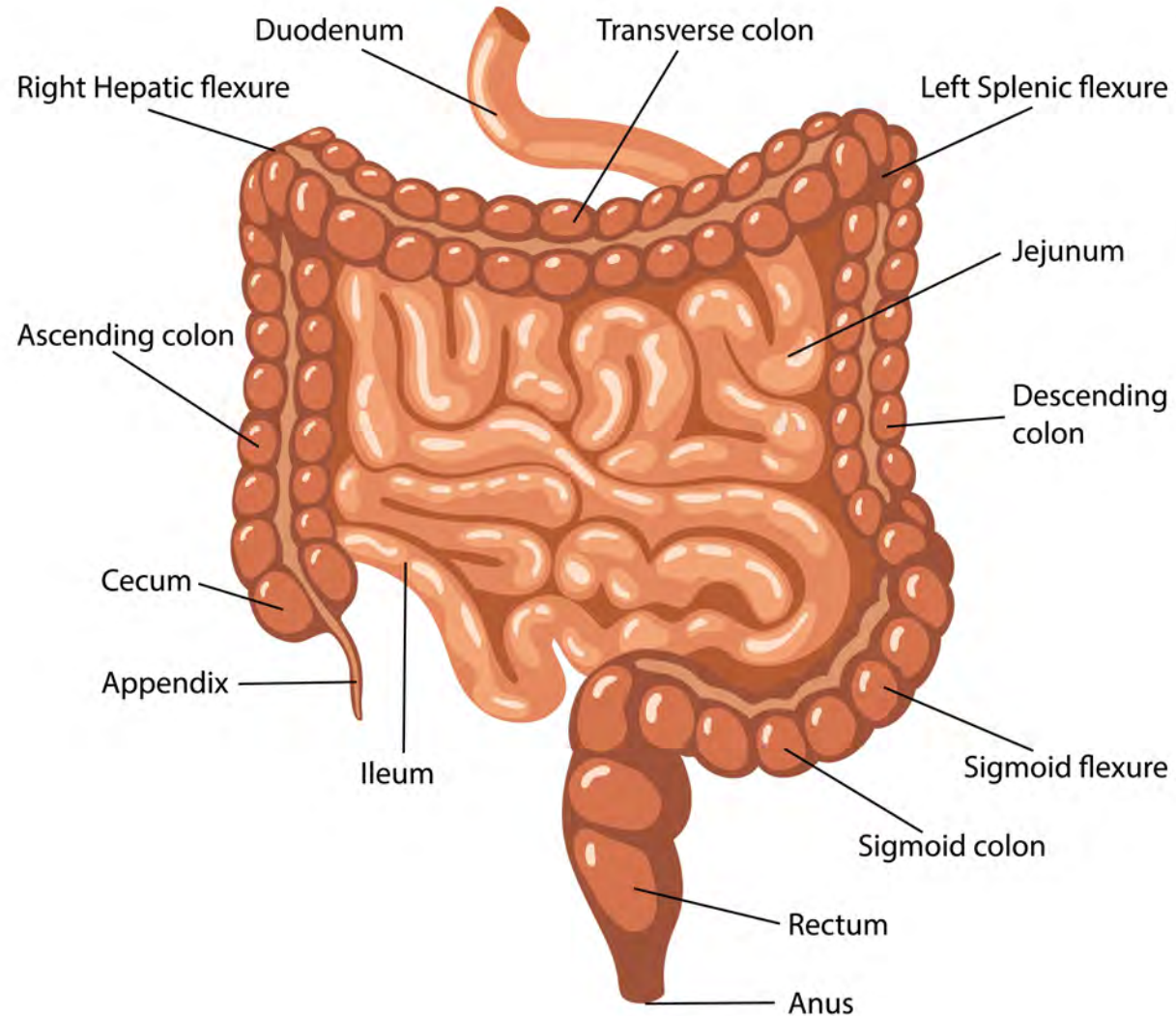
- Indications for surgery
 - Hemodynamic instability
 - Diffuse abdominal pain/peritonitis on clinical exam
 - Studies consistent with GI perforation
- Selective non-operative management
 - Stable
 - No peritoneal signs
 - No clear radiographic evidence

Stomach Injury

Management

- Gastric decompression
- Decision for surgical intervention vs. non-operative management
- If contamination exists, copious peritoneal irrigation and delayed primary closure
- Monitor for postoperative complications

Intestinal Injuries



Small Intestine

Jejunum and Ileum

- Responsible for nutrient absorption and fluid and electrolyte shifts
- Jejunum lies in the umbilical region
- Ileum lies in the hypogastric and pelvic regions
- Vulnerable to seatbelt injury





Small Bowel Injury

Incidence

- Most frequently injured by penetrating trauma.
- Blunt injury is relatively uncommon.
- Presence of pancreatic and solid organ injury are predictive of increased risk for hollow viscus injury.

Assessment

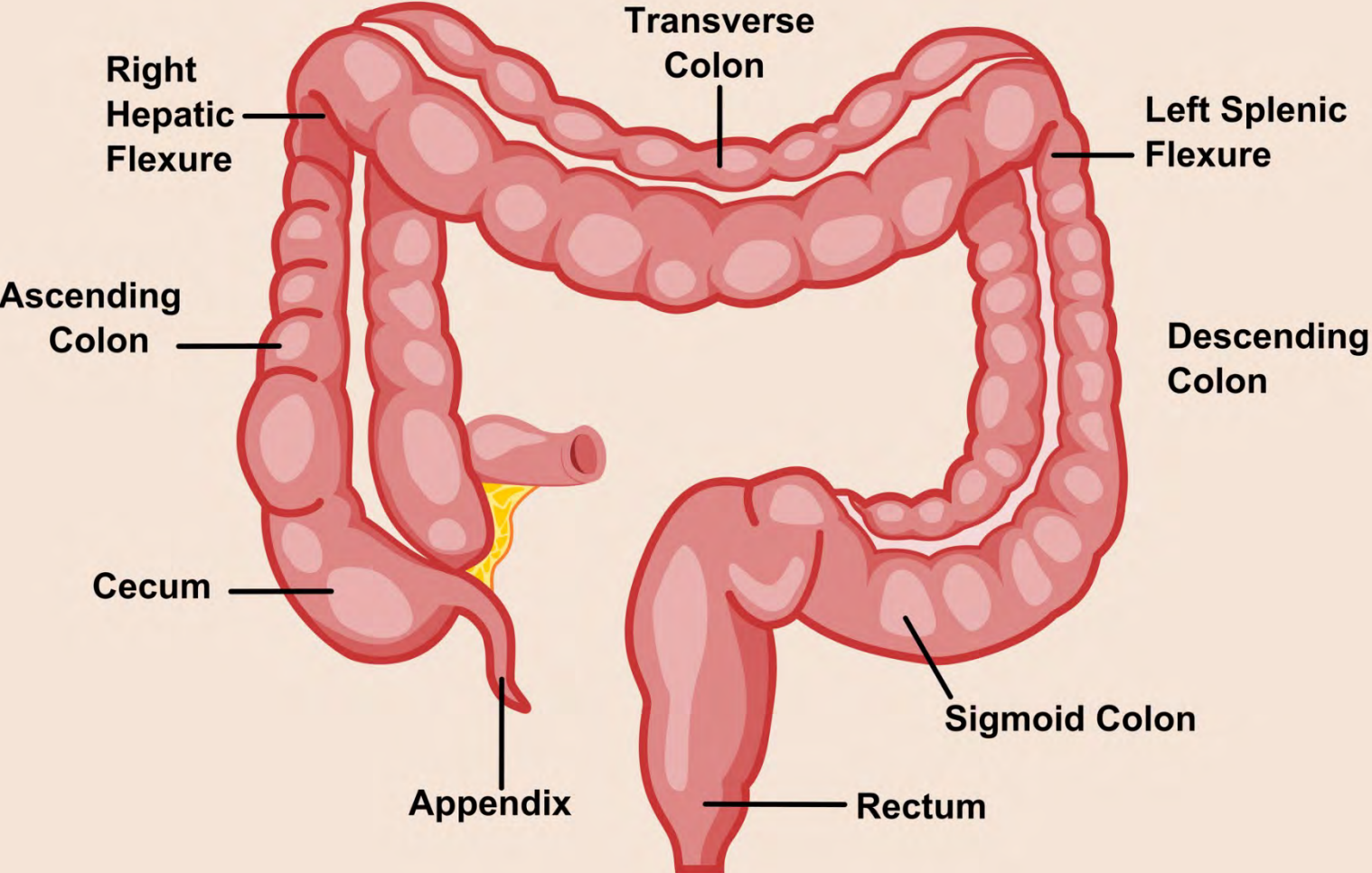
- Clinical signs may not be apparent initially.
- Blunt vs penetrating
- Signs of peritonitis develop.
- Any blow to the abdomen or penetrating injury to the lower chest or abdomen should increase suspicion of injury.

Small Bowel Injury

Management

- Bleeding should be controlled prior to exploration
- Debridement followed by primary closure and ligation of bleeders
- Bowel resection for multiple defects
- Gastric decompression and parenteral nutrition not usually required if isolated
- Antibiotics recommended
- Observe for complications such as wound infection and abscess

Large Intestine





Large Bowel Injury

Incidence

- One of the most lethal abdominal injuries
- Mortality affected by associated injuries
- Penetrating injury is the most common

Management

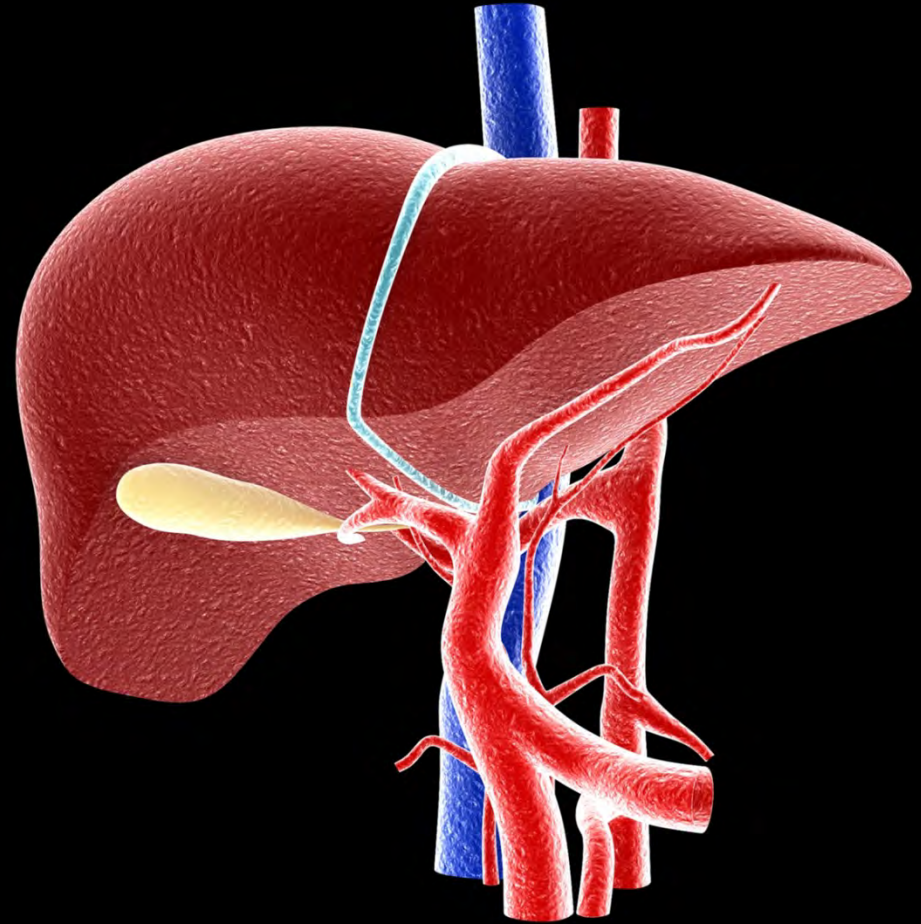
- Early recognition and control of contamination
- Exploratory laparotomy with primary repair and colostomy
- Preoperative antibiotics
- Observe for complications

