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TRAUMA LECTURES

SOCIETY OF TRAUMA NURSES

Traumatic Brain Injury

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Objectives

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

- Identify the functional anatomy of the brain and the effects of traumatic brain injury (TBI)
- Describe the neurologic assessment and initial management of the TBI patient
- Identify management strategies to reduce the risk of secondary injury and minimize complications

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Traumatic Brain Injury (TBI)

Definition:

Disruption in the normal function of the brain that can be caused by a bump, blow, jolt or penetrating head injury.

Aspen Photo/Shutterstock.com

(Centers for Disease Control, 2017)

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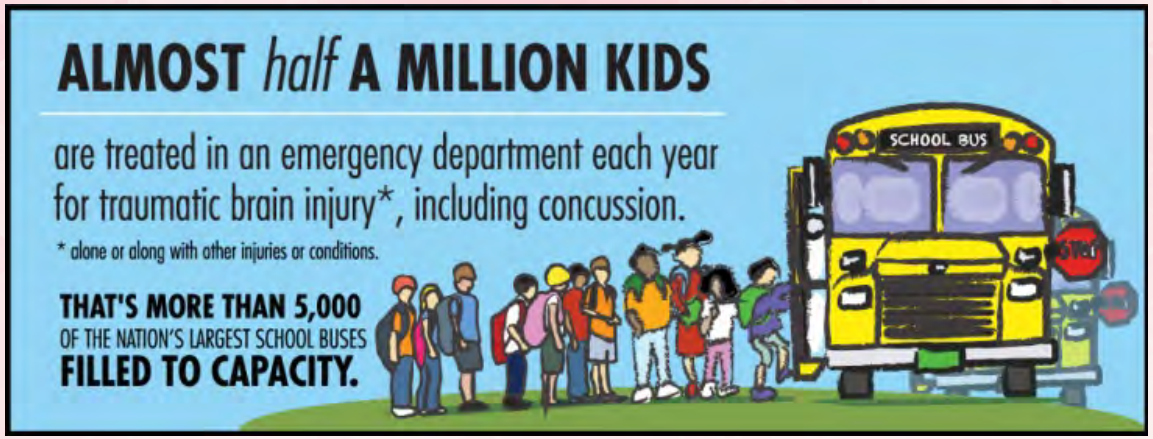
Epidemiology

- U.S. 2.8 million TBI annually
- 56,000 die; 30% of all injury deaths
- 282,000 hospitalized
- Elderly (>75 yrs) highest rates of TBI-related hospitalizations and deaths

(Centers for Disease Control, 2017)

Epidemiology

- Among children, ED visits for sports and recreation-related injuries more than doubled



(Centers for Disease Control, 2015)

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Mechanisms of Injury

- Blunt
  - Falls
  - Bicycle Crash
  - Pedestrian
  - Assault
  - MVC
- Penetrating
  - Gun Shot Wounds
  - Other penetrating

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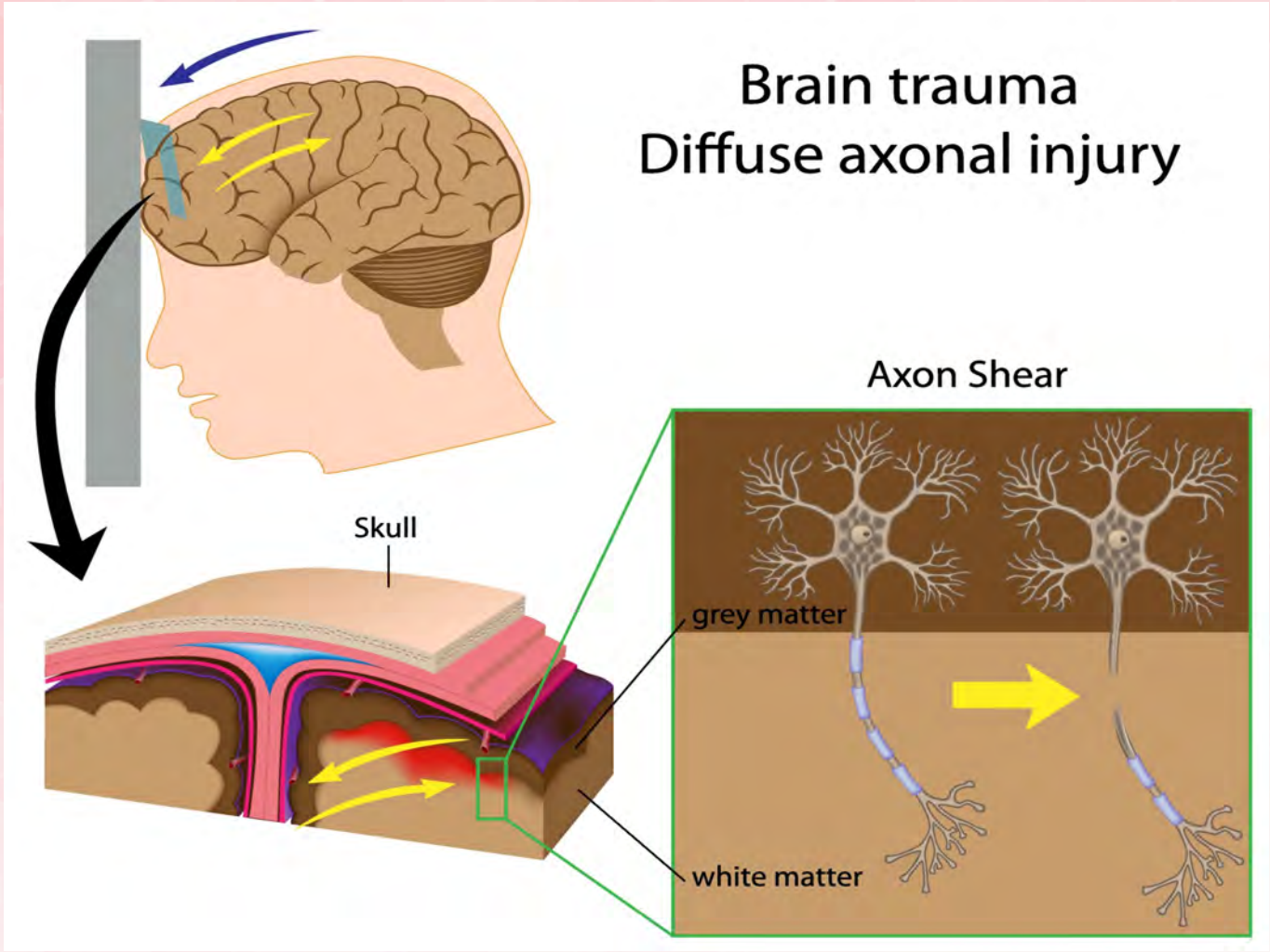
Focal Injury

- Contusions
- Lacerations
- Intracranial Hemorrhage

Diffuse Injury



Traumatic Brain Injury (TBI)

Primary Injury

- Occurs at the moment of impact due to blunt or penetrating mechanism

Prevention

- Includes fall prevention, bicycle helmets, pedestrian safety awareness, gun violence awareness

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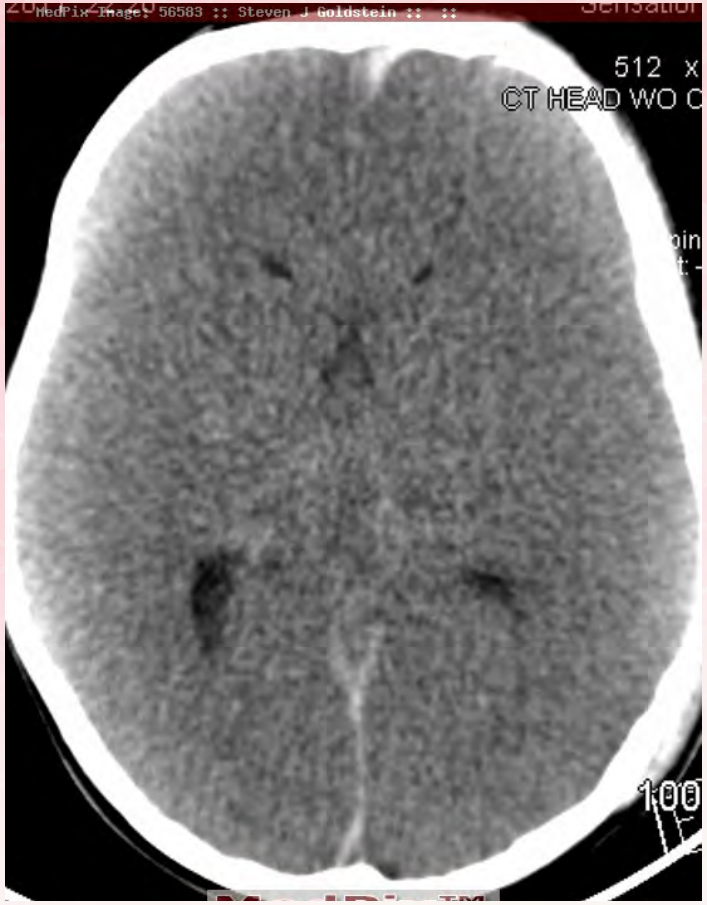
Traumatic Brain Injury (TBI)

Secondary Injury

- Can occur hours, days and months after initial trauma
- Results in additional neurochemical, metabolic and cellular changes
- Caused by events that occur AFTER the primary injury
  - inadequate perfusion (hypotension)
  - Hypoxia



(Pearn et al., 2017)

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Secondary Injury

Secondary injury is preventable and can be minimized through early assessment, efficient monitoring and management

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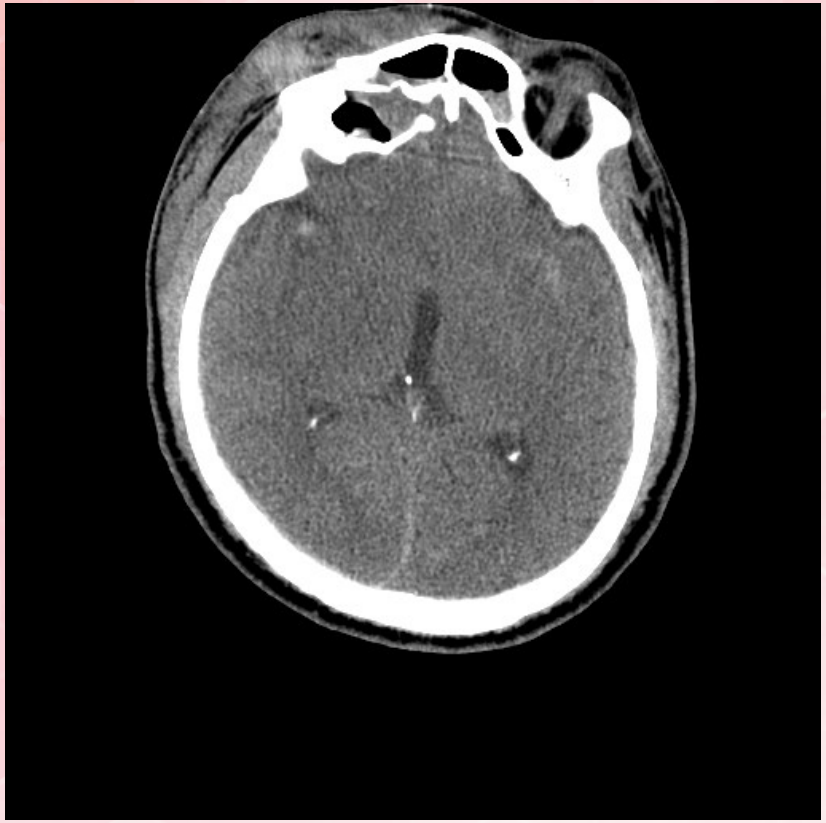
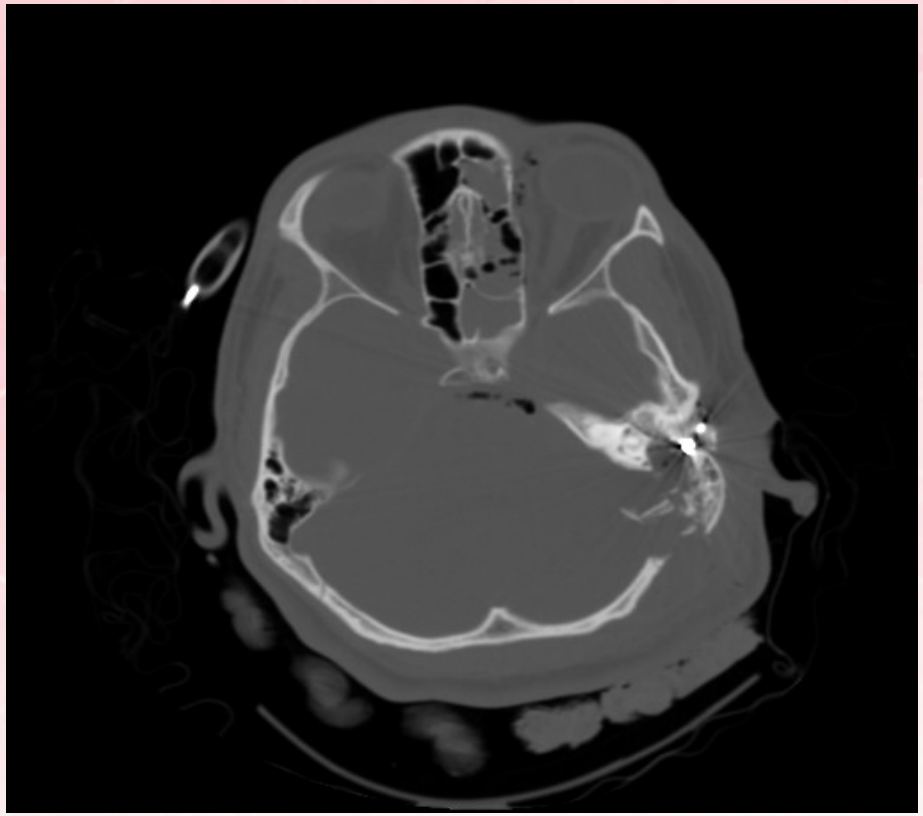
Primary/Secondary Insults

- Primary Injury – seconds to minutes
  - Vascular compromise
  - Diffuse axonal injury
  - Cellular injury
- Secondary injury – hours to days
  - Ischemia
  - Swelling
  - Inflammation