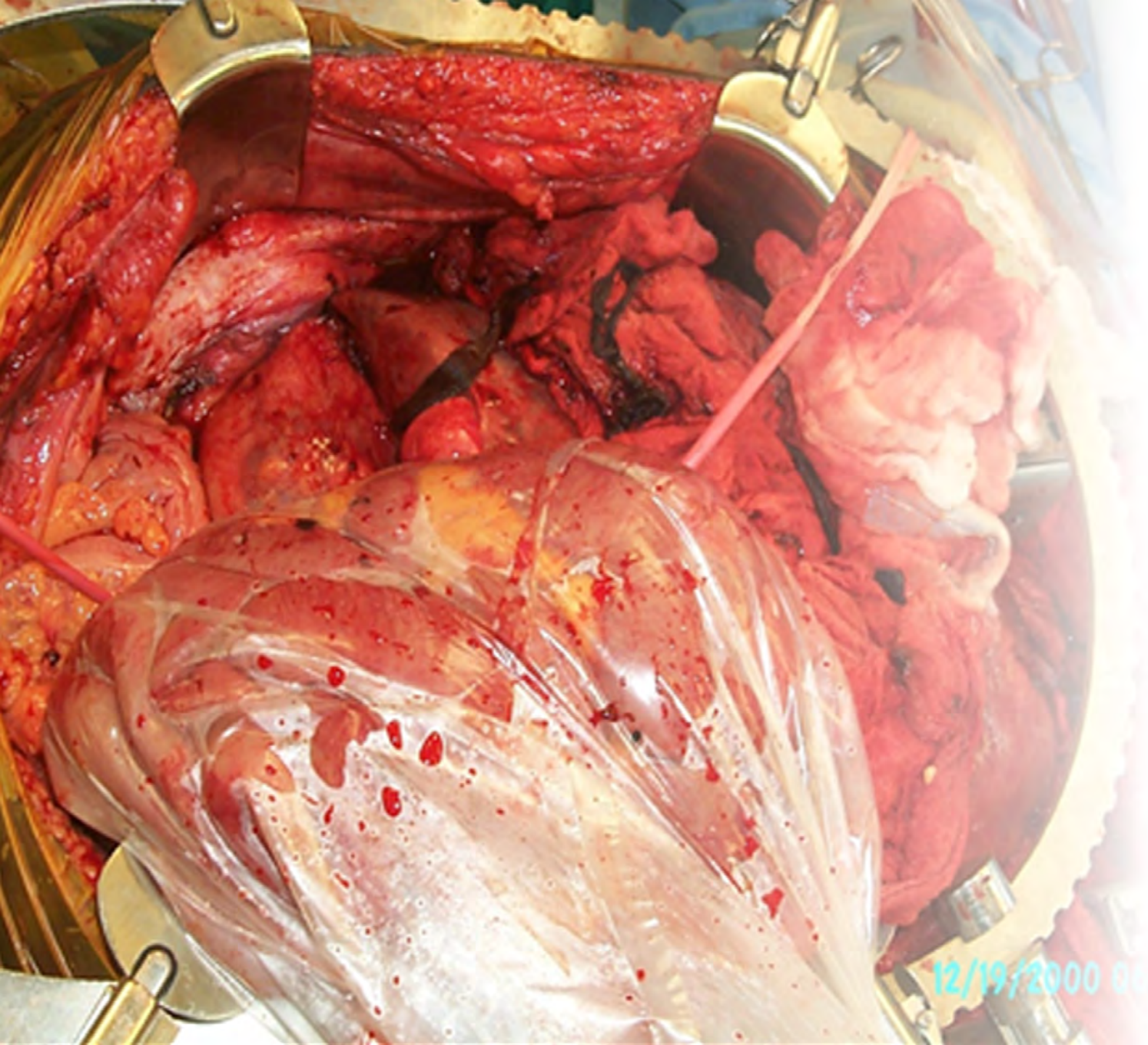


Liver Injuries

Liver Functions

- Detoxification
- Synthesis of plasma proteins
- Storage of iron and vitamins
- Metabolism of carbohydrates, protein, and fats
- Phagocytization of bacteria





Liver Injury

Incidence

- Commonly injured organ
- MVC most common cause
- Mortality ~10% to 15%

Liver Injury

Assessment

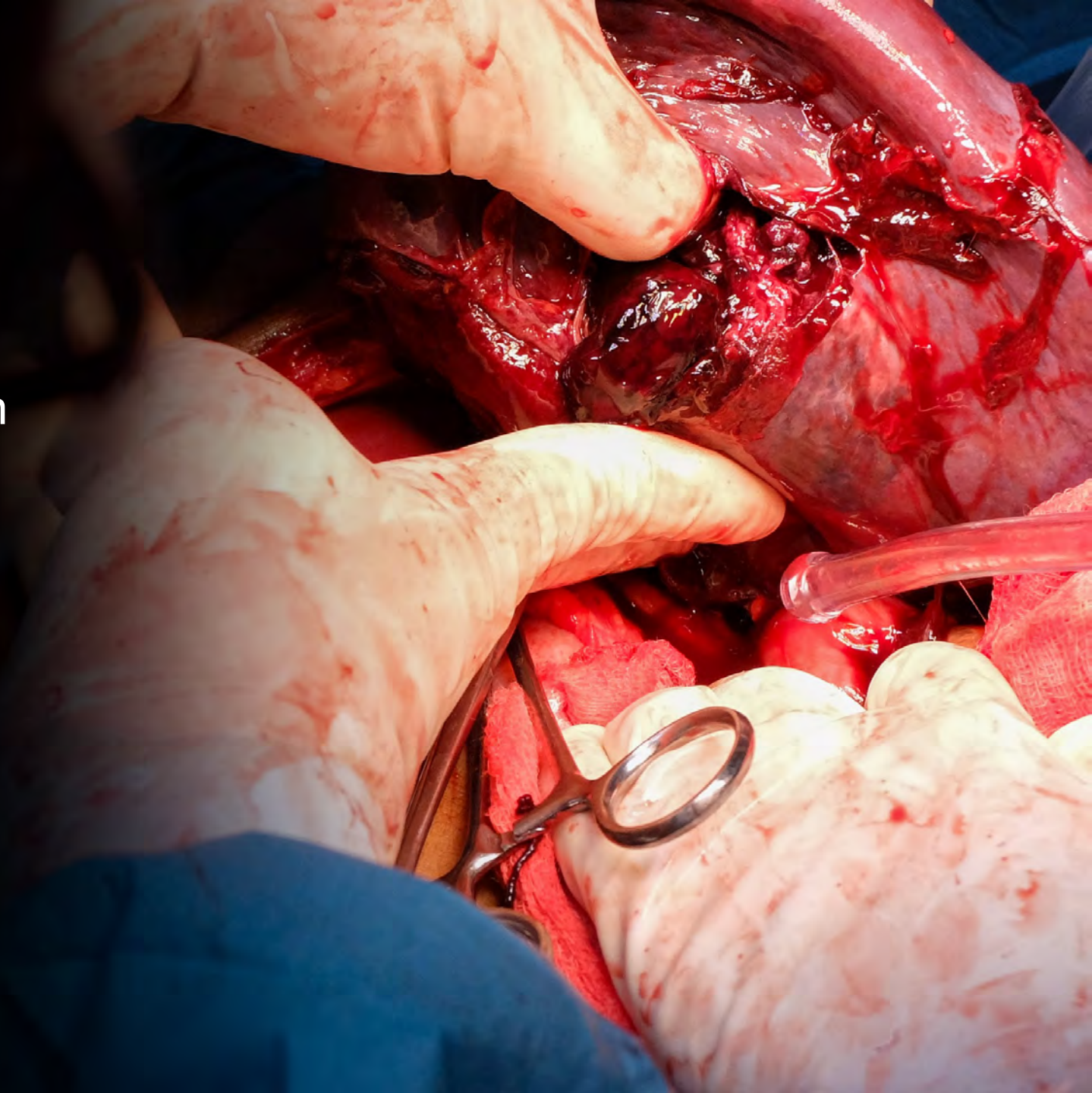
- Suspect in any patient with blunt injury to right side
- Penetrating trauma produces a range of injuries
- FAST, CT scan
- Grading system