TBI



Blunt



Penetrating

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Concussion

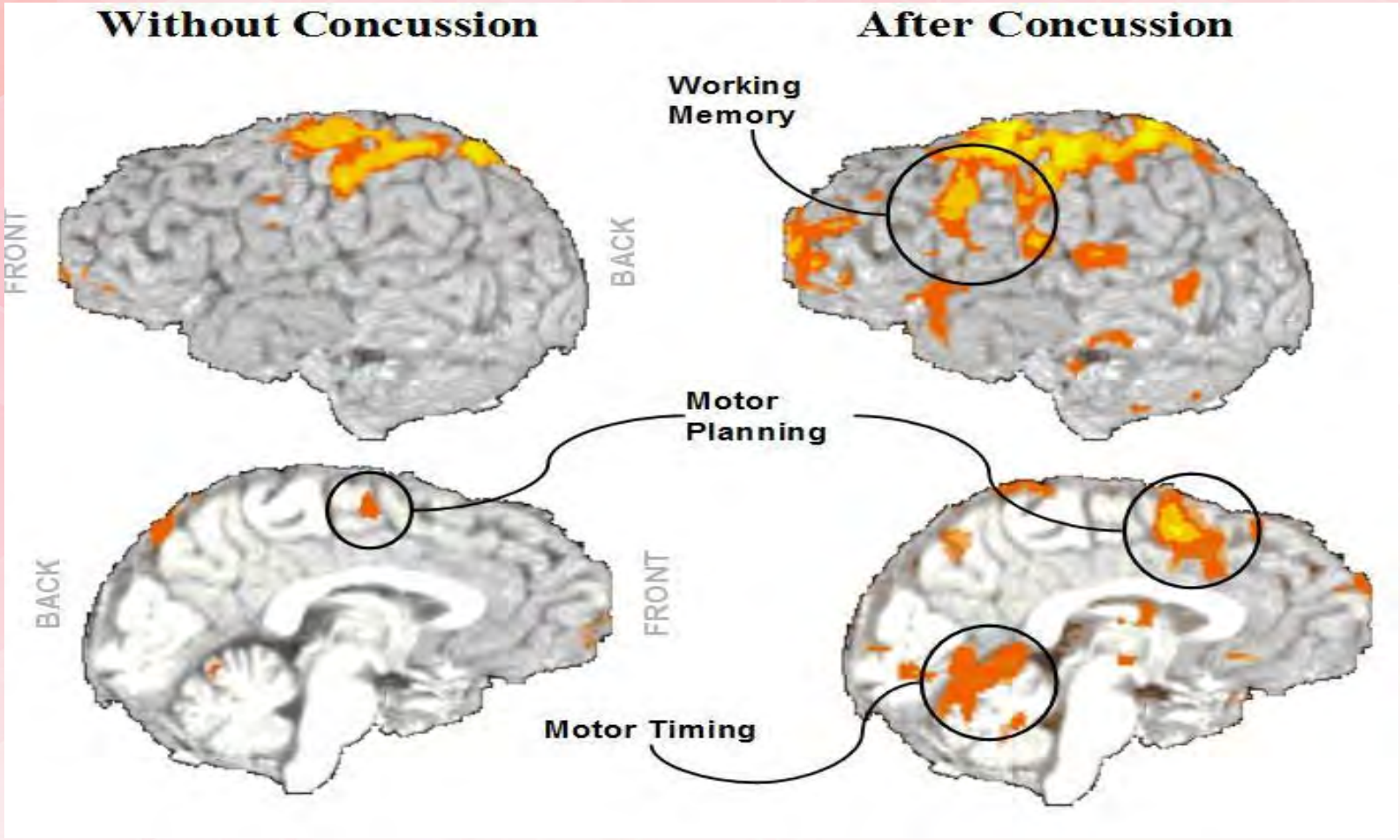

Image: Center for Complex Systems and Brain Sciences, Florida Atlantic University, Charles Schmidt College of Science

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Subdural Hematoma

- Acute, subacute and/or chronic
- Stretching or tearing of bridging vessels
- Presentation varies

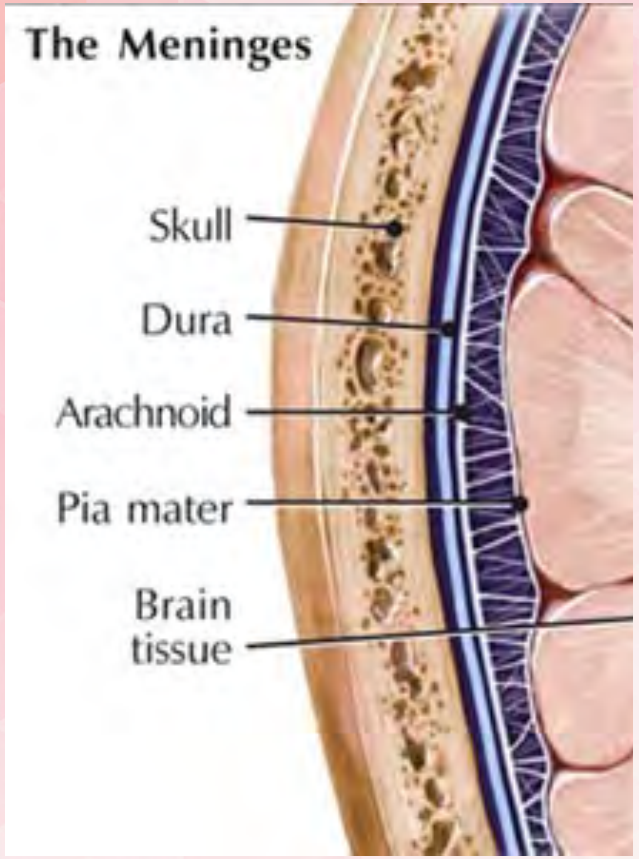
Epidural Hematoma

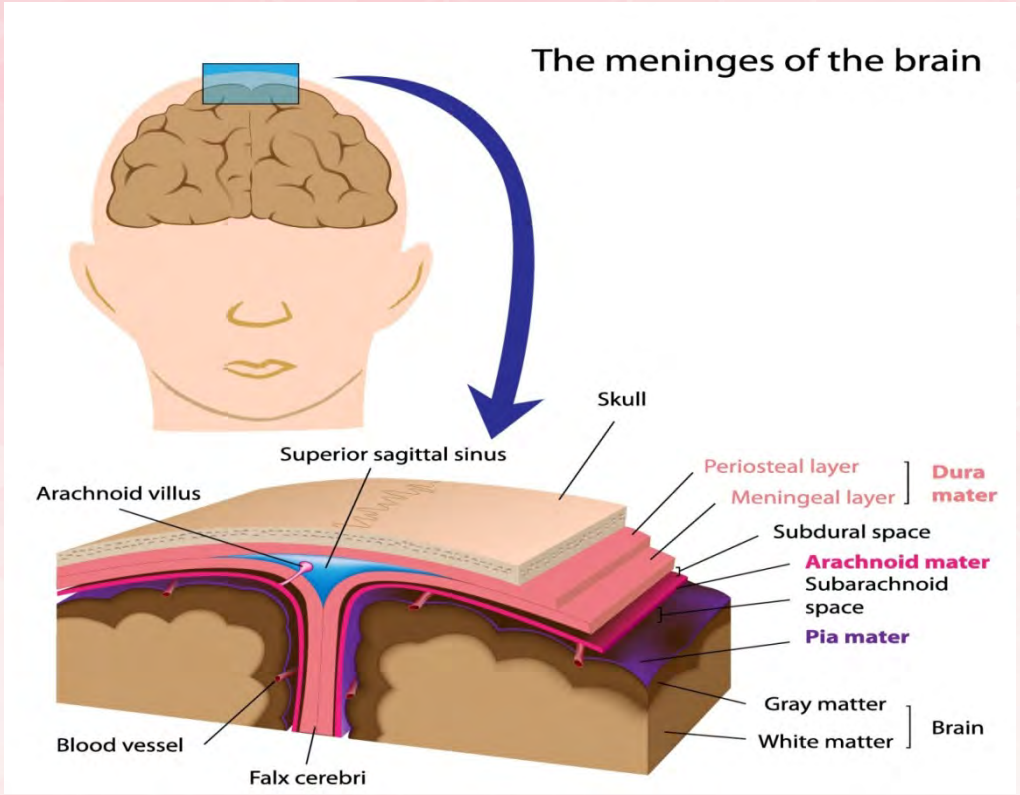
- Arterial bleed- Middle Meningeal Artery
- Direct blow
- Overlying skull fractures
- Acute Lucid interval followed by sudden decline in LOC

Anatomy of the Head - Skull

- The skull of the head is known as the cranium.
- Major bones of the skull: Ethmoid, parietal, sphenoid, temporal, and occipital
- Rigidly jointed together by articulations known as sutures, which form the protective housing for the brain
- The cranial sutures between bones initially serve as expansion joints but eventually fuse, which halts expandability in adults.
- The major structures of the head consists of the scalp, skull, meninges, brain, ventricular system and tentorium.
- The scalp consists of skin, connective tissue fibers, blood vessels and nerves.
- The scalp has a rich blood supply therefore lacerations to the scalp can be bleed profusely and lead to severe blood loss in trauma.

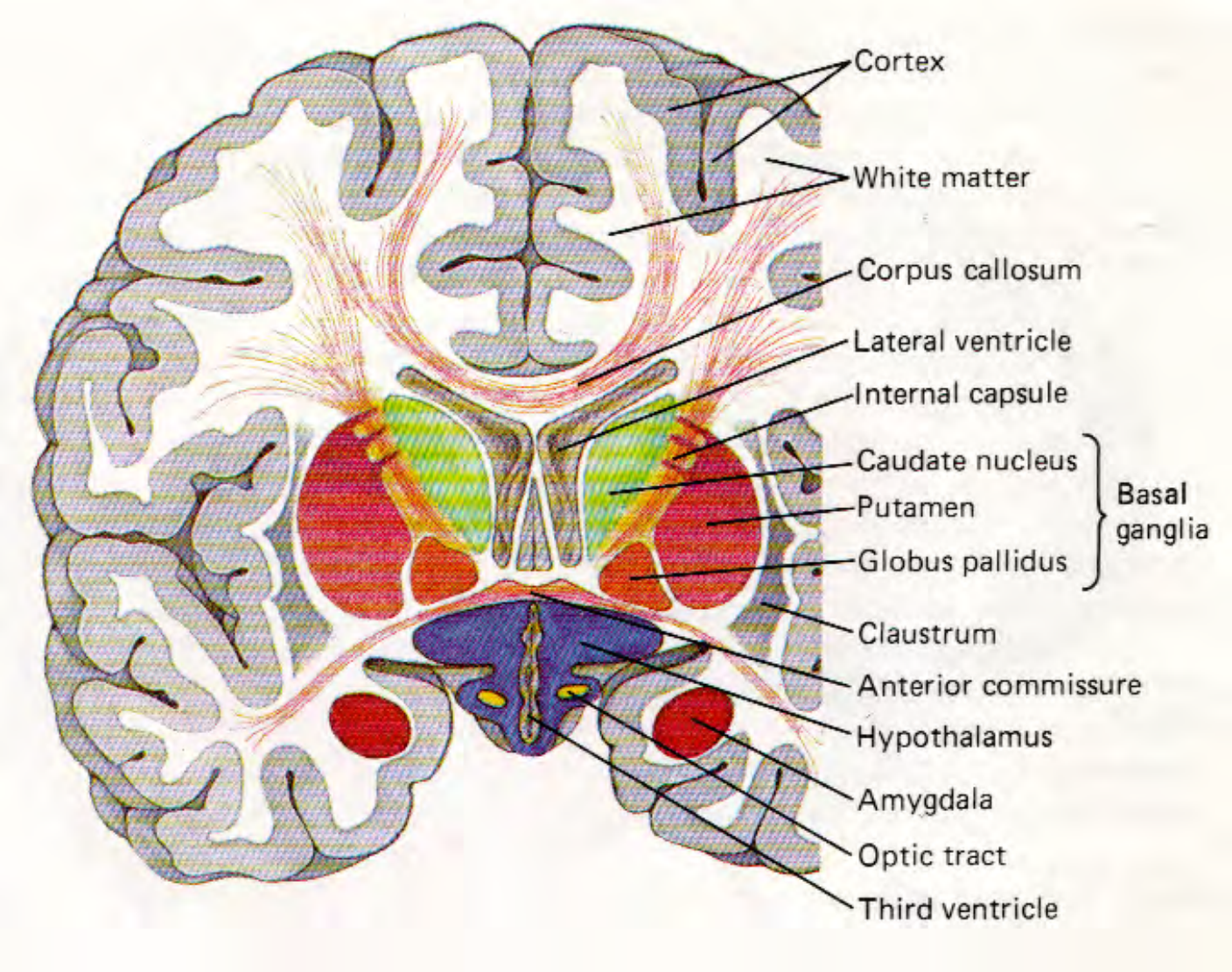
Anatomy of the Head - Meninges





http://anatowiki.wetpaint.com/page/The+Brain

Anatomy of the Head - Brain



http://www.ece.umd.edu/class/enee719v.S2002/figures/funfigs.html

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Functions of the Cerebral Lobes

FRONTAL LOBE
- Thinking
- Planning
- Problem Solving
- Emotions
- Behavioral Control
- Decision Making

TEMPORAL LOBE
- Memory
- Understanding Language
- Facial Recognition
- Hearing
- Vision
- Speech
- Emotion

PARIETAL LOBE
- Perception
- Object Classification
- Spelling
- Knowledge of Numbers
- Visuospatial Processing

OCCIPITAL LOBE
- Vision
- Visual Processing
- Color Identification
- Movement Perception

CEREBELLUM
- Fine Motor Skills
- Hand-Eye Coordination
- Balance

BRAIN STEM
- Regulates Body Temperature
- Regulates Sleep/Wake Cycle
- Heart Rate
- Swallowing
- Breathing

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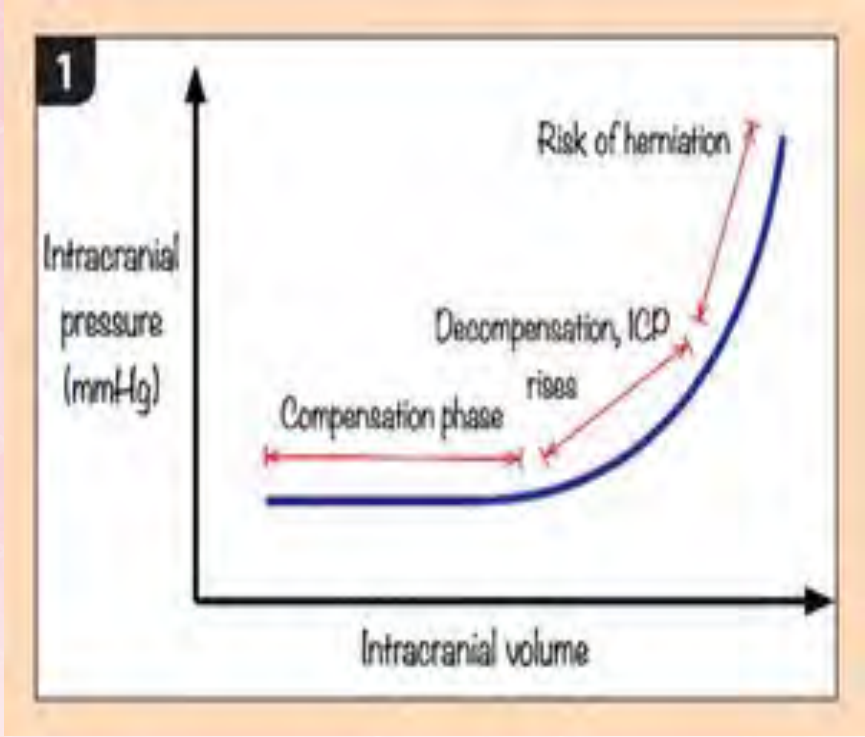
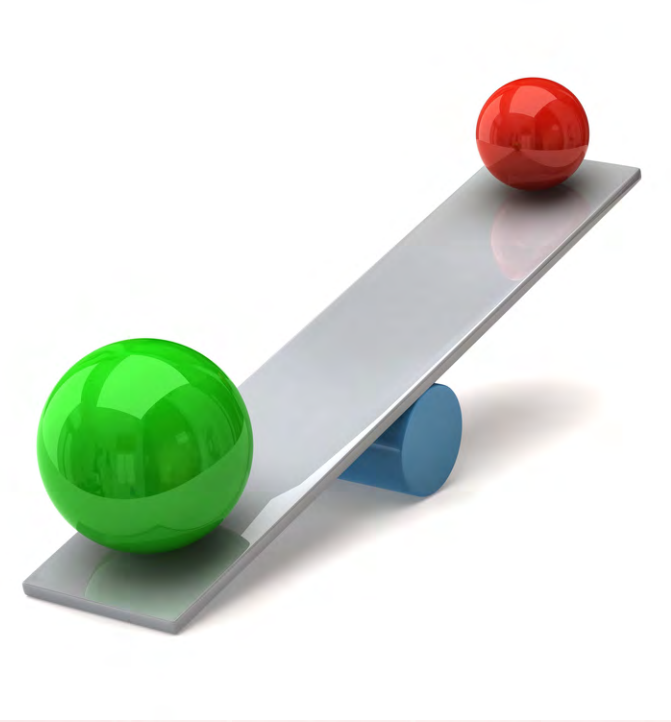
Monroe- Kellie Doctrine