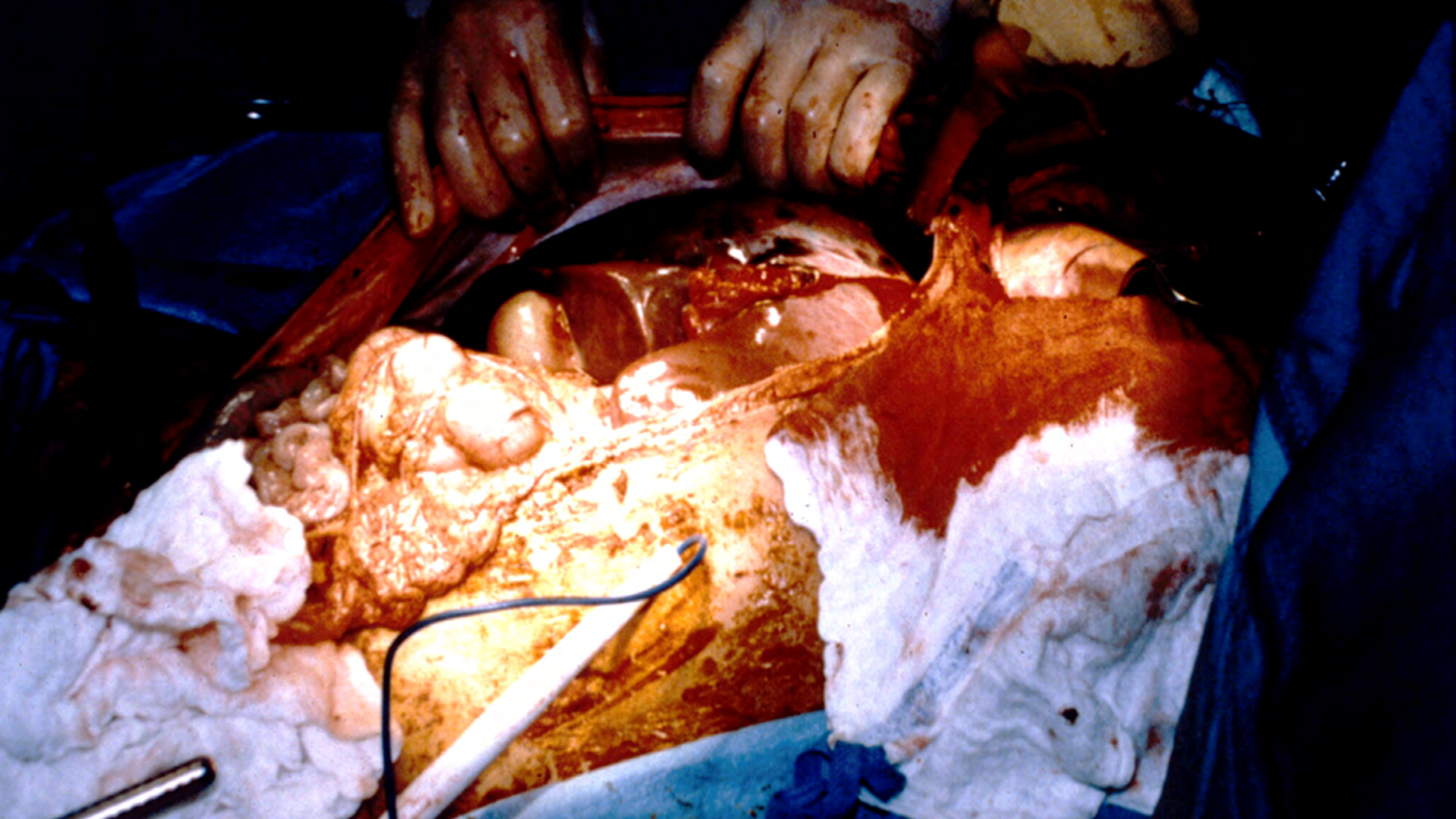


Liver Injury

Management

- Nonoperative management in select patients
- OR for complex lacerations; arterial blush
- Angioembolization
- Aggressive intraoperative resuscitation
- Possible damage control





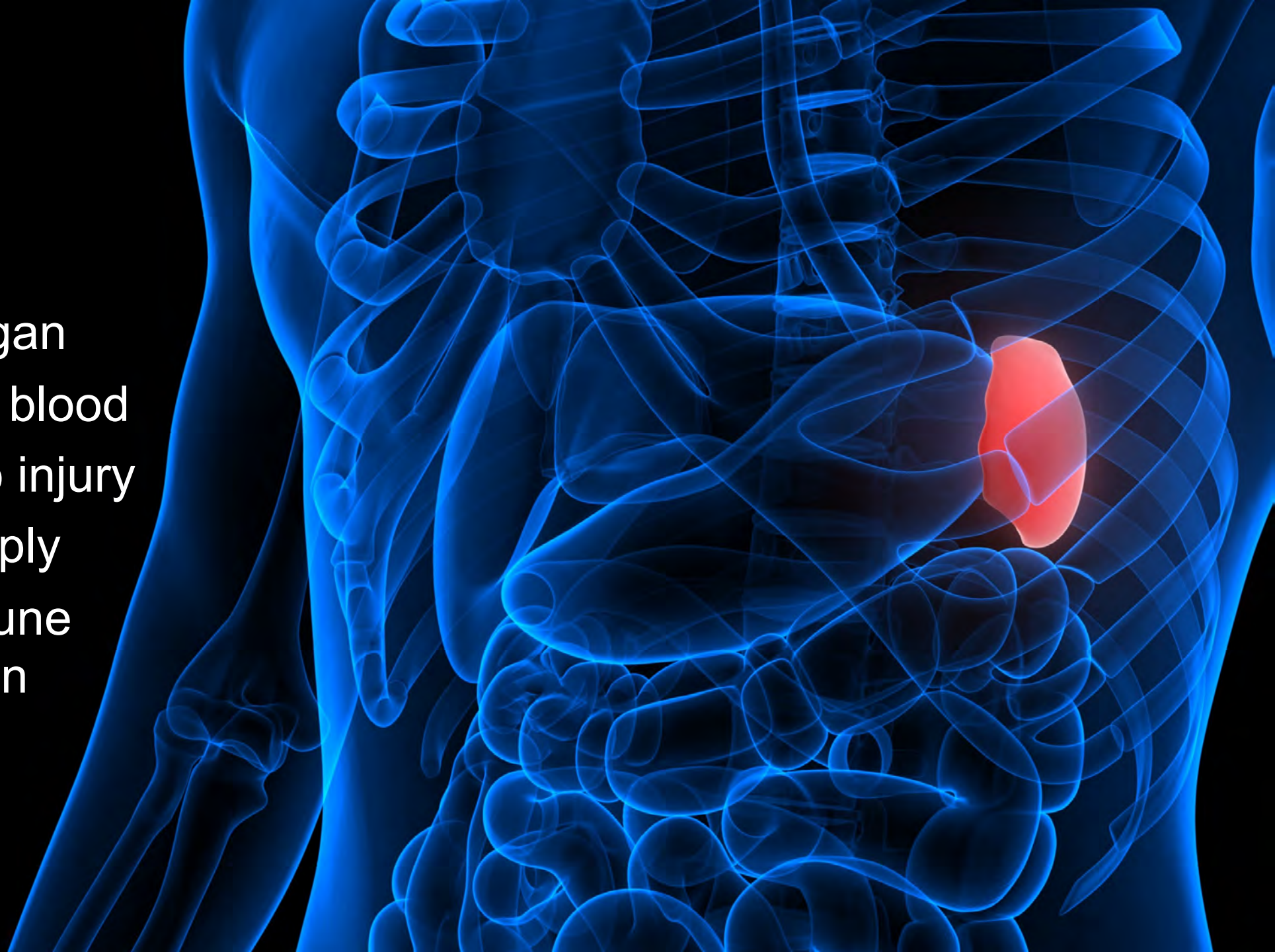
Liver Injury

Observe for complications

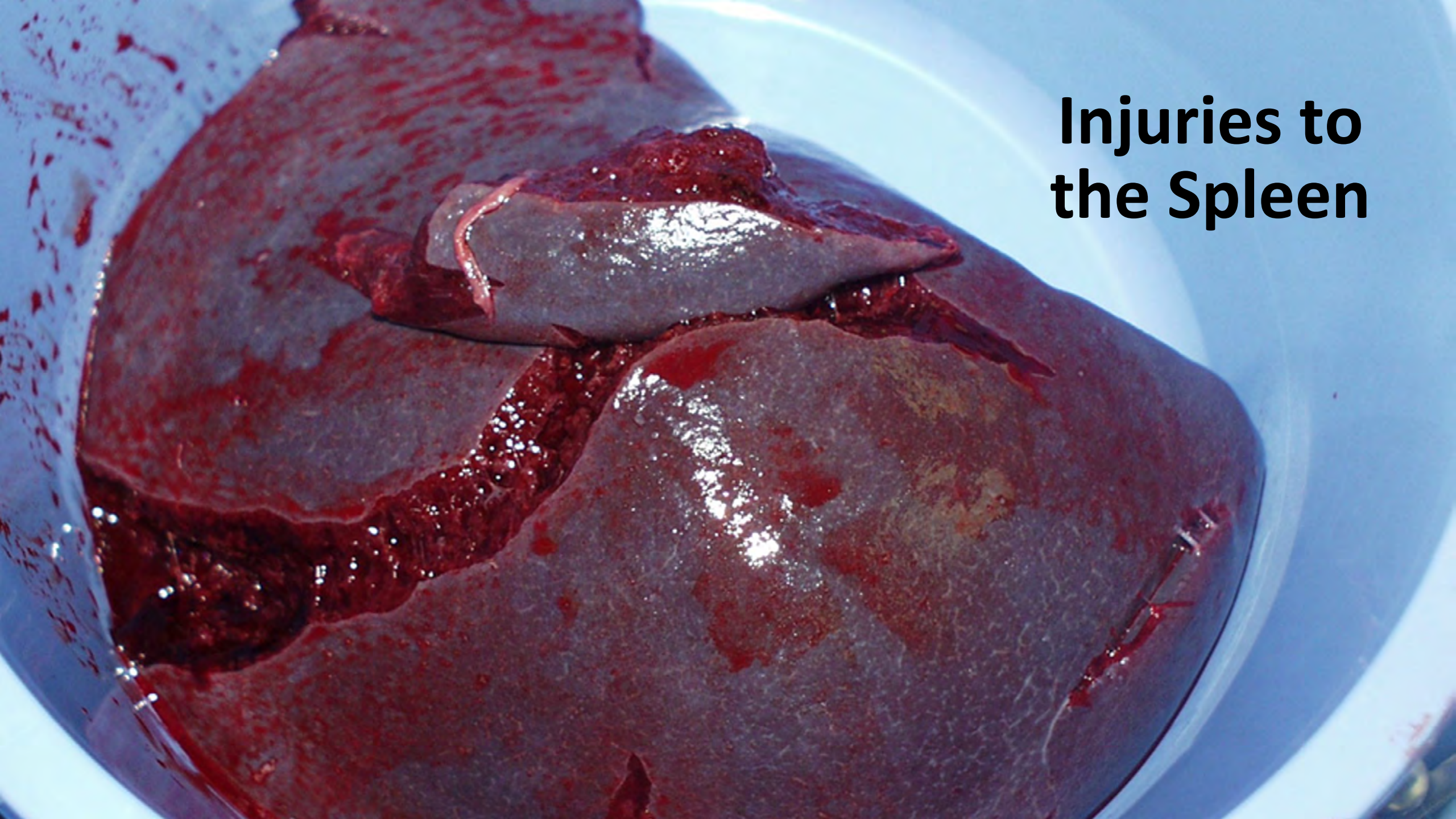
- Recurrent bleeding
- Hemobilia
- Abscess
- Biliary fistula
- Arterial-portal venous fistula
- Sepsis
- Liver failure

Spleen

- Lymphoid organ
- Reservoir for blood
- Vulnerable to injury
- Vascular supply
- Primary immune defense organ



Injuries to the Spleen



Splenic Injury

Incidence

- 2nd most commonly injured abdominal organ
- Mortality depends on the type of trauma and associated injuries
- Mortality related to uncontrolled hemorrhage, delayed rupture, and sepsis

Splenic Injury

Assessment

- Suspect in any patient with blunt injury to left side
- Penetrating trauma can produce a range of injuries
- FAST, CT scan, Angio
- Grading system

Splenic Injury

Management

- Nonoperative in select patients
- Splenorrhaphy and partial splenectomy
- Splenectomy
- Aggressive intraoperative resuscitation
- Possible damage control



Splenic Injury

Management

- Monitor for failed observation
- Observe for postoperative complications
 - Bleeding
 - Thrombocytosis
 - Gastric distention
 - Pancreatitis
 - Infection
- Ensure vaccines are given prior to discharge

Discharge Instructions

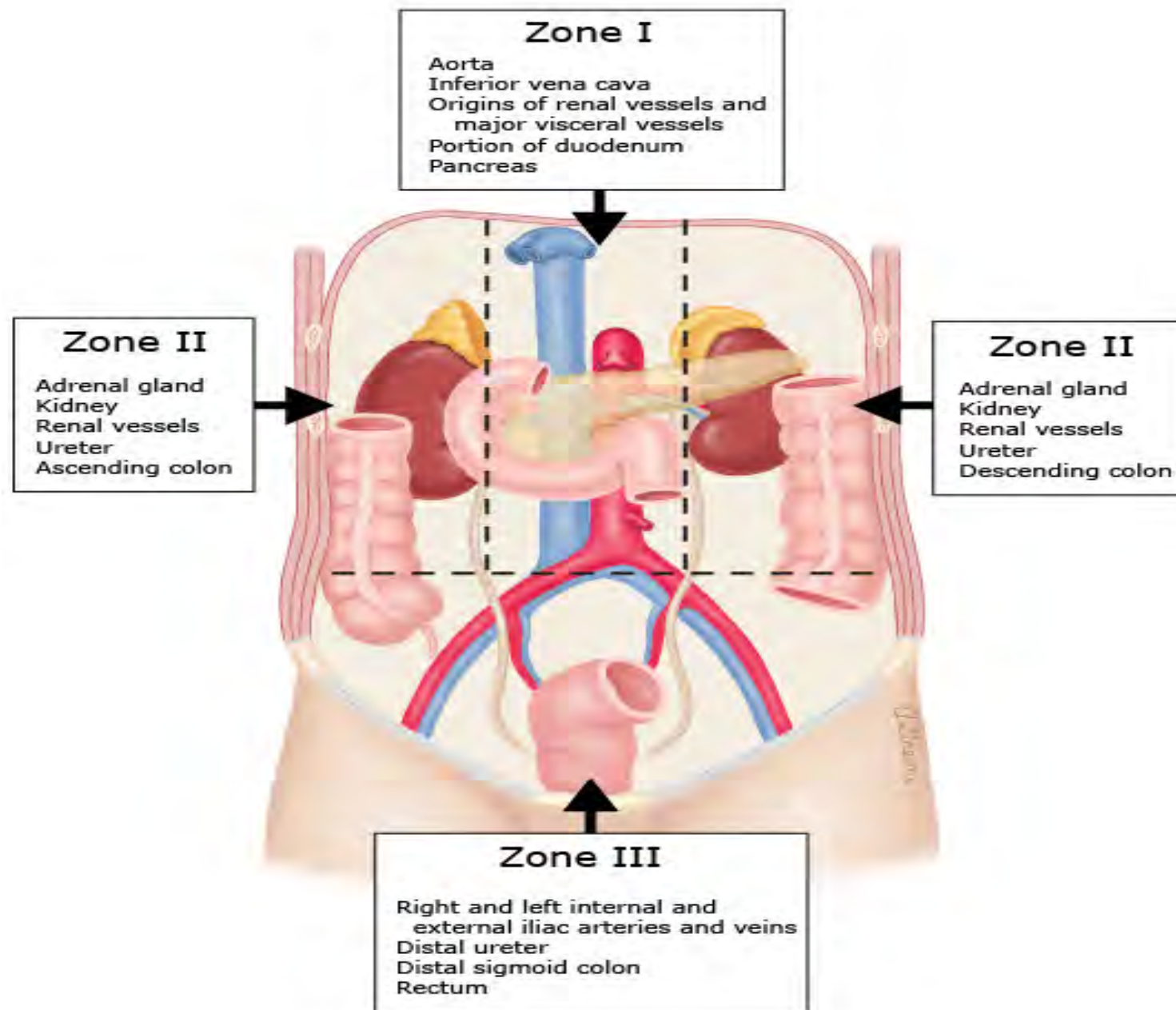


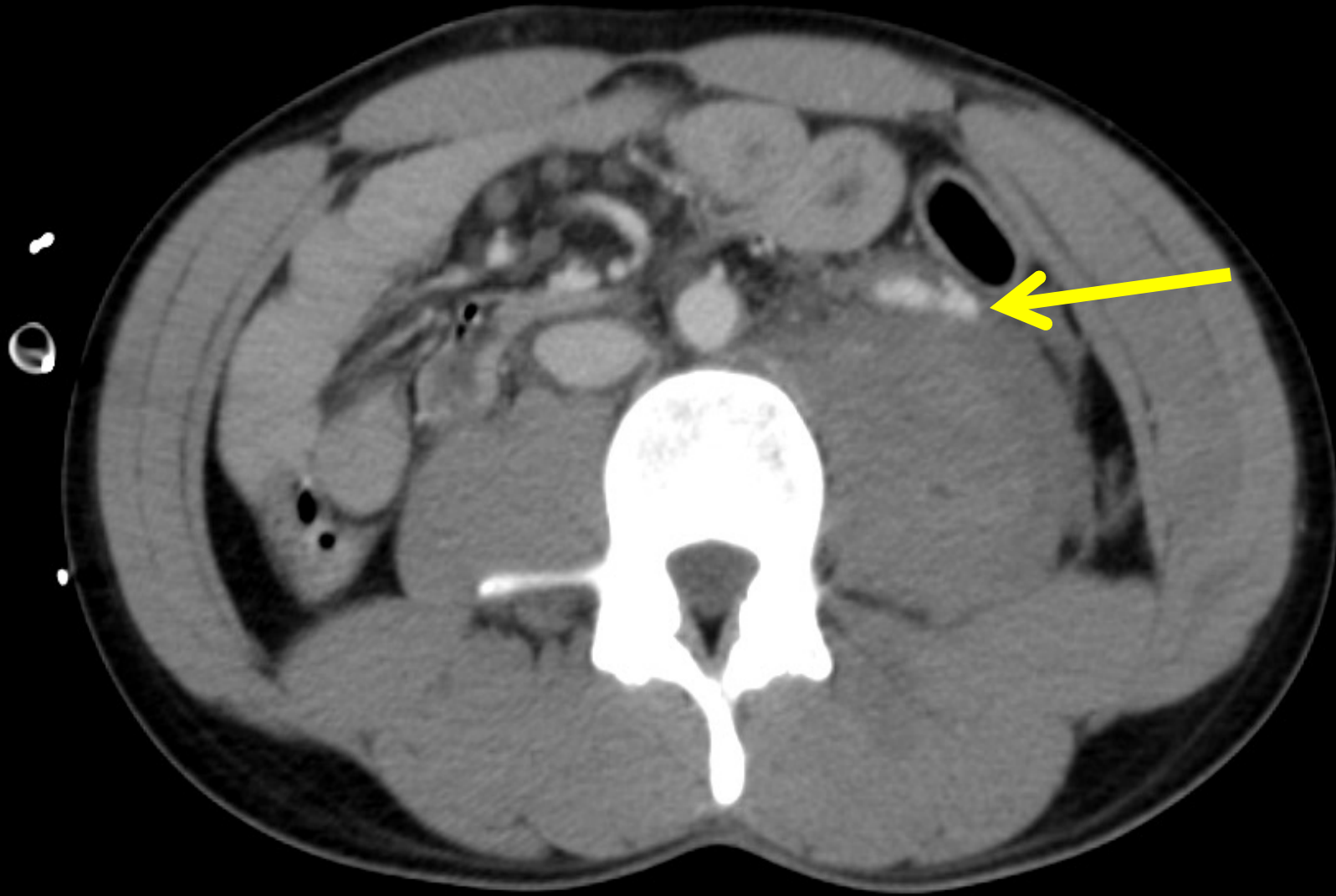
Overwhelming Postsplenectomy Sepsis (OPSI)

- Rare
- Can occur from 1 to 5 years after surgery
- Illness presents with flu-like symptoms, shock from sepsis, and DIC followed by death
- Mortality is 50%
- Preventative measures include vaccinations, chemoprophylaxis and education

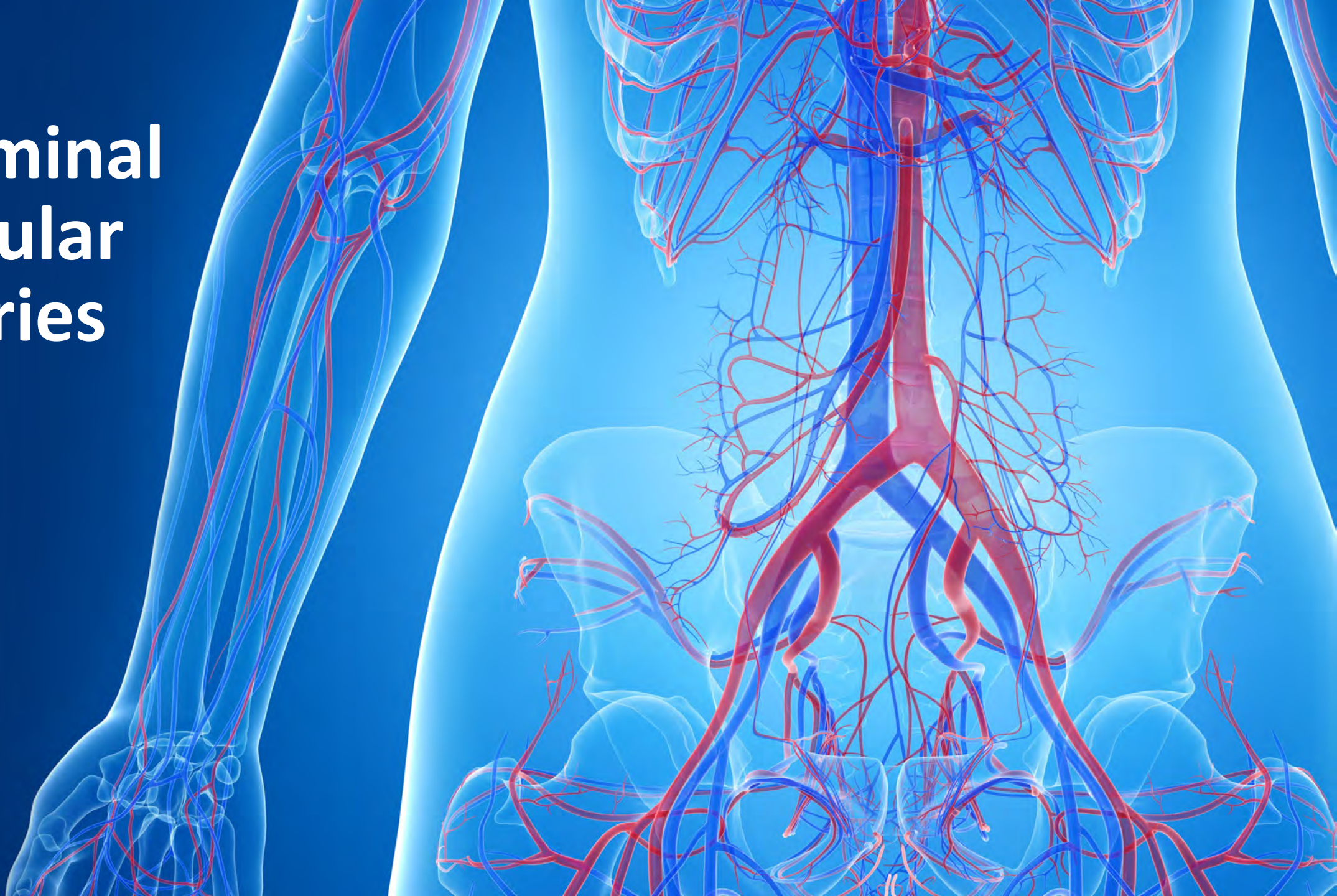
Retroperitoneal Hemorrhage

- Management depends on the location
- Penetrating trauma requires exploration
- Blunt trauma – pelvic fractures
- Hematoma – explore vs. leave alone