- The cranium is a non-expandable Vault
- The total volume of intracranial contents must remain constant
  - Brain - 80%
  - Blood - 10%
  - CSF - 10%
- An increase in one causes a decrease in one or both of the remaining two



Autoregulation

- The intrinsic ability of the cerebral blood vessels to dilate or constrict in response to changes in the brain environment
- Enables cerebral blood vessels to maintain cerebral blood flow in presence of wide fluctuation in mean arterial pressure



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Autoregulation - Impaired

- Autoregulation fails if MAP is < 50 or >150 mmHg
- Autoregulation failure affects CPP by impacting the pressure gradient that drives cerebral blood flow

TBI Recognition and Management

- Prehospital Care
- ABCDE Management
- Mitigate Secondary Injury

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Pre Hospital Care

- Timing and transport
- Oxygenation
- Intubation
- ETCO2
- Blood Pressure
- Transport decisions

(Sasser et al., 2011)

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Glasgow Coma Scale (GCS)

Adult			Pediatric	
Spontaneously	4	**Best Eye Opening**	Spontaneously	4
To verbal stimuli	3		To verbal stimuli	3
To painful stimuli	2		To painful stimuli	2
No eye opening	1		No eye opening	1
Oriented	5	**Best Verbal Response**	Appropriate coo & cry	5
Confused	4		Irritable cry	4
Inappropriate words	3		Inconsolable crying	3
Incomprehensible	2		Grunts	2
No verbal response	1		No verbal response	1
Obeys commands	6	**Best Motor Response**	Normal spontaneous	6
Localizes pain	5		Withdraws to touch	5
Withdraws to pain	4		Withdraws to pain	4
Flexion to pain	3		Flexion to pain	3
Extension to pain	2		Extension to pain	2
No motor response	1		No motor response	1

https://online.epocrates.com/diseases/51521/Evaluation-of-traumatic-brain-injury-acute/Diagnostic-Approach

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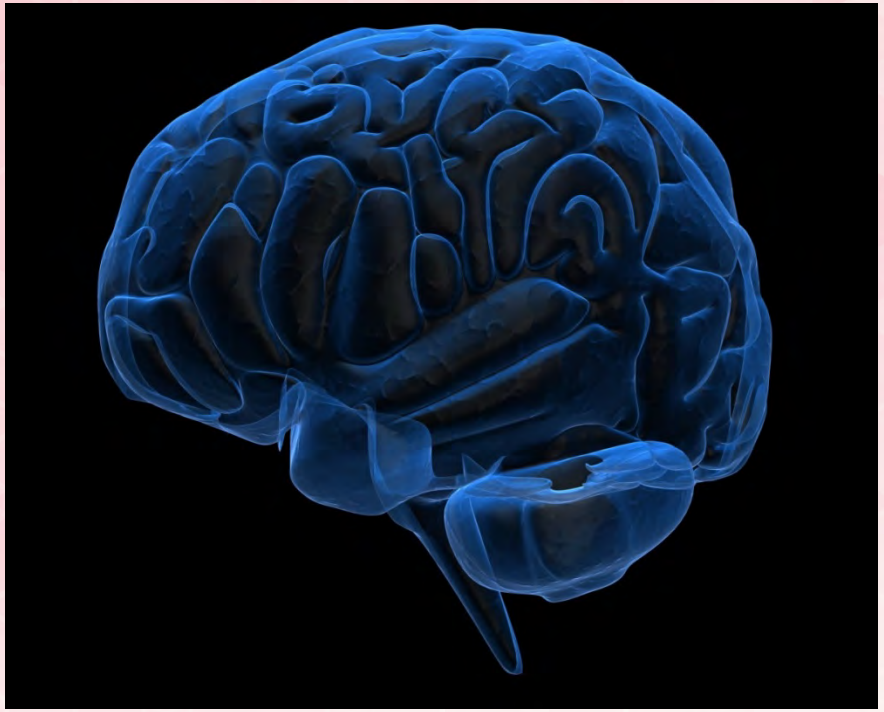
Classification of TBI

- Mild
  - GCS Score 14-15
- Moderate
  - GCS Score 9-13
- Severe
  - GCS Score 3-8



Mild TBI

- Most Prevalent TBI
- 10-15% of patients diagnosed experience long-term problems including:
  - headache
  - fatigue, sleep disturbances
  - balance disorders
  - cognitive impairments
  - mood or affective disorders

drdanmadock.com

(Marshall et al., 2015)

Signs and Symptoms of Mild TBI

- Confusion/Disorientation < =24 hrs
- Loss of consciousness up to 30 minutes
- Post-traumatic Amnesia <=24 hrs
- GCS 13-15
- Normal structural imaging

(Voss, Connolly, Schwab, & Scher, 2015)

Signs and Symptoms of Mild TBI

- Difficulty thinking clearly
- Headache
- Balance problems
- Irritable Sensitivity to light or noise
- Does not “feel right”

(Voss, Connolly, Schwab, & Scher, 2015)

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Management of Mild TBI

- Assessment
- Diagnostics
- Management and Interventions
- Discharge Education
- Recovery and rehabilitation

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Heads Up: Concussion in Youth Sports

If you think your athlete has sustained a concussion

don't assess it yourself

Take him/her out of play

and seek the advice of a health care professional

(Centers for Disease Control and Prevention, 2017)

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Signs and Symptoms of Moderate TBI

- GCS 9-13
- Altered mental status
  - Mild confusion
  - Lethargy
- History of LOC -minutes to hours

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Management of Moderate TBI

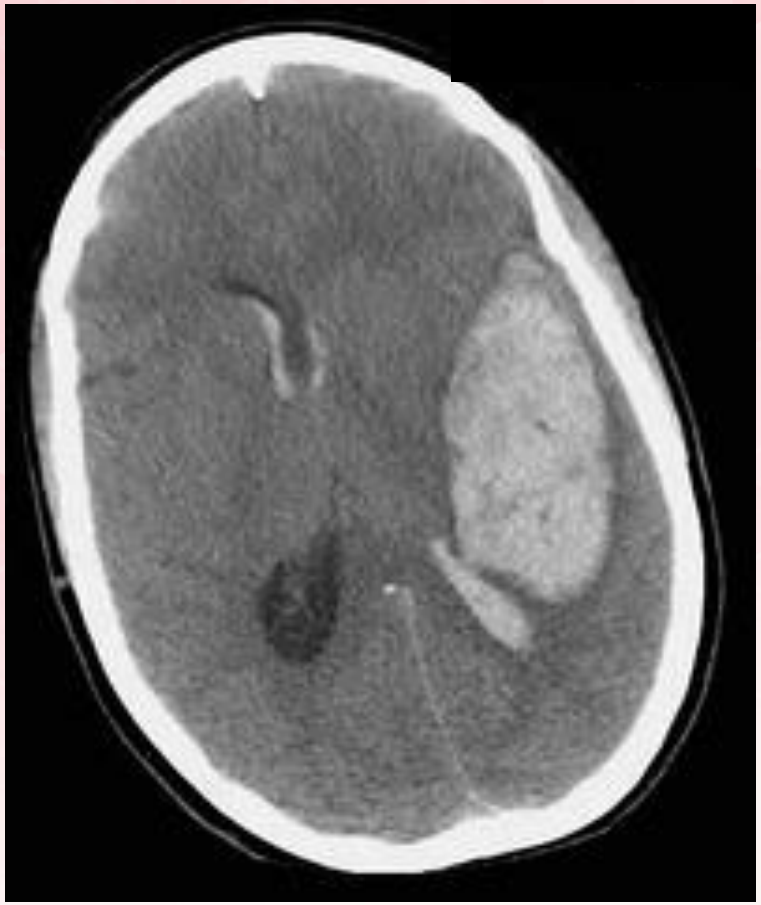
- Prevent secondary injury
- History
- Medications
- Labs
- Utilize A, B, C, D, E

Signs and Symptoms of Severe TBI

- GCS 3-8
- Prolonged LOC
- Posturing
- Pupillary changes

Initial Management of Severe TBI Patient

- Primary survey and resuscitation
  - ABCDEs
- Secondary survey
  - Head to toe assessment
  - AMPLE
  - Diagnostics



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Initial Management - ABCDE

A- Airway

- Obtain/maintain definitive airway with Cervical Spine immobilization.
- GCS ≤ 8- intubate
  - Rapid Sequence Intubation (RSI)

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Initial Management - ABCDE

B- Breathing

Goals

- Pa O2 >60mmHg,
- O2 sat > 98%
- ETCO2 ~ 35mmHg

Avoid routine use of hyperventilation

Initial Management -ABCDE

C- Circulation

- Maintain MAP >60mmHg
- Maintain euvolemia
- Control hemorrhage
- Manage volume
- CPP > 60mmHg

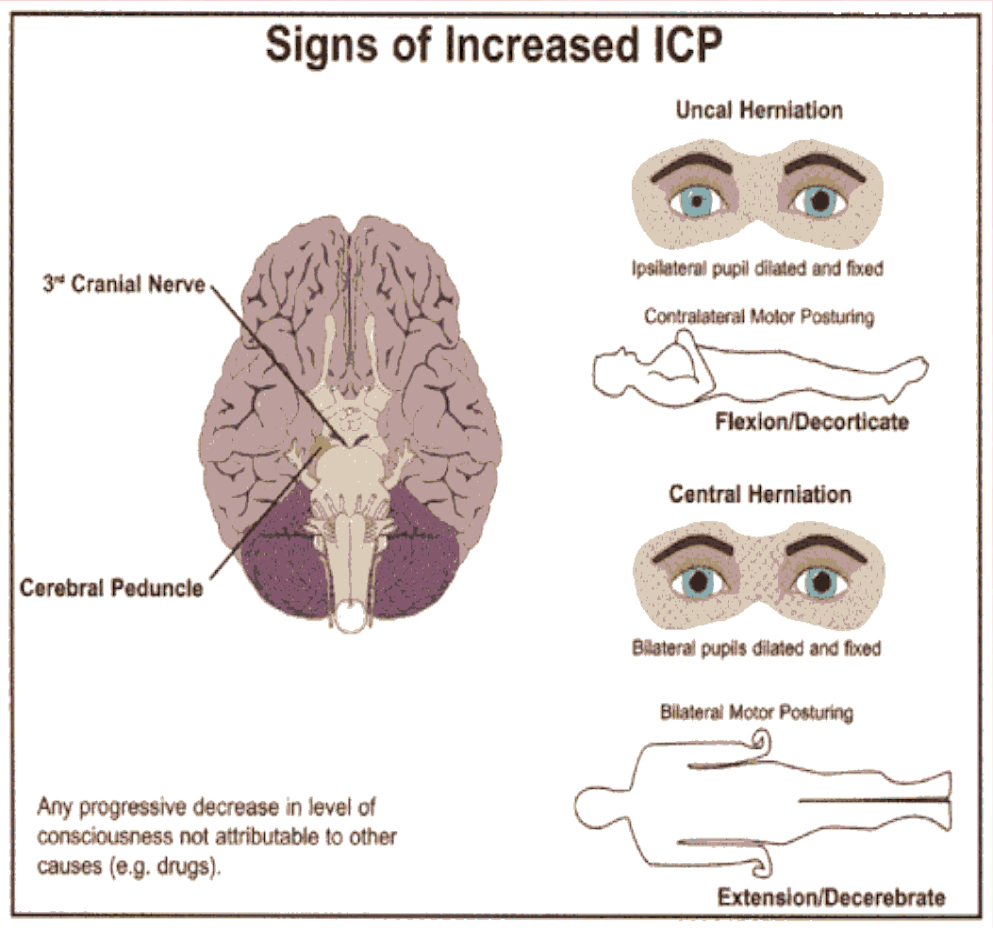
droualb.faculty.mjc.edu

(American College of Surgeons, 2012)

Initial Management - ABCDE

D - Disability

- GCS
- Pupils
- Motor function



ABCDE Considerations for TBI

E – Exposure/Environment/ Evaluation

- Expose to identify all injuries
- Maintain normothermia
- Evaluate interventions

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Initial Management – Secondary Survey

- Systematic Assessment
- Adjuncts:
  - Labs
  - Neurologic/ ICP Monitoring
  - Cardiac Monitoring
  - Arterial Line
  - Pulse Oximetry / Capnography
  - Core Temperature

Initial Management – Secondary Survey

- Clinical assessment and reassessment
  - Battles Sign
  - Raccoon Eyes
  - Rhinorrhea/ Otorrhea
  - Motor and sensory deficits
  - Pupillary response
  - Reflexes

Pupil Assessment

Pupils

Both dilated

- Nonreactive: brainstem
- Reactive: often reversible

- Slow: cranial nerve III
- Fluttering: often hysteria

Unilaterally dilated

- Reactive: ICP increasing
- Nonreactive (altered LOC): increased ICP
- Nonreactive (normal LOC): not from head injury

Slideplayer.com

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Clinical Manifestations of Secondary Injury

- Earliest signs and symptoms of increased ICP:
  - Agitation or restlessness
  - Confusion / Decreasing consciousness (LOC)
  - Headache
  - Nausea/vomiting
  - Seizures

Clinical Manifestations of Secondary Injury

- Late signs and symptoms of increased ICP :
  - Posturing
  - Bradycardia
  - Altered respiratory patterns
  - Hypertension
  - Unilateral or bilateral pupil dilation

Cushing's Triad

Indicates an increase in ICP

- Increased SBP (with widening pulse pressure)
- Bradycardia
- Irregular respirations

Last attempt of the brain to compensate during the process of herniation

These signs are opposite of HYPOVOLEMIC SHOCK

- Decreased SBP
- Tachycardia
- Increased respiratory rate

ICP Monitoring

- Management of severe TBI patients using information from ICP monitoring is recommended to reduce in-hospital and 2 week post-injury mortality
- Normal ICP: 0-10 mm Hg

(Carney et al., 2017)

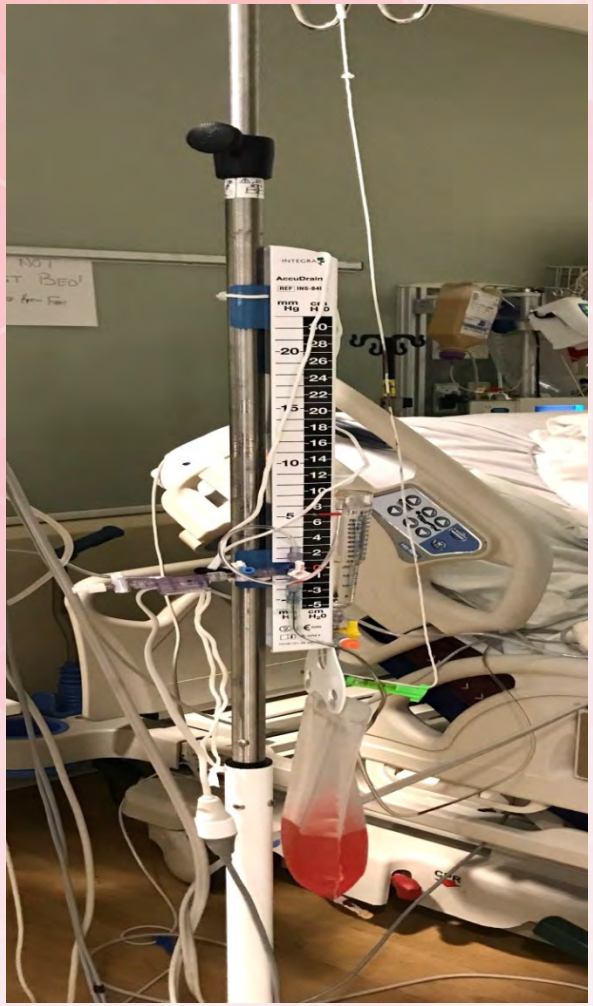
ICP Monitoring

- Indications:
  - All salvageable patients with GCS 3-8 and abnormal CT scan
  - TBI patients with normal CT and 2 or more of the following: age over 40 years, unilateral or bilateral motor posturing, or SBP <90 mm Hg

Monitoring Devices

- External Ventricular Drains
- Subarachnoid Screw or Bolt
- Subdural catheter
- Intraparenchymal fiberoptic catheter

External Ventricular Drainage (EVD)



- Monitoring in closed position- allows for ICP measurement
- EVD in an open position- allows for drainage of CSF; potential treatment to lower ICP
- Antimicrobial- impregnated catheters may be considered

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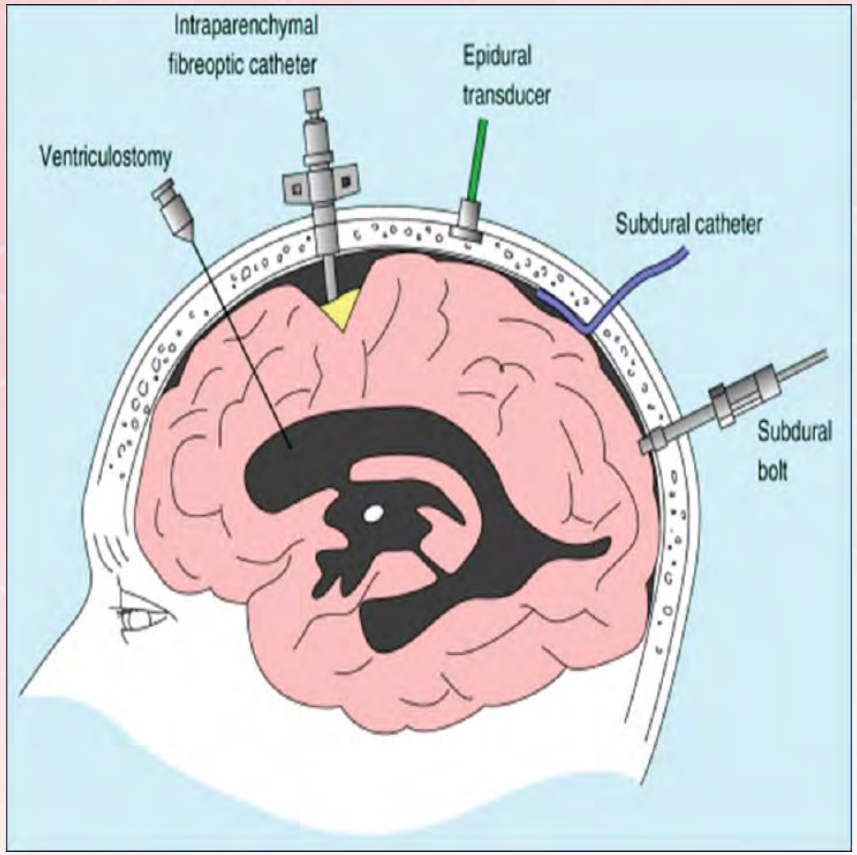
ICP Monitoring



(Ristic, Sutter, & Steiner, 2015)

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Advanced Monitoring

- PbtO2
- Licox Therapy
- Transcranial doppler (TCD)
- SjVo2
- $AVDO_2$

CAMINO® ICP Monitoring Catheter
with Integrated Bolt Fitting
Integralife.com

Cerebral Perfusion Pressure

$$CPP = MAP - ICP$$

Cerebral Perfusion Pressure (CPP) = Mean Arterial Pressure (MAP) – Intracranial Pressure (ICP)

Represents the pressure gradient driving cerebral blood flow and

hence oxygen and metabolite delivery

$$Goal = 60\text{-}70mmHg$$

(Prabhakar, Sandhu, Bhaqat, Durga, & Chawla, 2014)

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Surgical Intervention

- Burr Holes
- Craniotomy
- Decompressive Craniectomy

Medical Management

- Maintain normal ICP
- Maintain normal BP- Goal SBP:
  - >100mmHg for 50-69 years
  - >110 mmHg for 15-49 and >70 years
- Ventilation
  - Goal: PaCo2 35-45 mm Hg
  - Prophylactic hyperventilation of PaCo2 is not recommended
- Hyperosmolar therapy
  - Mannitol
  - Hypertonic Saline

(Carney et al., 2017)

Medical Management

Seizure Management

- Medications such as Phenytoin and Levetiracetam may be considered for *early* posttraumatic seizure prevention
- Barbiturate therapy may be considered if other treatments have failed

Medical Management

- Pain and Sedation Management
- Always assess for hypoxia/hemodynamic/ ICP changes prior to administration of all agents

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Medical Management

- Early Tube Feeds : Obtain basal caloric replacement by the 5th day
- Transgastric jejunal feeding is recommended to reduce the incidence of VAP
- VTE Prophylaxis
- Monitor Blood Glucose

Prophylactic Hypothermia

Brain Trauma Foundation Guidelines state:

- Insufficient evidence to support recommendation
- Early, short-term prophylactic hypothermia is **not** recommended to improve outcomes in patients with diffuse injury
- Hypothermia risks include coagulopathy, immunosuppression and cardiac dysrhythmias

(Carney et al., 2017)

Steroids

- Not recommended for reducing ICP
- High-dose methylprednisolone is associated with increased mortality and is contraindicated

Nursing Interventions

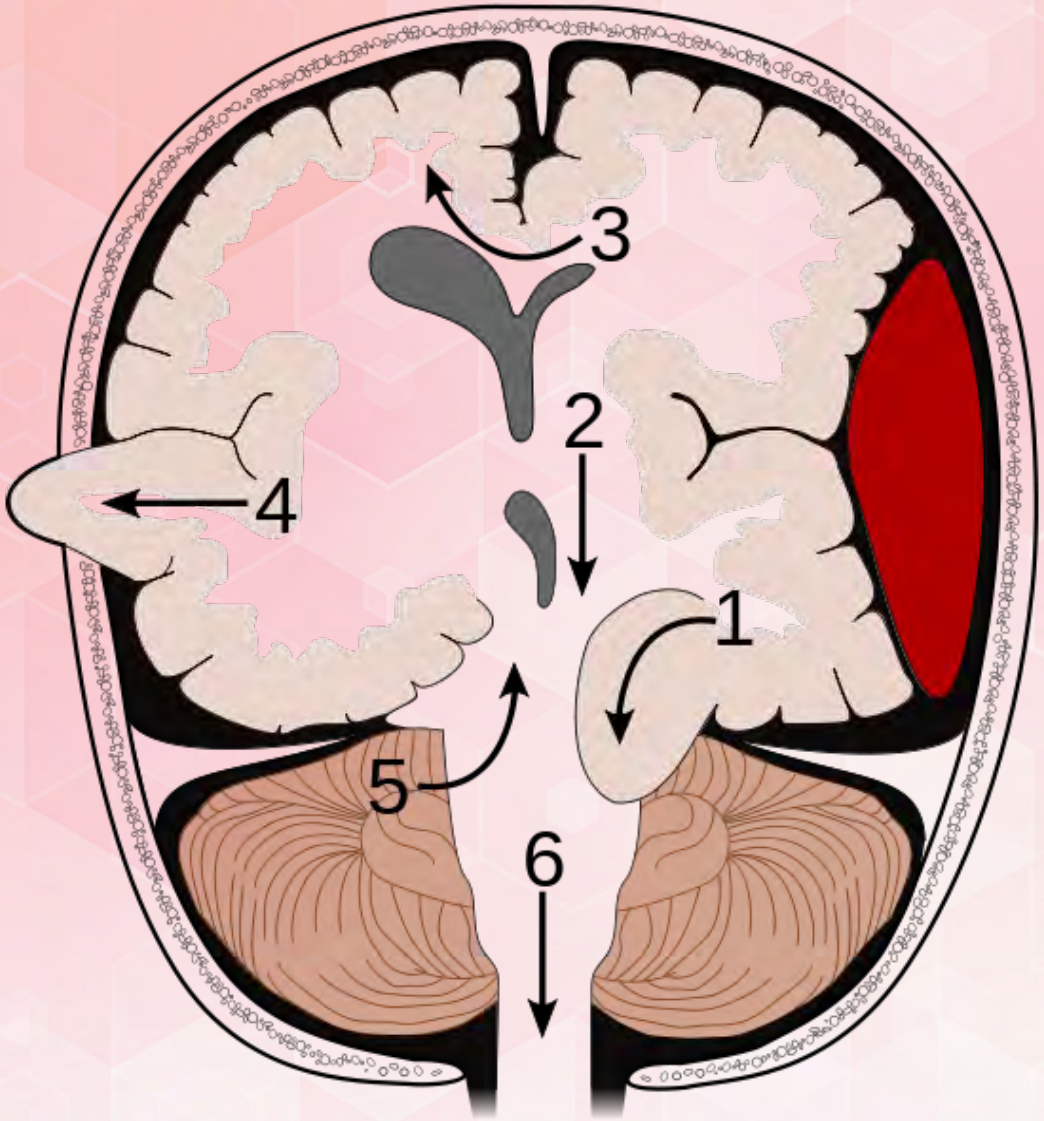
Patient Positioning

- Elevate head of bed
- Maintain neutral alignment of head and neck
- Avoid gatching at knees

Environmental Control

- Avoid overstimulation
- Bundle care to provide periods of rest
- Comfort measures

Herniation



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Supratentorial

1. Uncal
2. Central (transtentorial)
3. Cingulate
4. Transcalvarial

Infratentorial

5. Upward Cerebellar
6. Tonsillar

Brain Death

- Irreversible loss of all functions of the brain, including brainstem
- Legally and clinically dead
- Essential findings:
  - Coma
  - Lack of brainstem reflexes
  - Apnea

(Goila & Pawar, 2009)

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End of Life

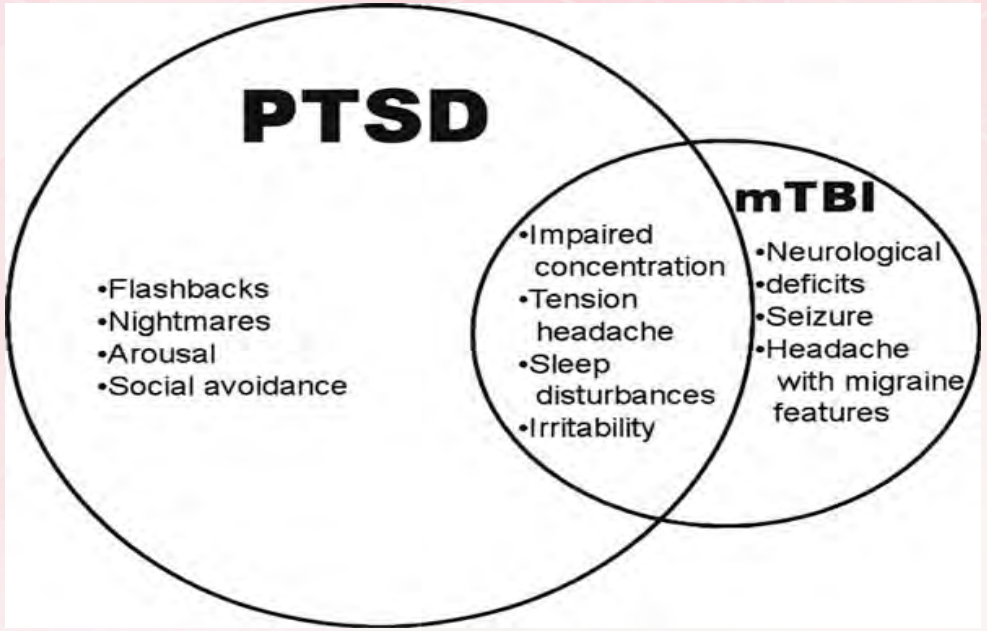
- Family support
- End of Life Decisions
  - Palliative Care
  - Organ Donation

Post-Acute Care

- Early discharge planning
- PT and OT Consults
- Speech Consultation
- Physical Medicine and Rehabilitation consults
- Inpatient / outpatient rehabilitation

Risks for Post-Acute Complications

- Depression
- Dementia
- Alcoholism / Drug Abuse
- PTSD



Studyblue.com

Summary

- TBI is a major healthcare problem
- The initial management of the TBI patient is critical to mitigation of secondary injury and complications
- Nursing interventions are valuable in management and outcomes of TBI patients.
- Prevention and rehabilitation for post-injury sequelae requires further attention and research.

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Maxillofacial and Ocular Injuries

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Objectives

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

- Identify the key anatomical structures of the face and eye and the impact of force on those structures
- Discuss assessment priorities for a patient with maxillofacial and ocular injuries
- Prioritize the care of a patient with facial and ocular injuries
- Discuss psychosocial support for a patient with maxillofacial and ocular injuries

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Mechanism of Injury

- Low velocity
- High velocity

Pathophysiology

- Bones of face make up the most complex skeletal area of the body
- Maxillofacial fractures result from either blunt or penetrating trauma

Pathophysiology

- ‘G’ force is a measure of acceleration not produced by gravity
- **High Impact:**
  - Supraorbital rim – 200 G
  - Symphysis Mandible –100 G
  - Frontal – 100 G
  - Angle mandible – 70 G
- **Low Impact:**
  - Zygoma – 50 G
  - Nasal bone – 30 G