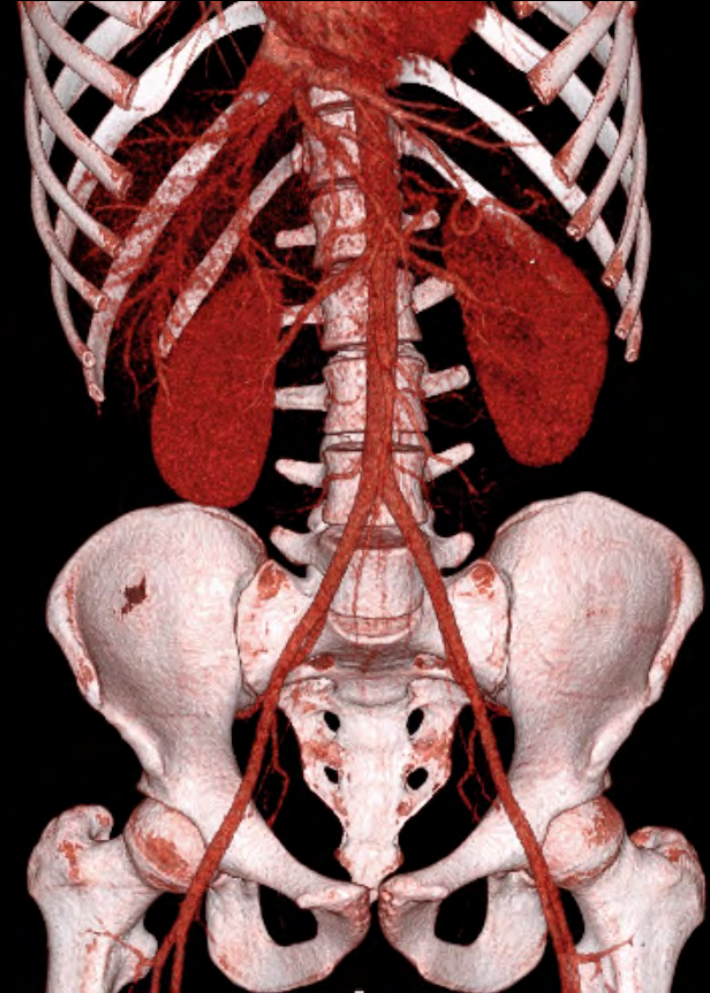
Abdominal Vascular Injuries



Abdominal Vascular Injury

Arterial injury

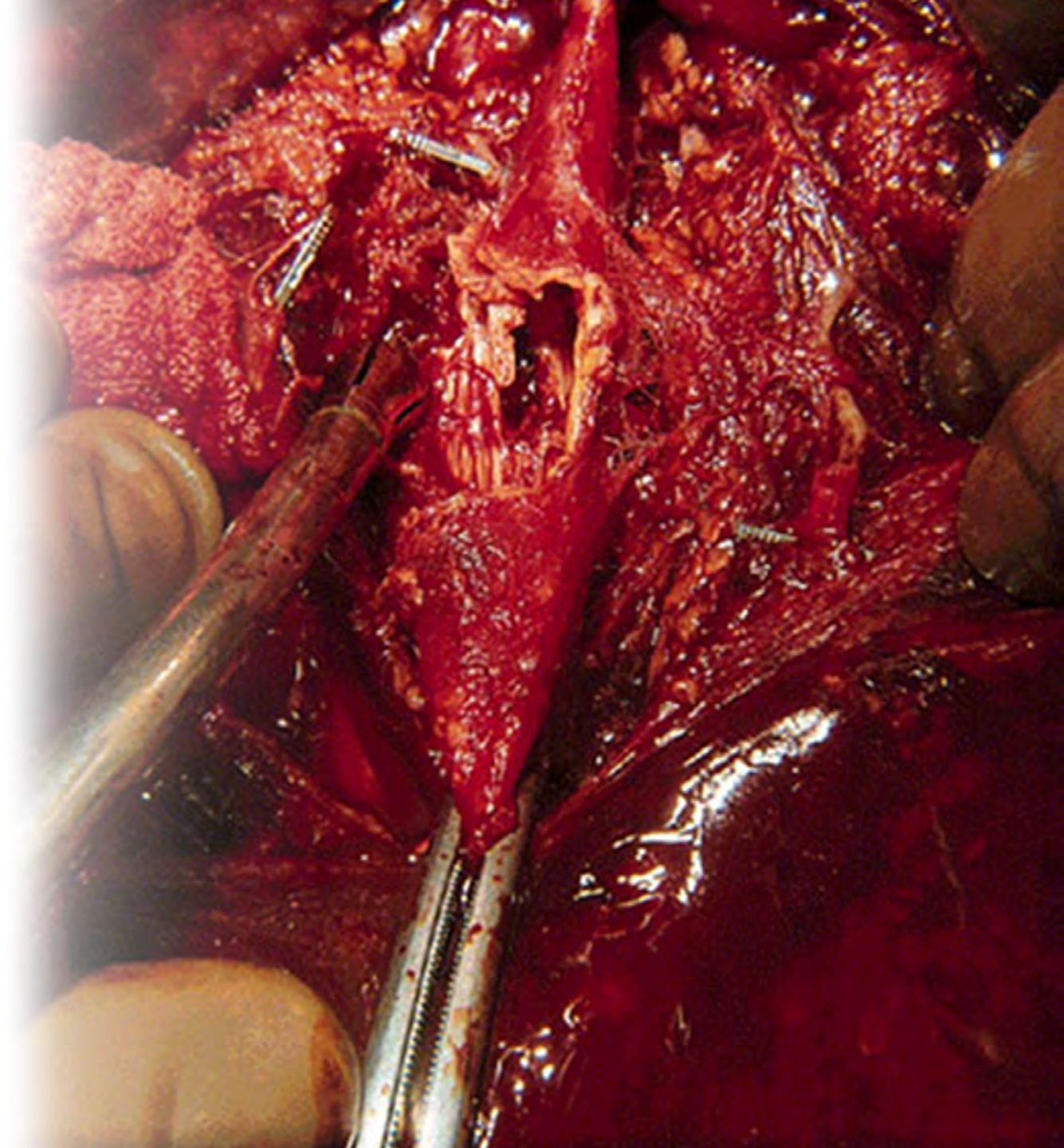
- Can stop bleeding spontaneously
- Usually occur with pelvic, thoracic, or visceral injury
- Vascular signs may be obscured initially
- Symptoms may include abdominal pain, back pain, hypoactive bowel sounds, tender abdominal mass



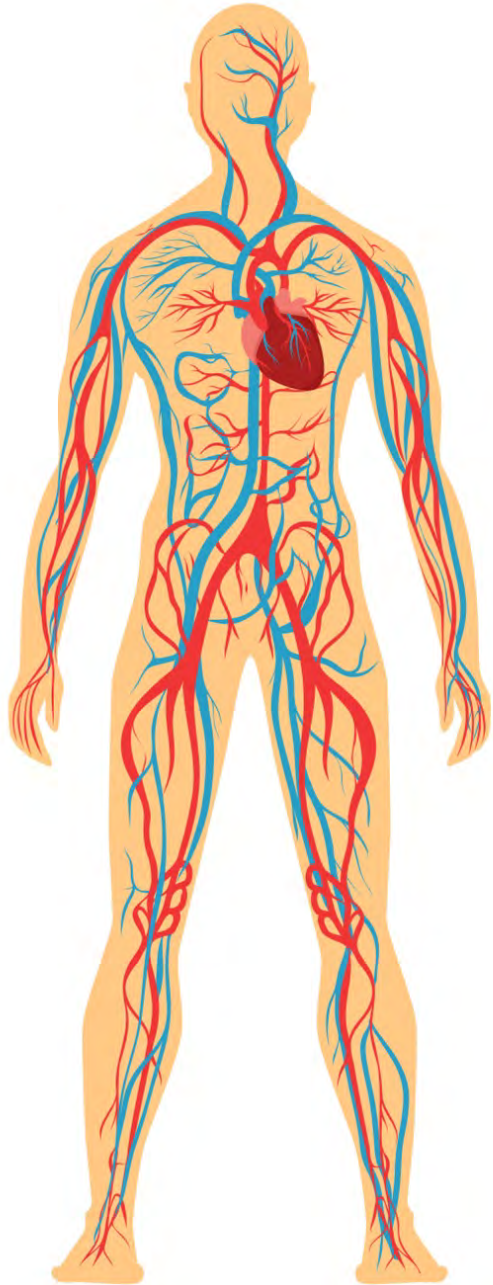
Arterial Vascular Injury

Arterial Injury Management

- BP control
- Blood replacement
- Immediate surgery
- End-to-end anastomosis or graft
- Monitor for adequate volume status postoperatively