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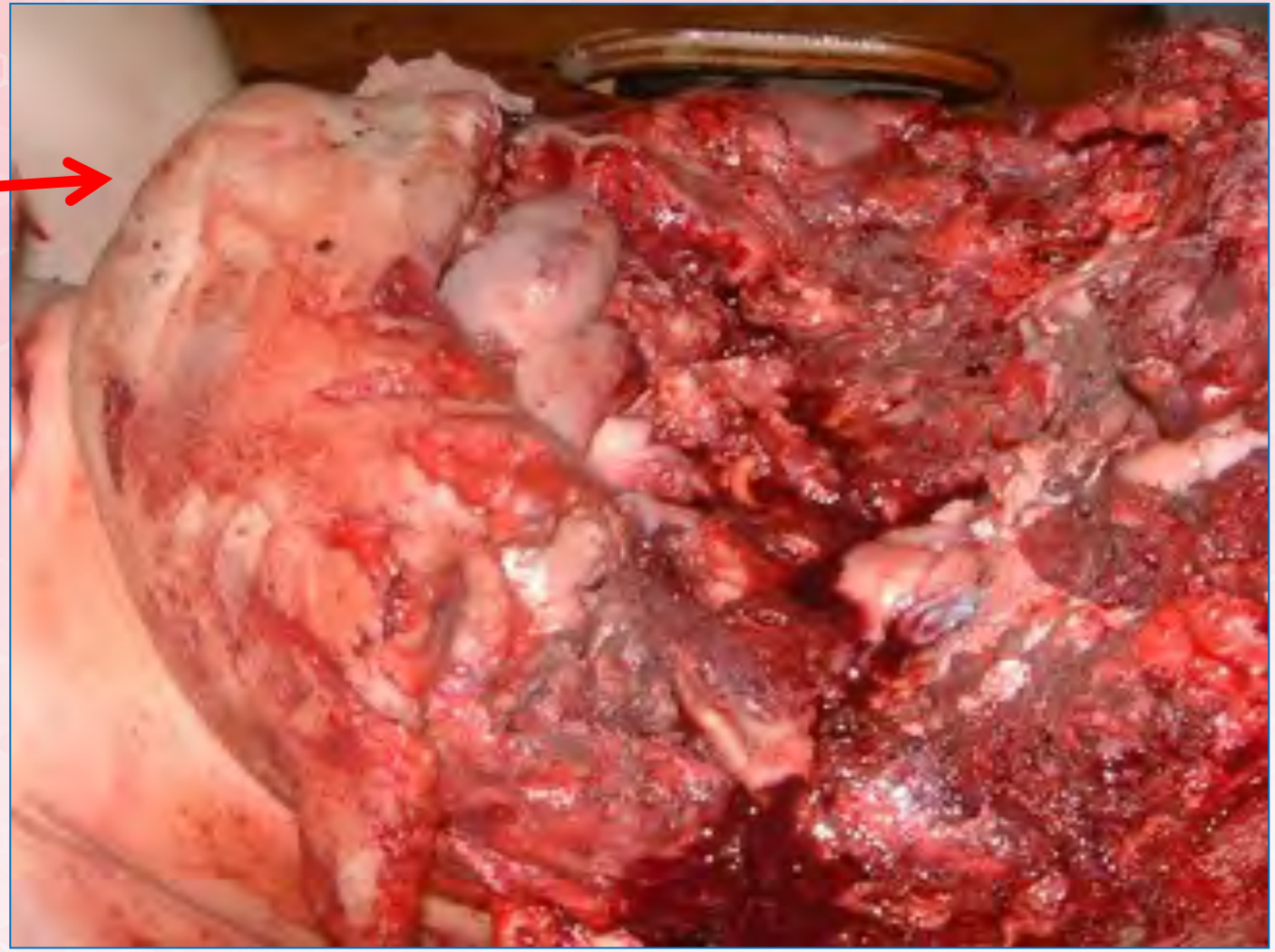

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Etiology

- 60% of patients with severe facial trauma have multisystem trauma and the potential for airway compromise

Etiology

- Approximately one quarter of women with facial trauma are victims of domestic violence
  - Index of suspicion increases if an orbital wall fx is present
- Approximately one quarter of patients with severe facial trauma will develop Post Traumatic Stress Disorder

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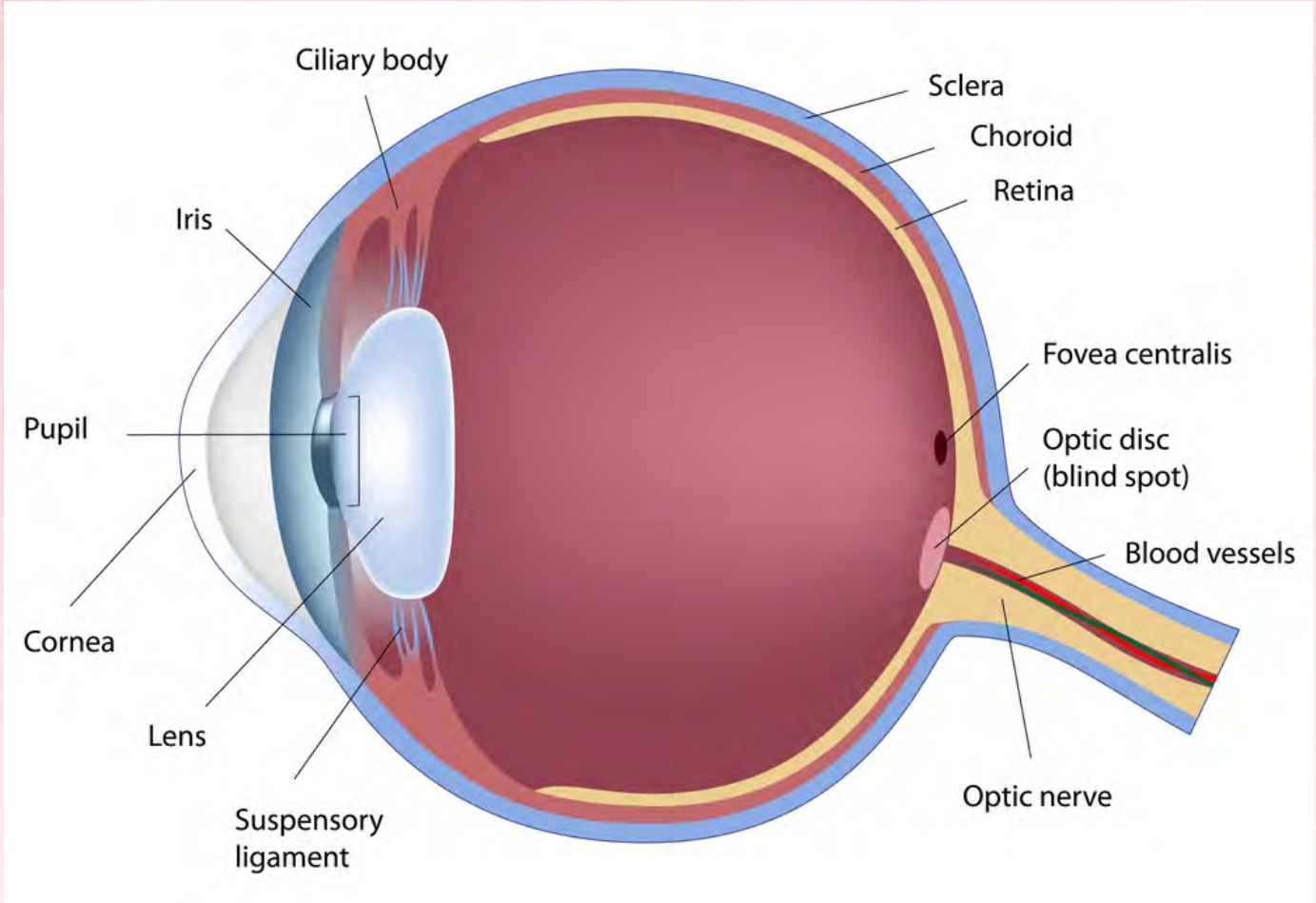
Ocular Structures

Human Eye Anatomy



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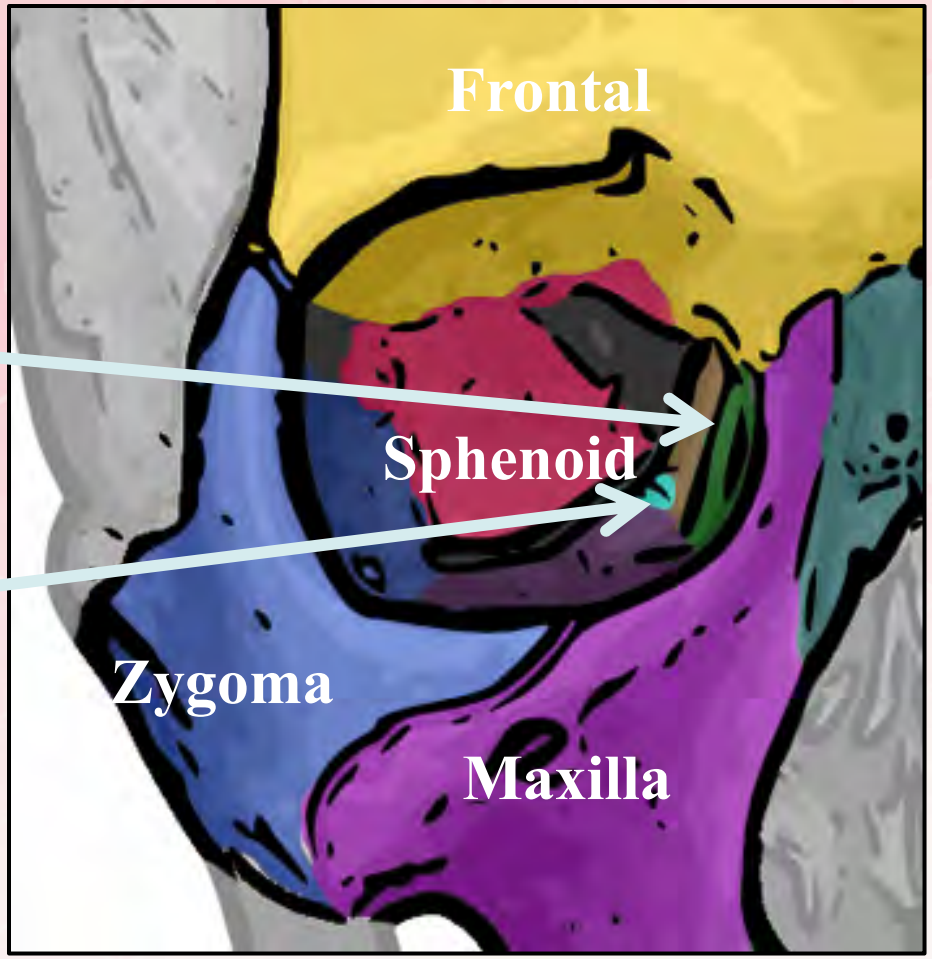
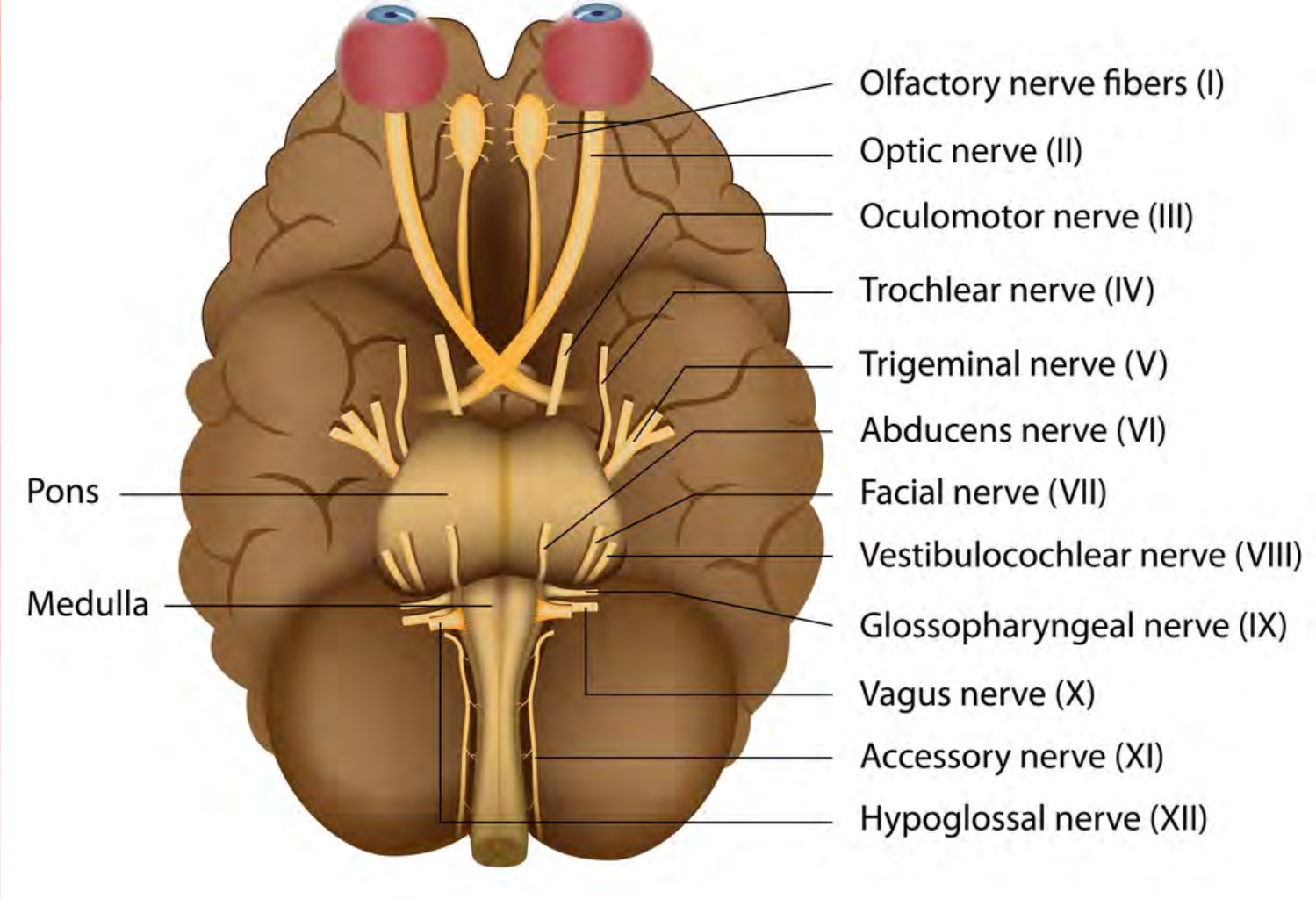
Bony Orbit

- Roof
  - Frontal bone
  - Sphenoid
- Medial wall
  - Maxilla,
  - lacrimal, ethmoid
  - body of sphenoid
- Floor
  - Maxilla
  - Palatine
  - Zygoma
- Lateral
  - Zygoma and greater sphenoid



Cranial Nerves



Orbital Fractures

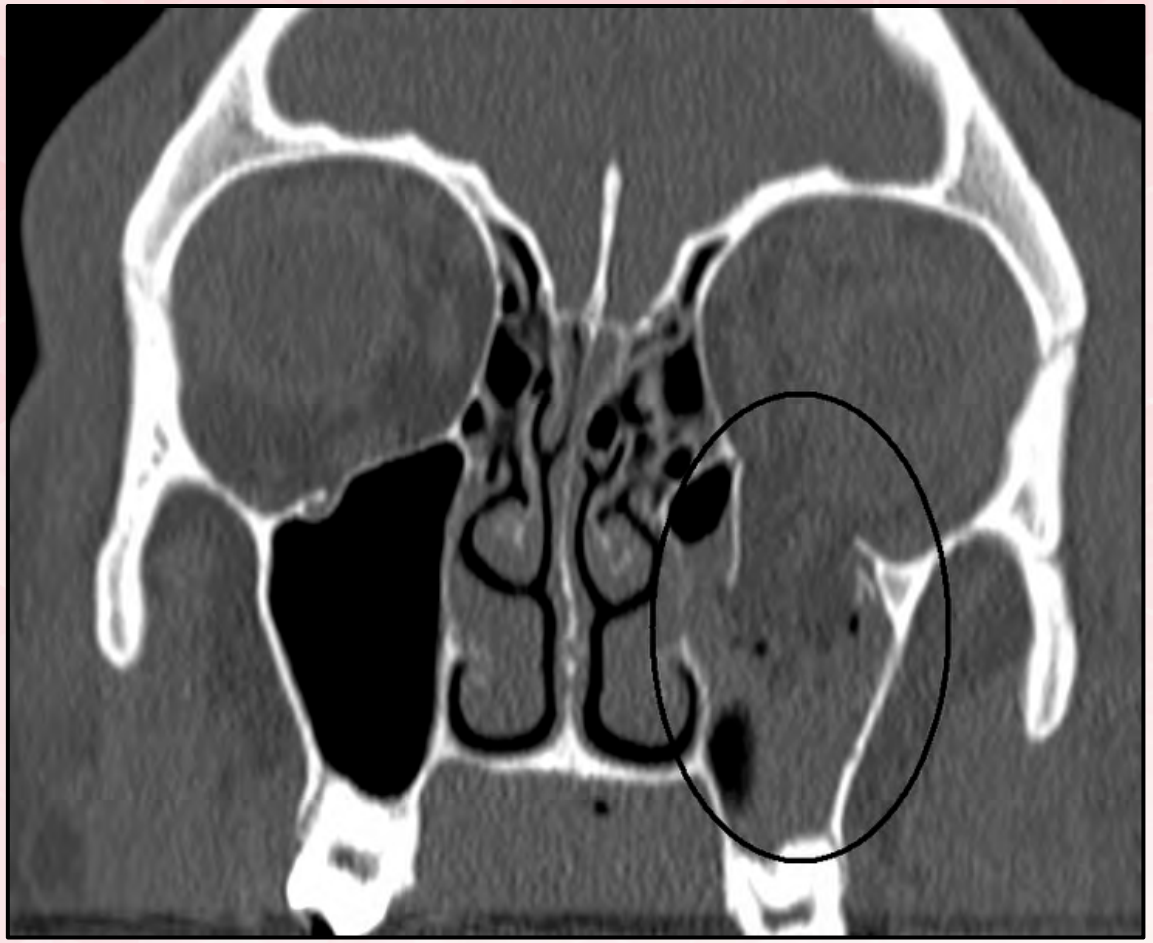


Image: Wikimedia.com

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Orbital Fractures

- Orbital Fractures
  - Usually through floor or medial wall
  - Enophthalmos
  - Anesthesia
  - Diplopia
  - Infraorbital stepoff deformity
  - Subcutaneous emphysema

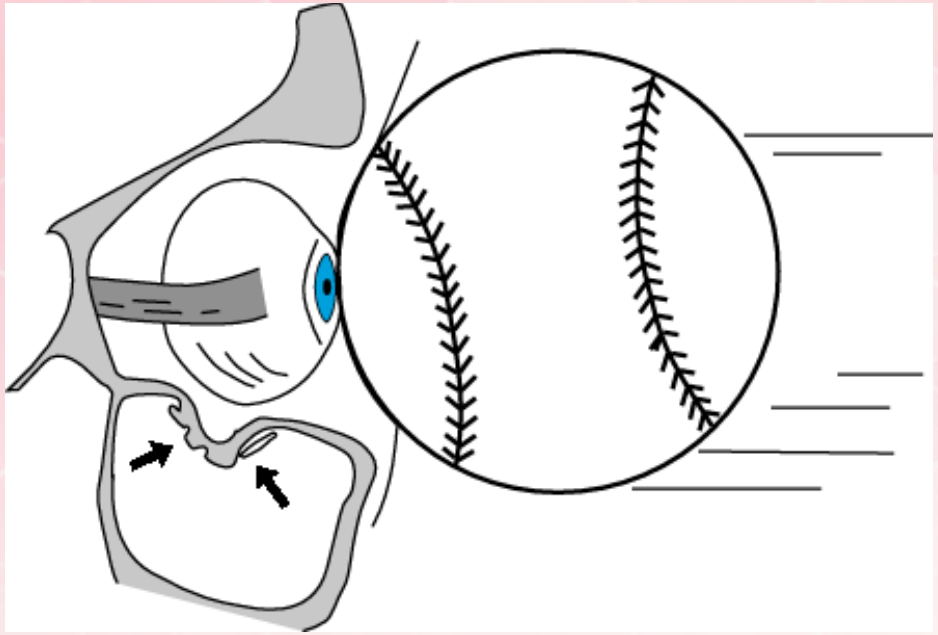


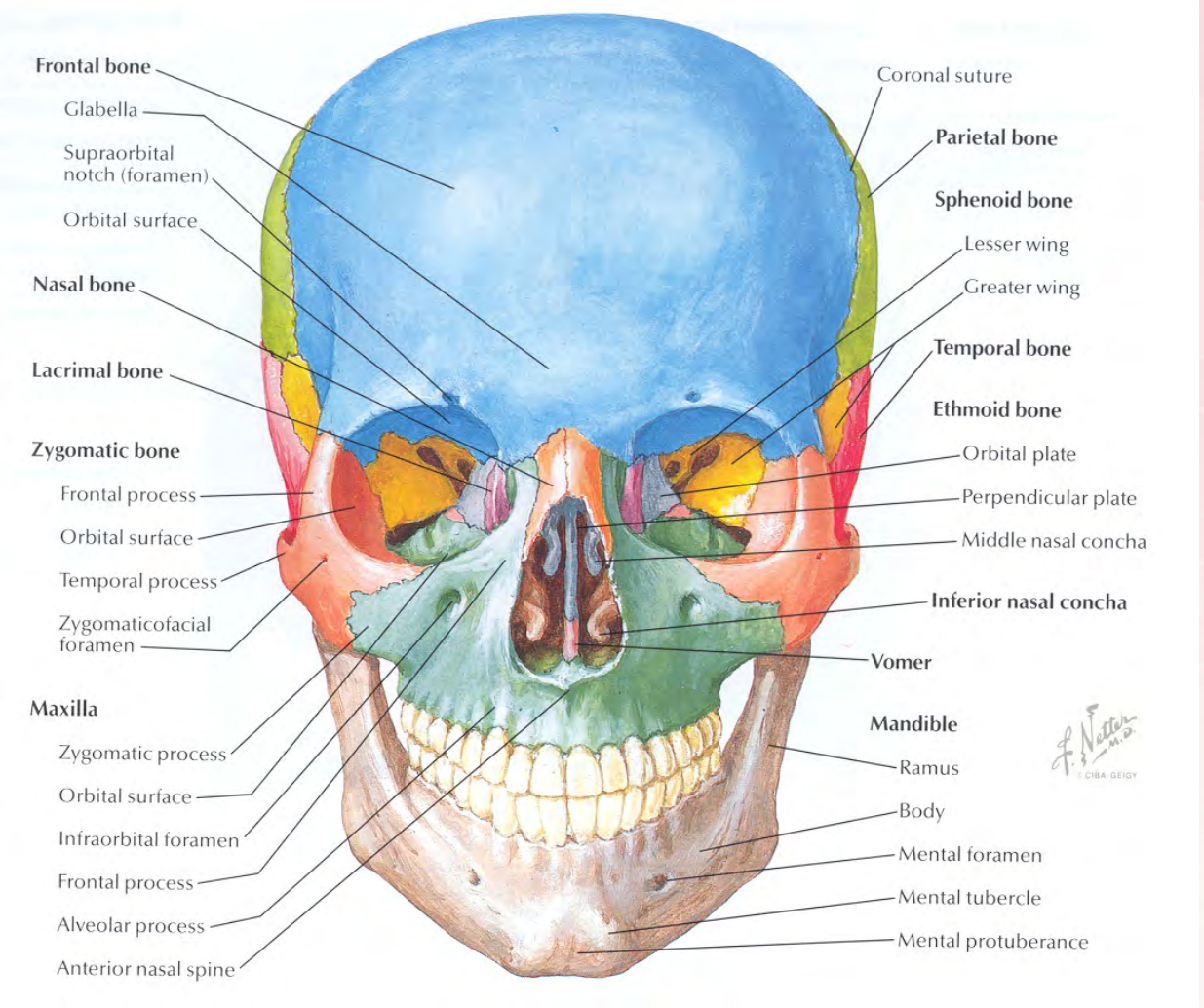
Image: Rad.washington.edu

Orbital Fractures

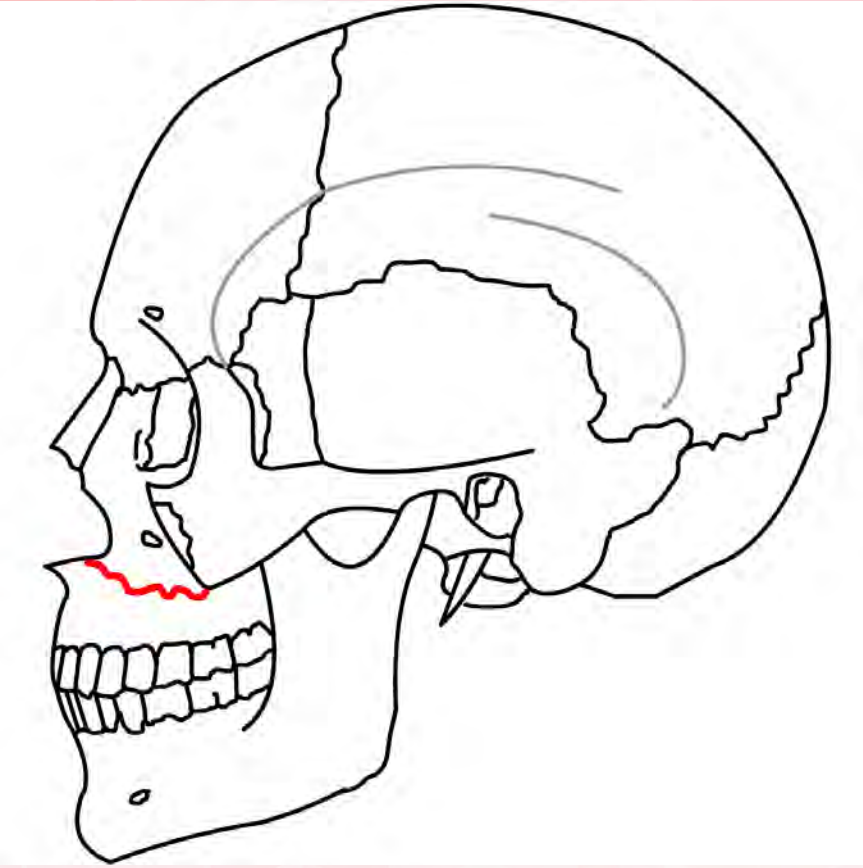
- Symptoms
  - Periorbital swelling
  - Crepitus
  - Proptosis
  - Ophthalmoplegia
  - Enophthalmos
  - Palpable defects
- Assess for globe injury
- Avoid nose blowing
- Assess for entrapment


FLT:e3
L R
1 1
1 0
1 2
FLT:e3
L
1
1
1
kV 140
mA 350
Head

Facial Structures



LeFort I Fracture



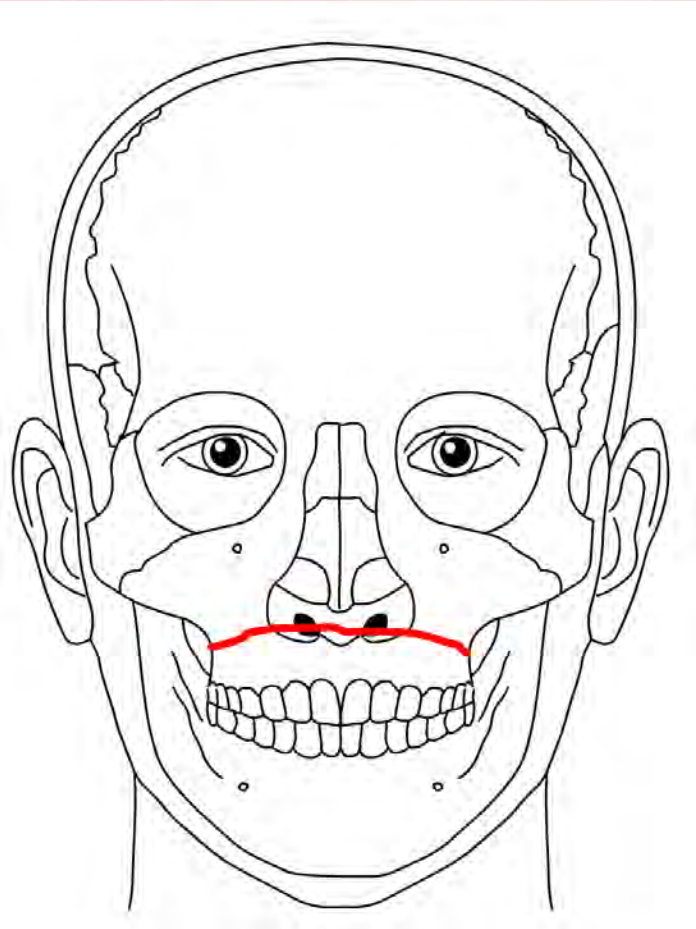
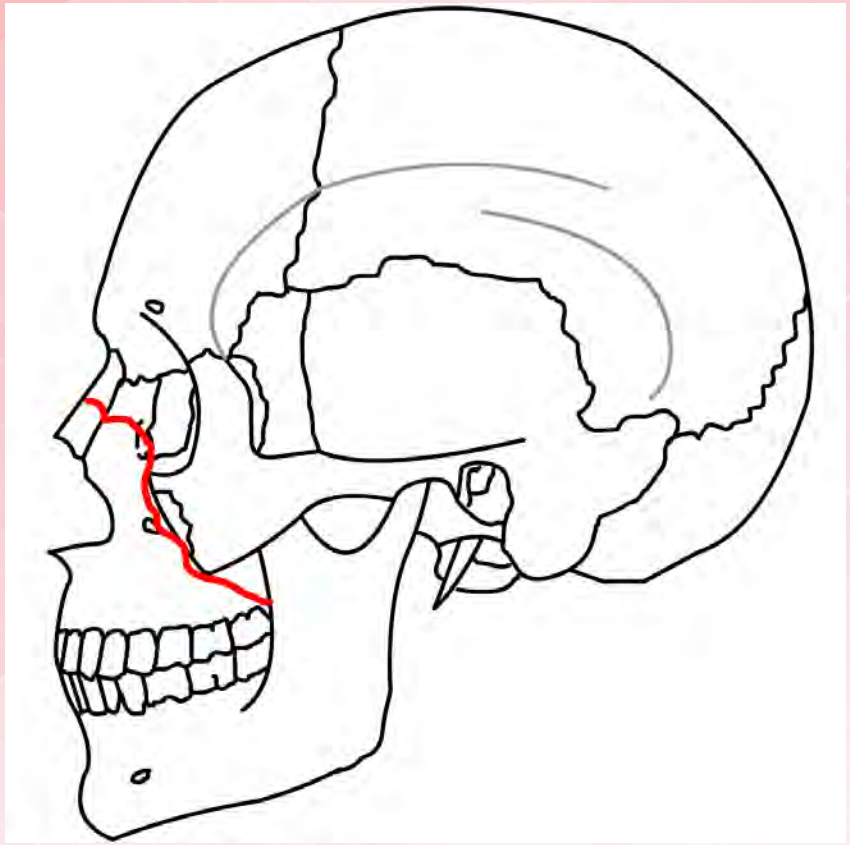