Venous Vascular Injury

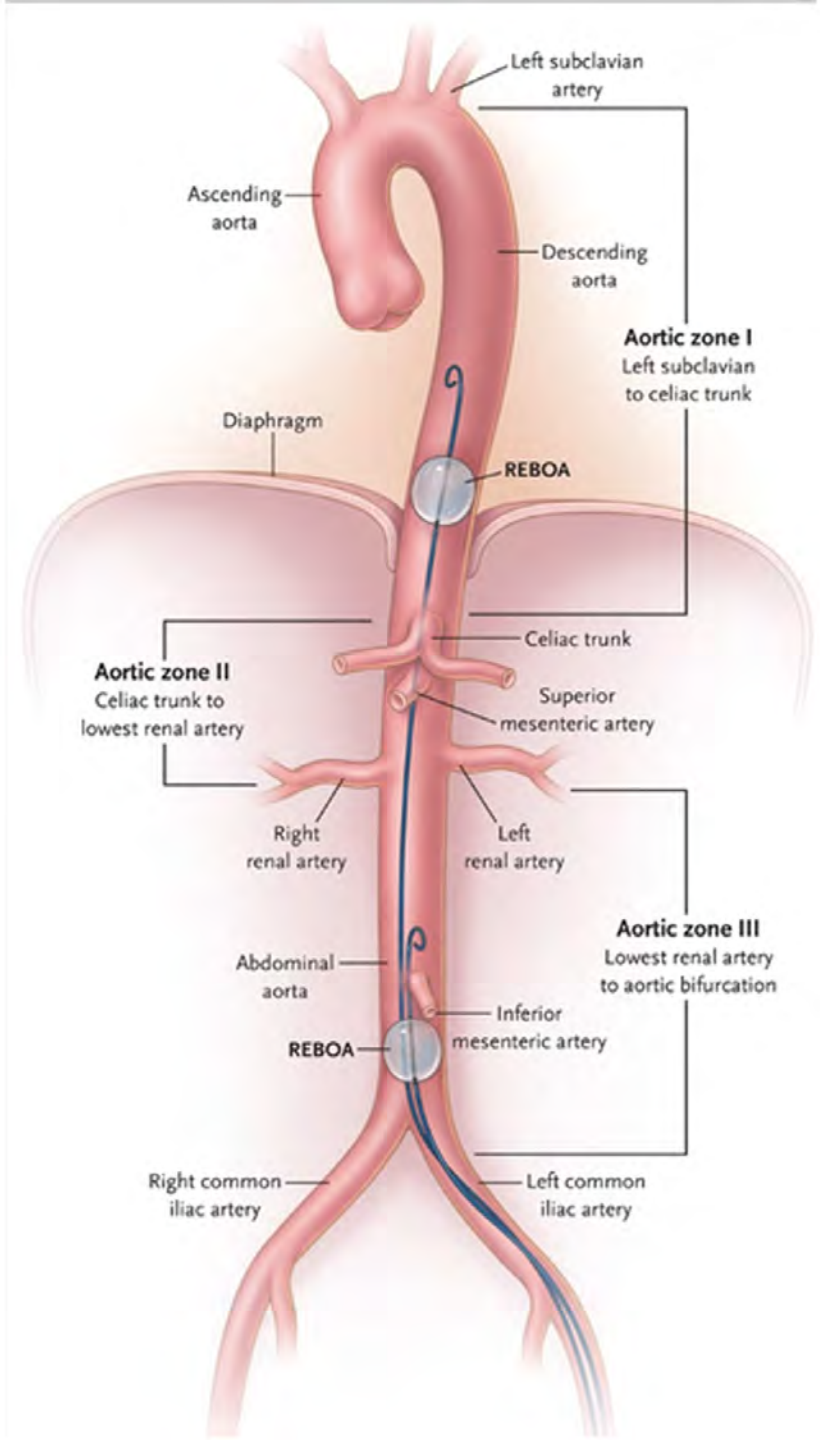


Venous Injury Management

- Quick assessment
- Massive fluid resuscitation
- Pressure and packing
- Operative repair to include ligation and grafting
- Monitor for complications

REBOA

- Resuscitative Endovascular Balloon Occlusion of the Aorta
- Management of non-compressible hemorrhage
- Risk of ischemia and reperfusion injury
- No high grade evidence for improved outcomes



Damage Control



Damage Control

- Abbreviated laparotomy
- Containment of bleeding and contamination
- Temporary intra-abdominal packing
- ICU for physiologic restoration
- Definitive repair





Damage Control

Three phases:

- Control hemorrhage and contamination
- Continued resuscitation in ICU
- Planned reoperation for removal of packing; definitive repair with attempted closure

Did You Know?

- Generally speaking, a retained sponge at any time during the period which the abdomen is “open” with a VacPak™ or Whitman patch™ is not considered an adverse event and is simply part of the management of “Damage Control” and the open abdomen.
- Check own institutional protocols for details and specific policies

Surgical Counts

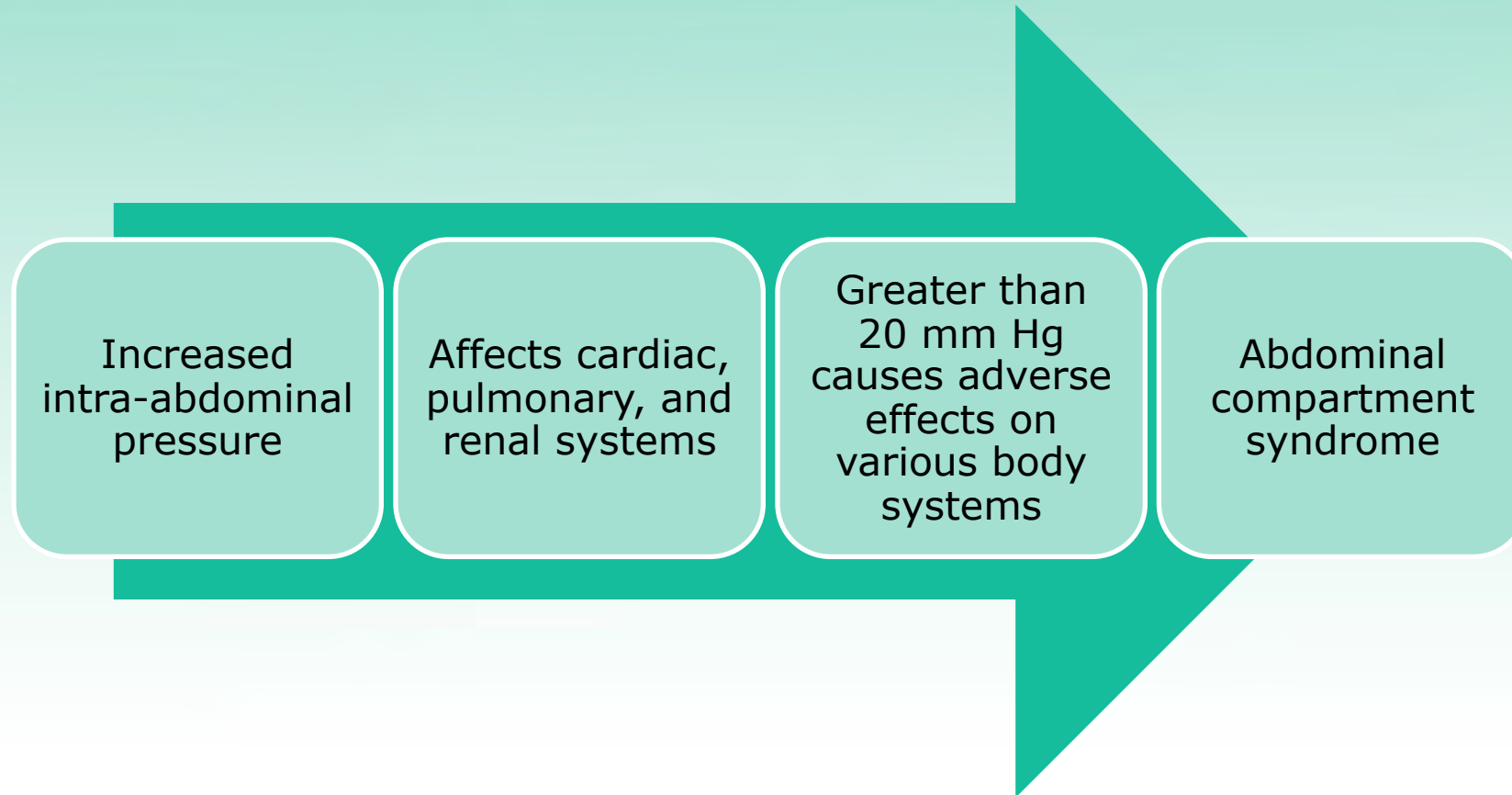
- X-ray detectable sponges
- Count “incorrect” on operative record
- Obtain an x-ray at end of permanent closure
- Document when x-ray is done in lieu of count