Image: Wikimedia.com

LeFort II Fracture



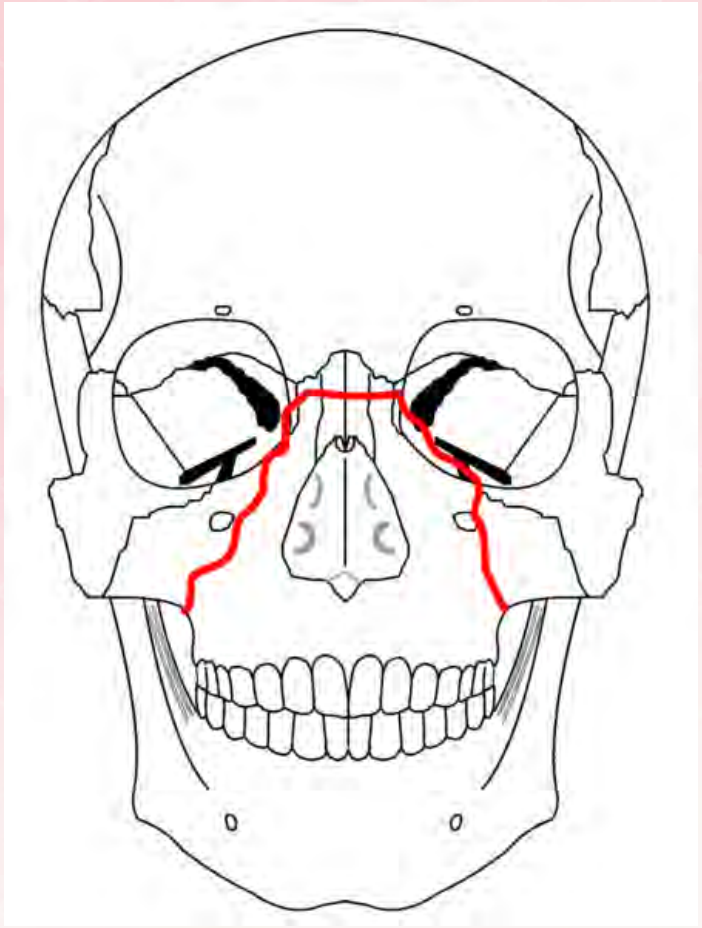


Image: Wikimedia.com

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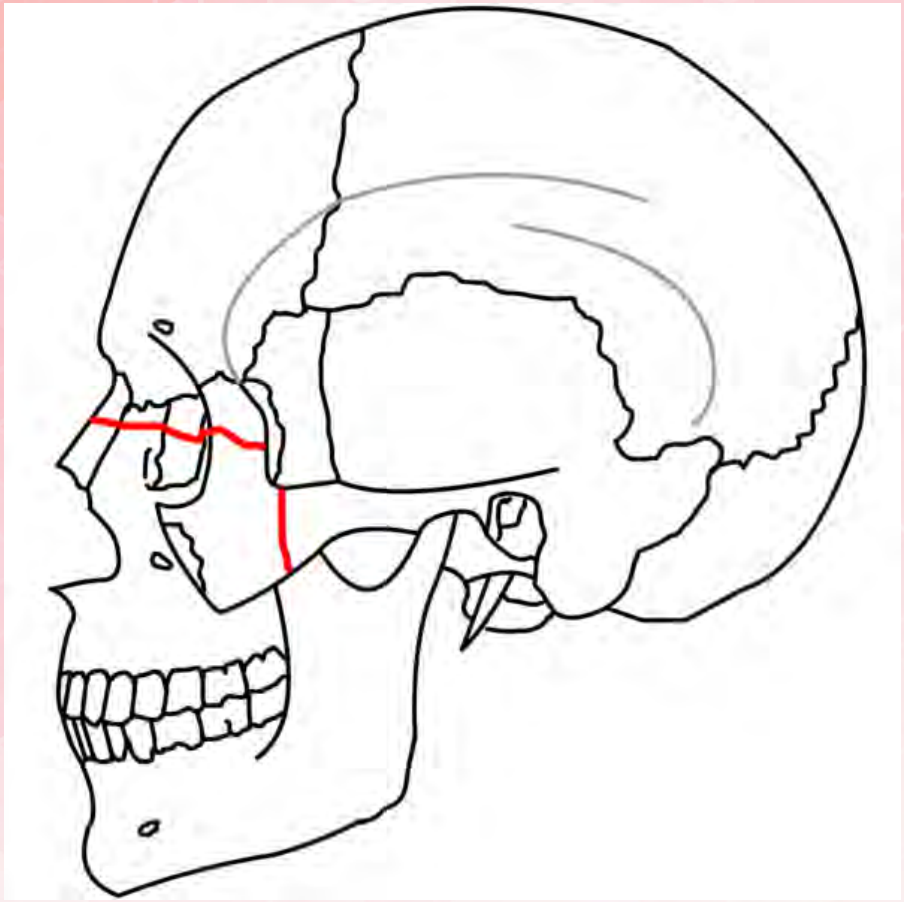
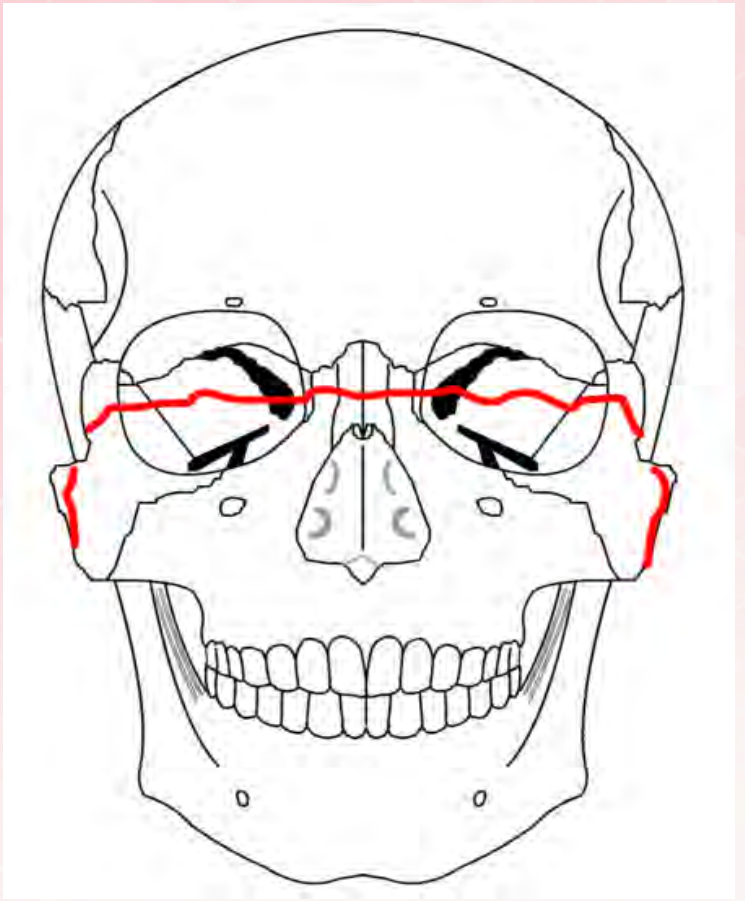
LeFort III Fracture





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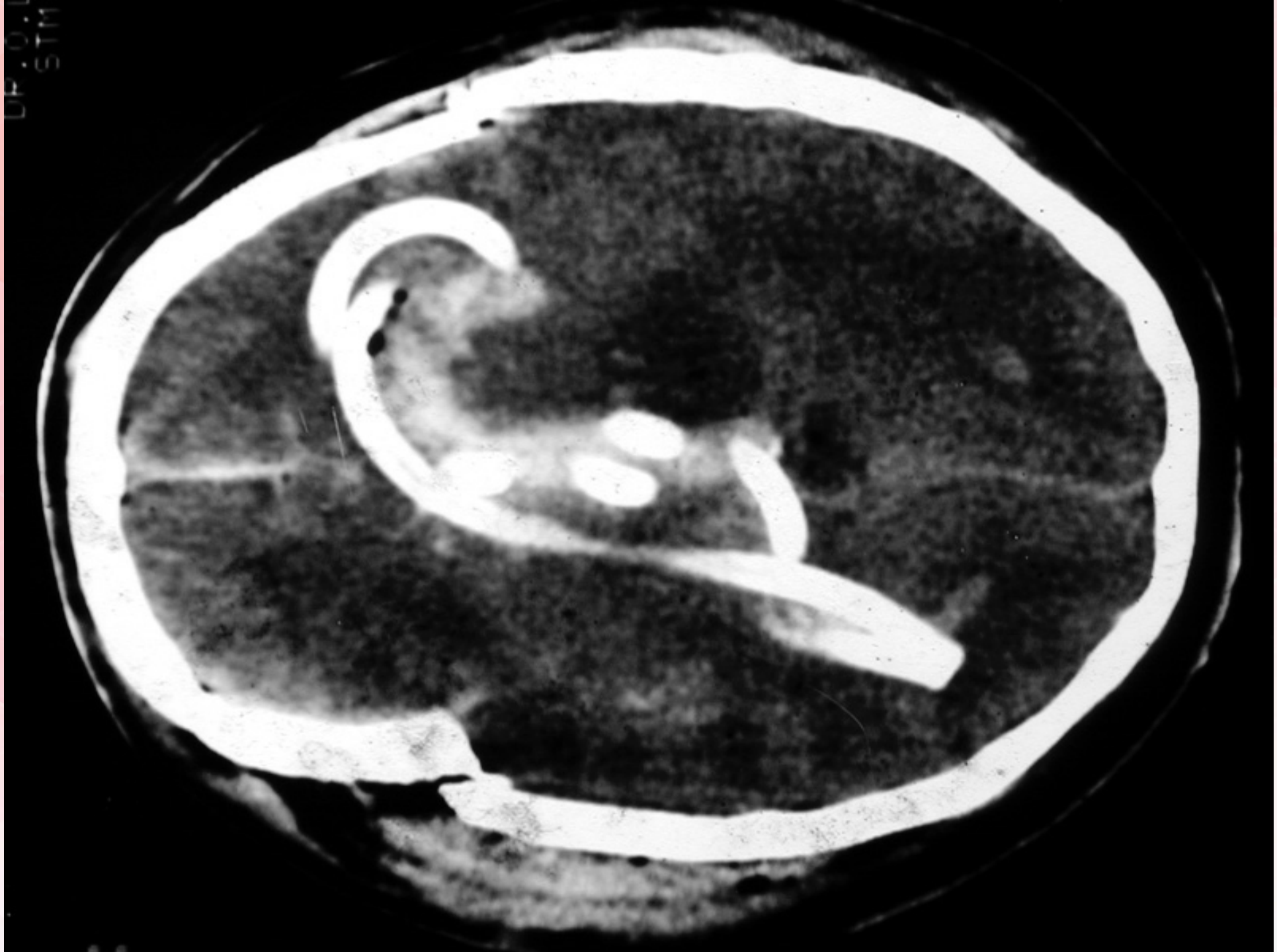
Le Fort Fractures

Le Fort III Fracture

- Periorbital hematoma
- Racoon eyes suggestive of basal skull fracture.
- Inappropriate placement of nasogastric tube



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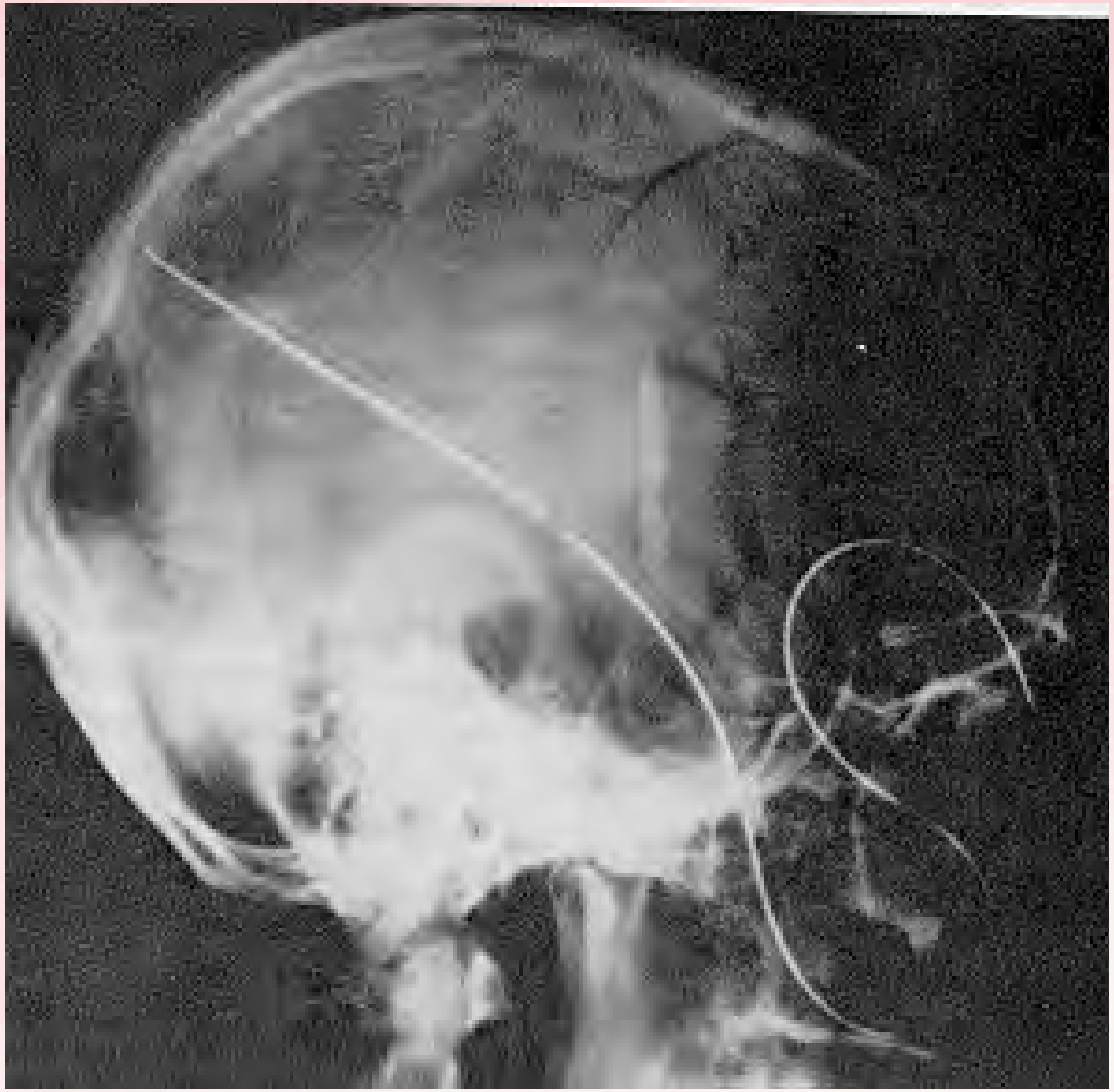

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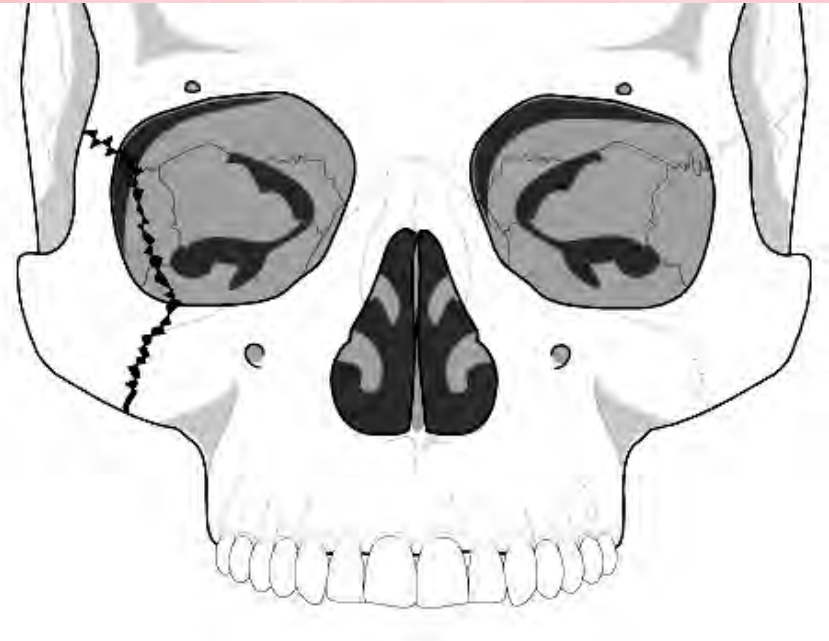
Tripod Fracture



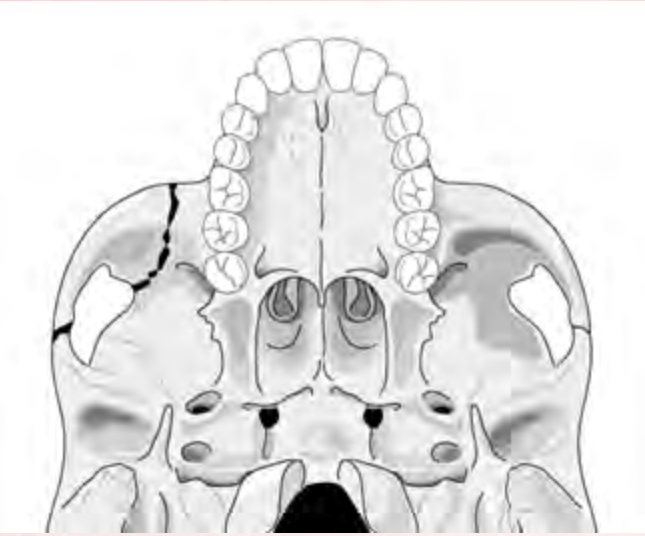


Image Rad.washington.edu

Orbitozygomatic Fractures

- Complex fractures of the zygoma and orbital floor
- May have double vision, ocular proptosis or enophthalmos
- Must assess for entrapment of extraocular muscles
- Surgical management directed at decompression of entrapped muscles and anatomic realignment of zygoma

Naso-Ethmoidal-Orbital Fracture

- Fractures that extend into the nose through the ethmoid bones.
- Associated with lacrimal disruption and dural tears.
- Suspect if there is trauma to the nose or medial orbit.
- Patients complain of pain on eye movement.