Complications of Abdominal Trauma



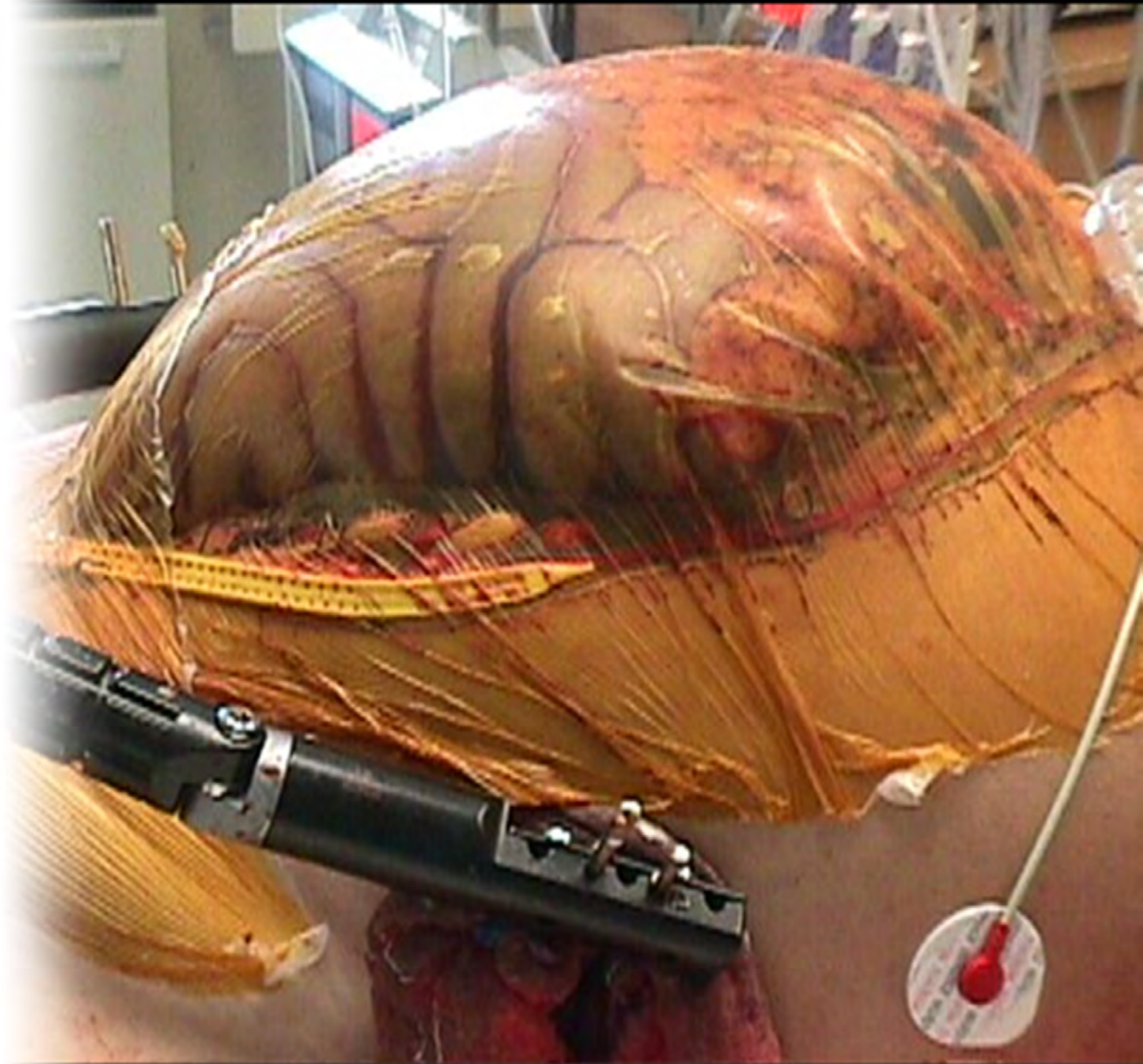
Abdominal Compartment Syndrome



Abdominal Compartment Syndrome

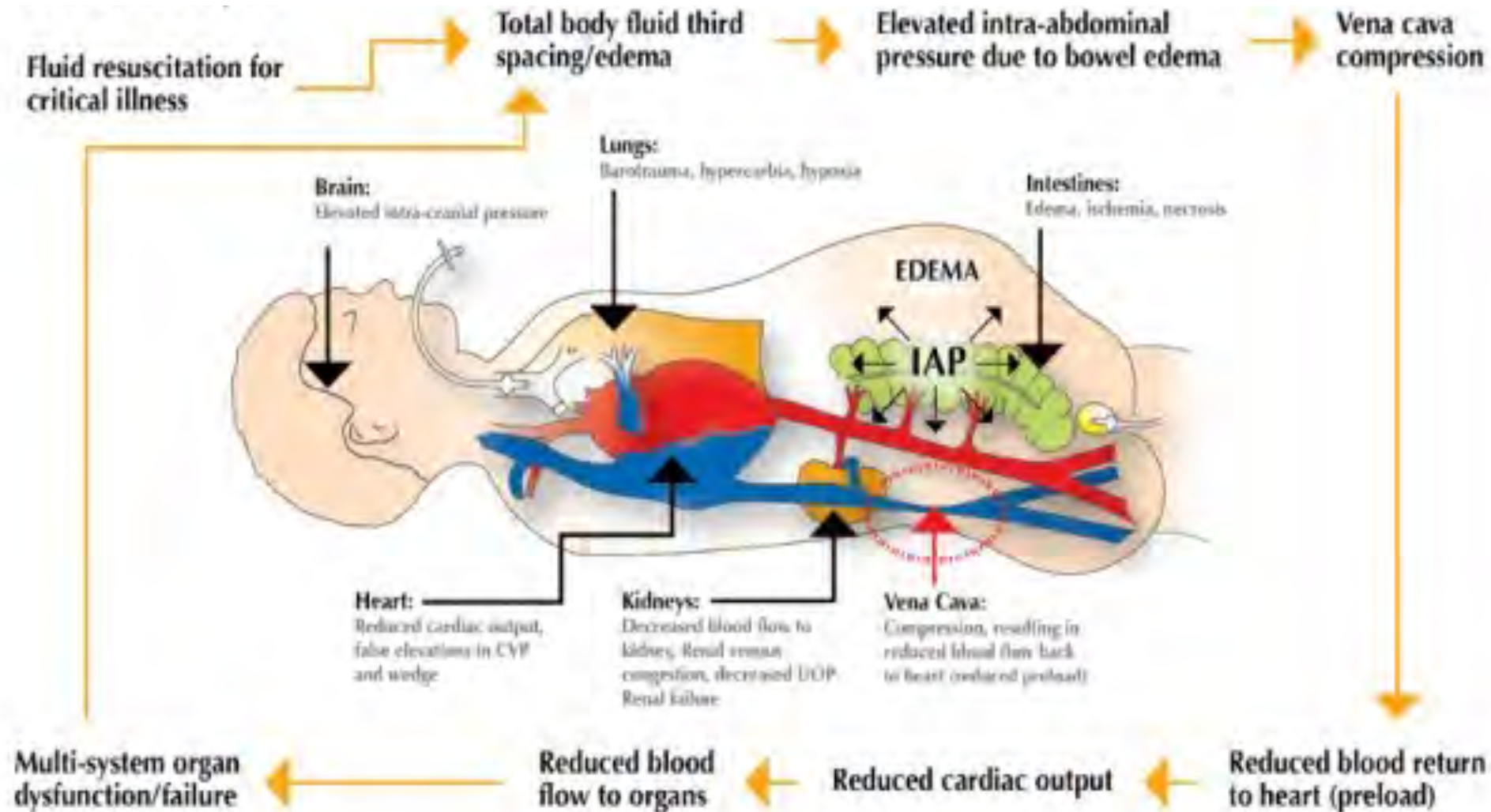
Primary Causes:

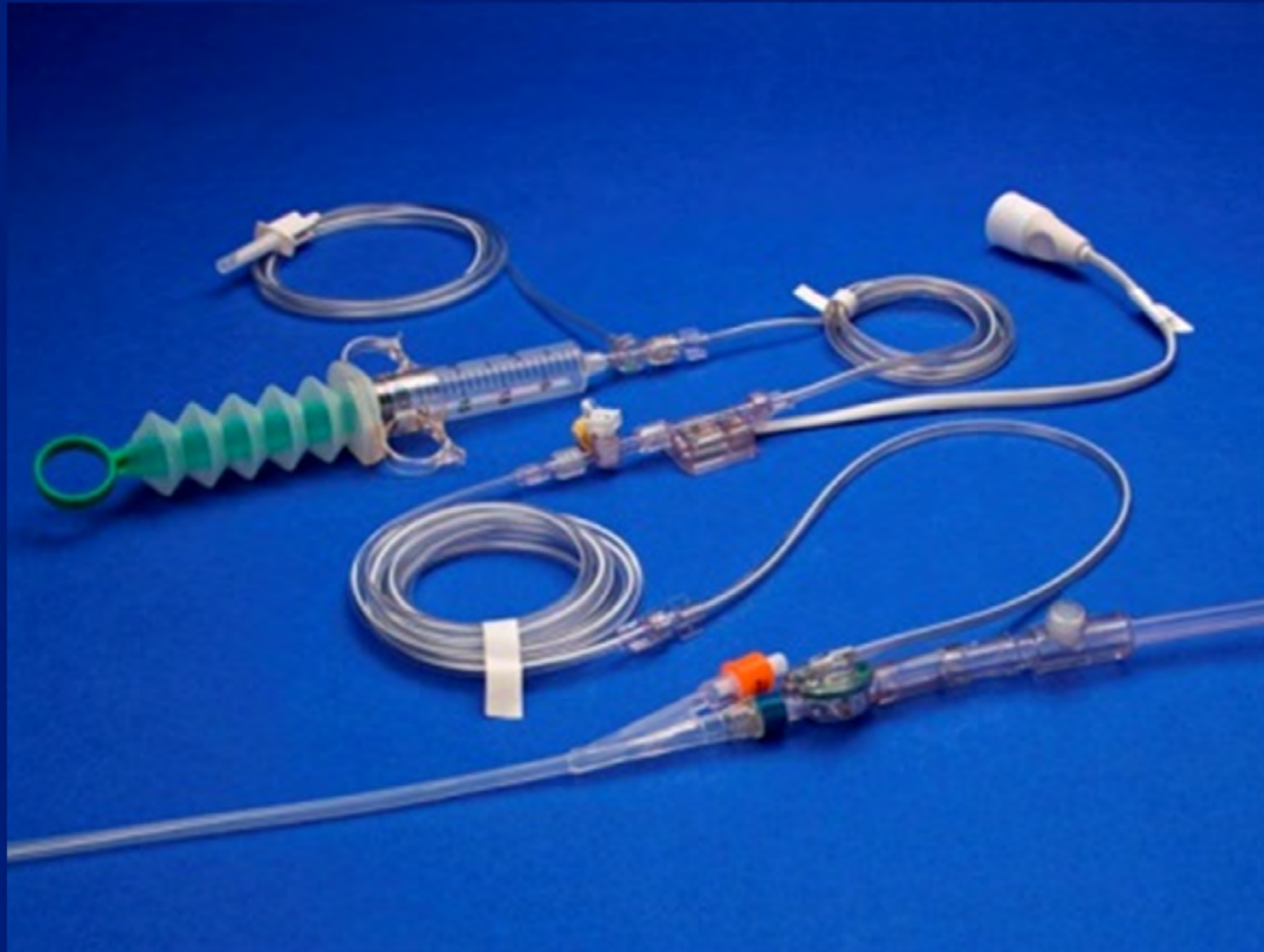
- Resuscitation edema
- Bowel edema
- Postoperative hemorrhage
- Bowel obstruction
- Closure of abdomen under tension
- Abdominal packing



What Happens to the Body's Organs?

A Vicious Cycle





Reperfusion Phenomenon

- Decompression
 - Release of accumulated acids, metabolites (byproducts of anaerobic metabolism)
 - Profound cardiac depression and hypotension
- To blunt effects
 - 50 mEq Bicarb – up to 4 amps may be ordered
 - Volume resuscitation

Acute Acalculous Cholecystitis (AAC)

- Acute inflammation of gallbladder
- Masked by concomitant injuries and interventions
- Contributing factors include decreased oral intake, TPN, use of narcotics and gallbladder ischemia may occur due to hypotension
- Diagnosis assisted by US, elevated WBC
- Requires surgical intervention

Common Pitfalls

- Failure to suspect intra-abdominal injury from the mechanism of injury
- Failure to fully evaluate abdominal pain after sustaining blunt abdominal injury
- Failure to prepare patient for timely operative intervention
- Failure to recognize hemodynamic compromise and support delay of surgery for additional diagnostic testing

General Nursing Considerations

- Preparation of patient
- Current knowledge of resuscitation
- Administer blood and blood products as ordered
- Prevent hypothermia
- Ongoing monitoring of patients
- Monitor intake and output
- Evidenced-based practice

Summary

- Abdominal trauma presents challenges.
- Not all injuries are easy to diagnose.
- Not all diagnostic modalities are useful in certain injuries.
- Nursing staff must be astute in assessment skills and injury management.
- Teamwork is essential.
- Optimizing outcomes is important.

Abdominal Trauma

1. A classic seat belt injury is associated with which of the following:
 - a. Thoracic wall disruption
 - b. Hollow viscous injury
 - c. Transection of major vessels
 - d. Fracture of cervical spine

2. The abdominal organ most susceptible to injury in blunt trauma is the:
 - a. Spleen
 - b. Small bowel
 - c. Esophagus
 - d. Pancreas

3. A persistent air leak after chest tube placement may indicate:
 - a. A diaphragmatic tear
 - b. An esophageal rupture
 - c. A gastric tear
 - d. A diaphragmatic hematoma

4. Mediastinitis should be anticipated in the patient sustaining the following injury:
 - a. Diaphragmatic rupture
 - b. Esophageal trauma
 - c. Small bowel trauma
 - d. Gastric injury

5. Pain that is referred to left shoulder due to peritoneal irritation is:
 - a. Chvostek's sign
 - b. Ballance's sign
 - c. Cullen's sign
 - d. Kehr's sign

6. A driver in a motor vehicle accident arrives in the emergency department complaining of diffuse abdominal pain, nausea, and vomiting. His vital signs are stable, and serial hemoglobin and hematocrit measurements are unremarkable. His serum amylase is elevated. You suspect he has sustained a:
 - a. Gastric injury
 - b. Splenic injury
 - c. Pancreatic injury
 - d. Small bowel injury

7. A diagnostic peritoneal lavage is not often used as diagnostic tool because:
- a. Findings are unreliable
 - b. Findings are nonspecific
 - c. It is too time consuming
 - d. CT is more specific and more sensitive
8. A priority nursing diagnosis for the patient who develops an intestinal fistula is:
- a. Impaired skin integrity
 - b. Pain
 - c. Infection
 - d. Fluid imbalance
9. Assessing for complications of abdominal trauma is imperative throughout patient recovery because:
- a. The potential for complications is ever present
 - b. Complications are normally specific to a single organ
 - c. An ileus is difficult to diagnose
 - d. Hemorrhage is the most common complication

Abdominal Trauma

1. A classic seat belt injury is associated with which of the following:
 - a. Thoracic wall disruption
 - b. Hollow viscous injury**
 - c. Transection of major vessels
 - d. Fracture of cervical spine
2. The abdominal organ most susceptible to injury in blunt trauma is the:
 - a. Spleen**
 - b. Small bowel
 - c. Esophagus
 - d. Pancreas
3. A persistent air leak after chest tube placement may indicate:
 - a. A diaphragmatic tear
 - b. An esophageal rupture**
 - c. A gastric tear
 - d. A diaphragmatic hematoma
4. Mediastinitis should be anticipated in the patient sustaining the following injury:
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References

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5th Edition

Abdulgafoor M. Tharayil, Adel Ganaw, Syed Abdulrahman, Zia M. Awan and Sujith M. Prabhakaran (July 12th 2017). Abdominal Compartment Syndrome: What Is New?, Intensive Care, Nissar Shaikh, IntechOpen, DOI: 10.5772/intechopen.68343. Available from: <https://www.intechopen.com/chapters/55014>

American College of Surgeons. (2018). Abdominal and pelvic trauma. In Advanced trauma life support: Student course manual (10th ed., pp. 83-101). Chicago, IL

Benjamin, E. (2020, Sep 14). Traumatic gastrointestinal injury in the adult patient. Up-toDate. Retrieved from: <https://www.uptodate.com/contents/traumatic-gastrointestinal-injury-in-the-adult->

Bickley, L. (2017). The Abdomen. In Bates Guide to Physical Examination and History Taking (12th ed. 449-507). Philadelphia, PA: Wolters Kluwer.

Bordoni, P.H.C., Santos, D.M.M.D., Teixeira, J.S., & Bordoni, L.S. (2017). Deaths from abdominal trauma: Analysis of 1888 forensic autopsies. Revista do Colegio Brasileiro de Cirurgioes, 44(6), 582-595. <https://doi.org/10.1590/0100-69912017006006>.

Bratcher, C. (2020). Abdominal and pelvic trauma. In Trauma nursing core course: Student course manual (8th ed., 141-159). Burlington, MA: Jones & Bartlett.

Bulger, E. M., Perina, D. G., Qasim, Z., Beldowicz, B., Brenner, M., Guyette, F., Rowe, D., Kang, C. S., Gurney, J., DuBose, J., Joseph, B., Lyon, R., Kaups, K., Friedman, V. E., Eastridge, B., & Stewart, R. (2019). Clinical use of resuscitative endovascular balloon occlusion of the aorta (REBOA) in civilian trauma systems in the USA, 2019: a joint statement from the American College of Surgeons Committee on Trauma, the American College of Emergency Physicians, the National Association of Emergency Medical Services Physicians and the National Association of Emergency Medical Technicians. Trauma surgery & acute care open, 4(1), e000376. <https://doi.org/10.1136/tsaco-2019-000376>

Chaundrey, M., Clark, J., Wilson, M. H., Bew, D., Yang, G.Z. & Darzi, A. (2015). Traumatic intra-abdominal hemorrhage control: Has current technology tipped the balance toward a role for prehospital intervention? Journal of Trauma and Acute Care Surgery, 78(1), 153-163. <https://doi.org/10.1097/TA.0000000000000472>

Christmas, A. & Jacobs, D. (2020, Jan.2). Management of hepatic trauma in adults. Up-toDate. Retrieved from: <https://www.uptodate.com/contents/management-of-hepatic-trauma-in-adults>

Coccolini, F., Montori, G., Catena, F., et al. (2015). Liver trauma: WSES position paper. World J Emerg Surg; 10:39. <https://wjcs.biomedcentral.com/articles/10.1186/s13017-015-0030-9>

Cowled P, Fitridge R. Pathophysiology of Reperfusion Injury. In: Fitridge R, Thompson M, editors. Mechanisms of Vascular Disease: A Reference Book for Vascular Specialists [Internet]. Adelaide (AU): University of Adelaide Press; 2011. 18. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK534267/>

De Laet, I.E., Malbrain, M.L.N.G. & De Waele, J.J. A Clinician's Guide to Management of Intra-abdominal Hypertension and Abdominal Compartment Syndrome in Critically Ill Patients. Crit Care 24, 97 (2020). <https://doi.org/10.1186/s13054-020-2782-1>

Diercks, D.B., & Clarke, S. (2021, Oct 11). Initial evaluation and management of blunt abdominal trauma in adults. UpToDate. Retrieved from <https://www.uptodate.com/contents/initial-evaluation-and-management-of-blunt-abdominal-trauma-in-adults>

Hamm, A.D., Burlew, C.C., & Moore, E.E. (2018). Penetrating abdominal trauma. In A.H. Harken & E.E. Moore (Eds.), *Abernathy's surgical secrets* (7th ed., pp. 115-120). Philadelphia, PA: Elsevier.

Harris, C. (2013). Abdominal trauma. In B.B. Hammond & P.G. Zimmermann (Eds.) *Sheehy's manual of emergency care* (7th ed. 419-426). St. Louis, MO: Elsevier Mosby.

Ho, V.P., Patel, N., Bokhari, F., Madbak, F.G., Hambley, J.E., Yon, J.,.....Como, J. (2017). Management of adult pancreatic injuries: A practice management guideline from the Eastern Association for the Surgery of Trauma. *Journal of Trauma and Acute Care Surgery*, 82(1), 185-199. <https://pubmed.ncbi.nlm.nih.gov/27787438/>

Hoff, W.S., Holevar, M., Nagy, K.K., Patterson, L., Young, J.S., Arrillaga, A., Najarian, M.P., Valenziano, C.P.; Eastern Association for the Surgery of Trauma. (2002). Practice management guidelines for the evaluation of blunt abdominal trauma: the EAST practice management guidelines work group. *Journal of Trauma*, 53(3), 602-15. <https://www.east.org/education-career-development/practice-management-guidelines/archived/blunt-abdominal-trauma-evaluation-of>

Hsu, J. M., & Pham, T. N. (2011). Damage control in the injured patient. *International journal of critical illness and injury science*, 1(1), 66–72. <https://doi.org/10.4103/2229-5151.79285>

Ikhlas M, Atherton NS. Vascular Reperfusion Injury. [Updated 2021 Aug 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK562210/>

Jang, T. (2017). Focused Assessment with Sonography in Trauma. Retrieved from: <https://emedicine.medscape.com/article/104363-overview#a2>

Jones, E.L., Stovall, R.T., Jones, T.S., Bensard, D.D., Burlew, C.C., Johnson, J.L., ...Moore, E. E. (2014). Intra-abdominal injury following blunt trauma becomes clinically apparent within 9 hours. *Journal of Trauma and Acute Care Surgery*, 76(4), 1020. <https://doi.org/10.1097/TA.000000000000131>

Katrancha E.D. (2018) Nursing Care of the Client with Abdominal Trauma. In: Rodriguez A., Barraco R., Ivatury R. (eds) *Geriatric Trauma and Acute Care Surgery*. Springer, Cham. https://doi.org/10.1007/978-3-319-57403-5_48.

Kirkpatrick, A.W., Roberts, D.J., Waele, J.D., Jaeschke, R., Malbrain, M.L.N.G., Keulenaer, B.D., Olvera, C. (2013). Intra-abdominal hypertension and the abdominal compartment syndrome: Updated consensus definitions and clinical practice guidelines from the World Society of Abdominal Compartment Syndrome. *Intensive Care Medicine*, 39, 1190-1206. <https://pubmed.ncbi.nlm.nih.gov/23673399/>

Jones MW, Ferguson T. Acalculous Cholecystitis. [Updated 2021 Sep 21]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK459182/>

Jurkovich, G. (2021, Nov 15). Management of duodenal trauma in adults. Up-ToDate. Retrieved from : <https://www.uptodate.com/contents/management-of-duodenal-trauma-in-adults>

Karaolani, G., Dimitrios, M., Cameron, M.C., Diamantis, T. I., Sotirios, G., & Bakoyiannis C. (2018). Contemporary strategies in the management of civilian abdominal vascular trauma. *Frontiers in Surgery*, 5, 7. <https://www.frontiersin.org/articles/10.3389/fsurg.2018.00007/full>

Kobayashi, L. M., Costantini, T. W., Hamel, M. G., Dierksheide, J. E., & Coimbra, R. (2016). Abdominal vascular trauma. *Trauma surgery & acute care open*, 1(1), e000015. <https://doi.org/10.1136/tsaco-2016-000015>

Machala, Waldemar & Wiśniewski, Tomasz & Brzozowski, Robert. (2014). Application of ultrasound examination in tactical conditions illustrated with an example of the Field Hospital of the Polish Military Contingent in Afghanistan. *Journal of Ultrasonography*. 14. 393-401. 10.15557/JoU.2014.0040. https://www.researchgate.net/publication/286775384_Application_of_ultrasound_examination_in_tactical_conditions_illustrated_with_an_example_of_the_Field_Hospital_of_the_Polish_Military_Contingent_in_Afghanistan/citation/download

Mandell, S. (2021, Oct.14). Overview of the diagnosis and initial management of traumatic retroperitoneal injury. UpToDate. Retrieved from <https://www.uptodate.com/contents/overview-of-the-diagnosis-and-initial-management-of-traumatic-retroperitoneal-injury>

Manzini, N., & Madiba, T.E. (2014). The management of retroperitoneal haematoma discovered at laparotomy for trauma. *Injury*; 45:1378. <https://pubmed.ncbi.nlm.nih.gov/24606980/>

Maung, A. & Kaplan, L. (2021, July 6). Management of splenic injury in the adult patient. Up-toDate. Retrieved from: <https://www.uptodate.com/contents/management-of-splenic-injury-in-the-adult>

Mubang RN, Sigmon DF, Stawicki SP. Esophageal Trauma. [Updated 2021 Aug 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK470161/>

Newman, R.K., Dayal, N., & Dominique E. Abdominal Compartment Syndrome. [Updated 2021 Apr 22]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK430932/>

Raymond, D. (2021, Nov 5). Overview of esophageal injury due to blunt or penetrating trauma in adults. Up-ToDate. Retrieved from: <https://www.uptodate.com/contents/overview-of-esophageal-injury-due-to-blunt-or-penetrating-trauma-in-adults>

Santos, G. E., Sánchez, S. A., Verde, J.M, et al. (2015). Duodenal injuries due to trauma: Review of the literature. *Cir Esp*, 93:68. <https://pubmed.ncbi.nlm.nih.gov/25443151/>

Sharma, R.S., Kumar, S., Damole, S., Vivekbhaskar, D. & Ghandi, A. (2017). Clinical study of hollow viscus and solid organ injury in blunt abdominal trauma and it's management. *International Journal of Information Research and Review*, 4(4), 3963-3966. Retrieved from <http://www.ijrr.com/sites/default/files/issues-files/1940.pdf>

Society of Trauma Nurses. (2018). Initial assessment and management. In *Advanced trauma care for nurses: Student manual companion to ATLS 10th edition* (8th ed., 17).

Tahir, F., Ahmed, J., & Malik, F. (2020). Post-splenectomy Sepsis: A Review of the Literature. *Cureus*, 12(2), e6898. <https://doi.org/10.7759/cureus.6898>

Tortora, G. J. & Derrickson, B.H. (2017). *Principles of anatomy and physiology* (15th ed.) Hoboken, NJ: Wiley.

Williams, M. (2021, Nov 15). Recognition and management of diaphragmatic injuries in adults. Up-ToDate. Retrieved from: <https://www.uptodate.com/contents/recognition-and-management-of-diaphragmatic-injury-in-adults>