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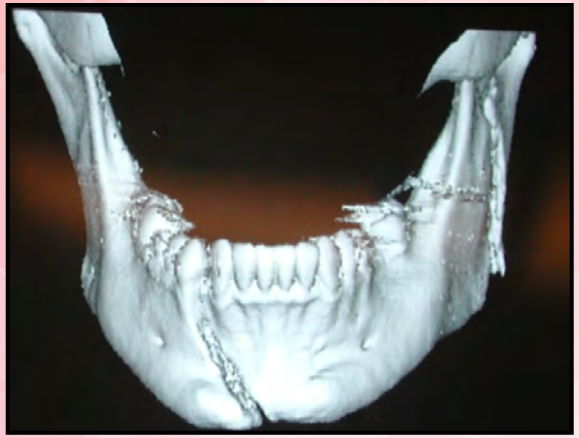
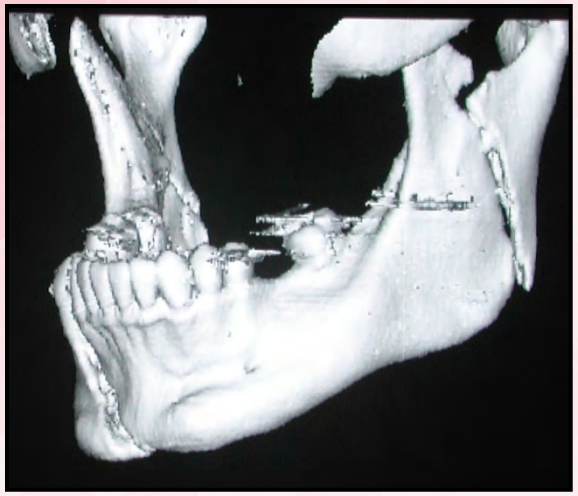
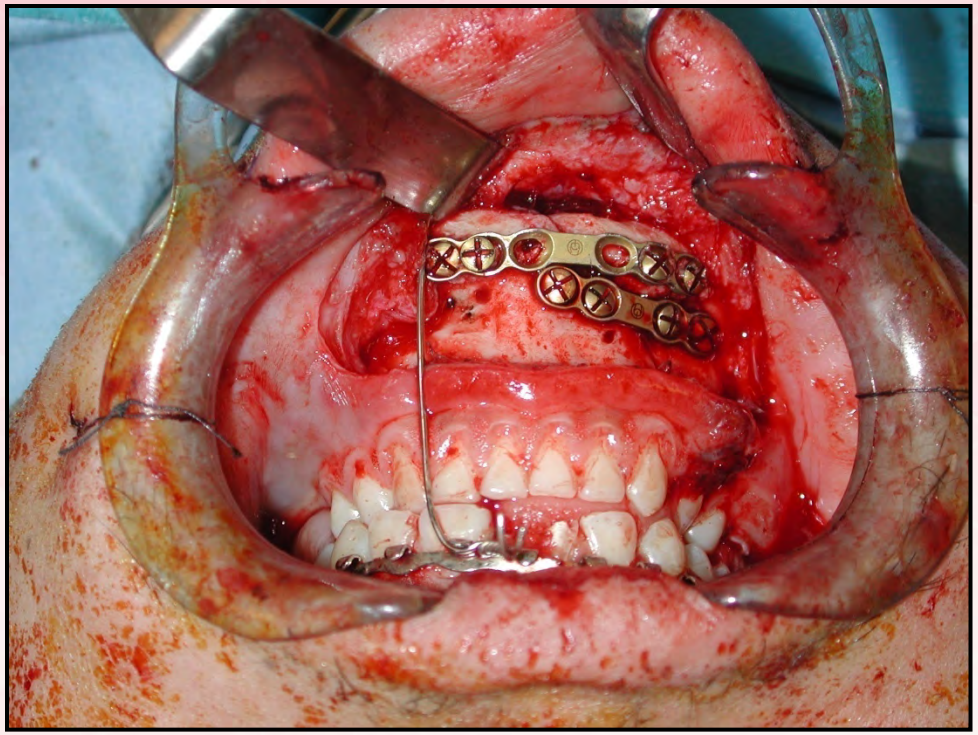
Mandibular Fractures







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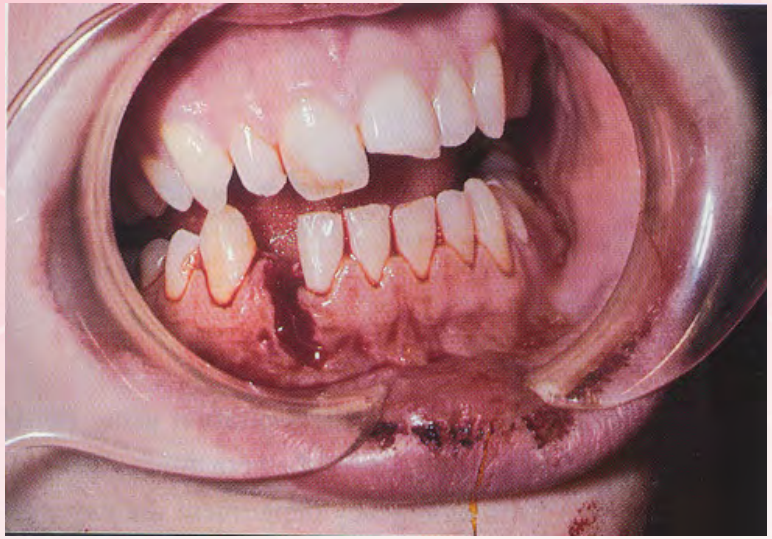
Mandible Fractures

- Pain
- Malocclusion
- Separation
- Inability to open mouth
- Tongue blade test



(Shaffer, Brismée, Sizer, & Courtney, 2014)

Mandibular Fracture

- Direct frontal trauma with jaw fracture

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Mandibular Fractures Treatment

- Insufficient evidence to support single approach in mandibular fracture management
- Non-displaced fractures can sometimes be treated conservatively
- Displaced fractures, open fractures and fractures with associated dental trauma
  - Urgent oral surgery consultation

(Nasser et al, 2013; Pickrell, Serebrakian, & Maricevich, 2017)

Maxillofacial Injuries General Assessment

- ABC's
- Assess for symmetry of facial structures
  - Assess for paresthesias
  - Assess symmetry of facial movements
- Assess the ears, nose and oral cavity for occult lacerations, hematomas
- Palpate for crepitus, tenderness or deformity
- Assess sense of smell

Ocular Assessment

- Visual acuity
- Pupil assessment
- Extraocular movements
- Eye position and movement
- Intraocular pressure

Physical Examination

- Inspect open wounds for foreign bodies
- Palpate the entire face
  - Supraorbital and Infraorbital rim
  - Zygomatic-frontal suture
  - Zygomatic arches

Physical Examination

- Inspect the nose for asymmetry, telecanthus, widening of the nasal bridge
- Inspect nasal septum for septal hematoma, CSF or blood
- Palpate nose for crepitus, deformity and subcutaneous air
- Palpate the zygoma along its arch and its articulations with the maxilla, frontal and temporal bone

Physical Examination

- Inspect the teeth
- Intraoral examination:
  - Check for lacerations
  - Stress the mandible
  - Tongue blade test
- Palpate the mandible for tenderness, swelling and step-off.

Physical Examination

- Check visual acuity
- Check pupils for roundness and reactivity
- Examine the eyelids for lacerations
- Test extra ocular muscles
- Palpate around the entire orbits

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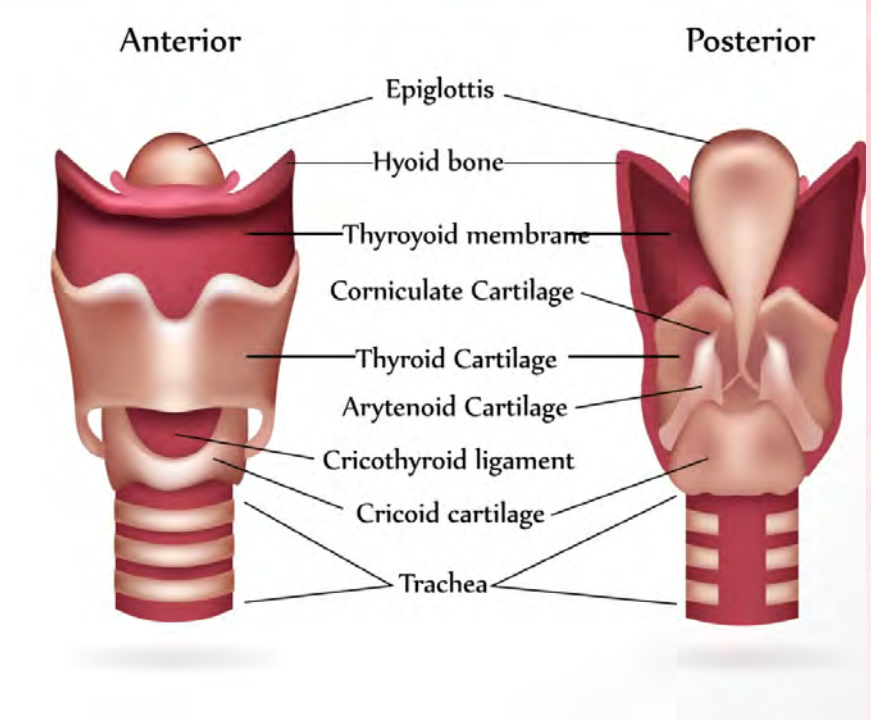
Physical Examination

- Examine the cornea for abrasions and lacerations
- Examine the anterior chamber for blood or hyphema

Airway Management



- Protect and maintain airway
  - Pull tongue forward with padded forceps or sutures
  - Endotracheal intubation
  - Anticipate need for cricothyroidotomy
- Prevent aspiration
- Ensure adequate oxygenation and ventilation

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Airway Management

Protection of airway

Keep HOB elevated

Aggressive pulmonary toilet

Frequent suctioning

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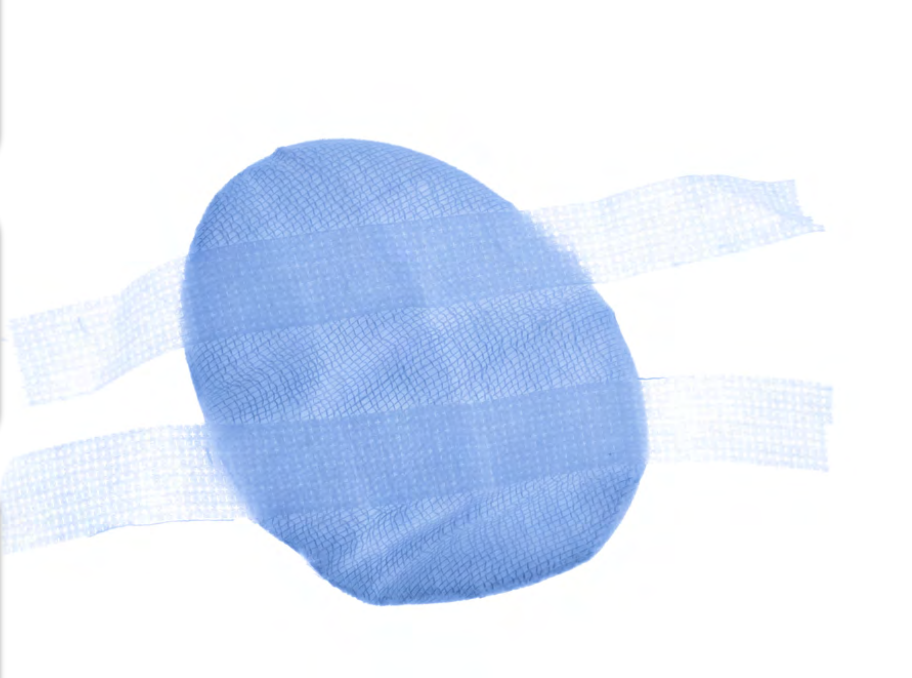
Management

- Control hemorrhage
  - Direct pressure
  - Nasal and oral packing
  - Reduce fractures
- Restore intravascular volume
- Anticipate intracranial injury and need for intervention
  - Serial neurologic exams

Management

- Protect eyes from further injury
- Pain management
- Early Rehab Consult



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Management

- Nutrition management
  - Early initiation of enteral feeding
  - Keep HOB elevated
  - Evaluate for swallowing dysfunction prior to oral feeding
  - Wire cutters at bedside at all times

Management

- Prevention of infection
  - Perioperative antibiotics
  - Frequent oral lavage
  - Minimize nasal packing and tubes
  - Decongestants
  - Avoid blowing nose
  - Avoid foreign bodies or instrumentation in nares or ear canal

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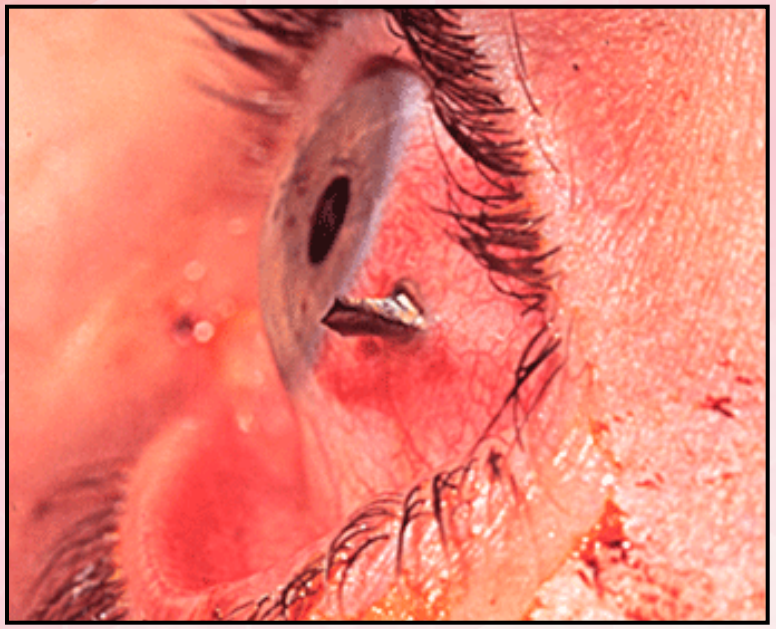
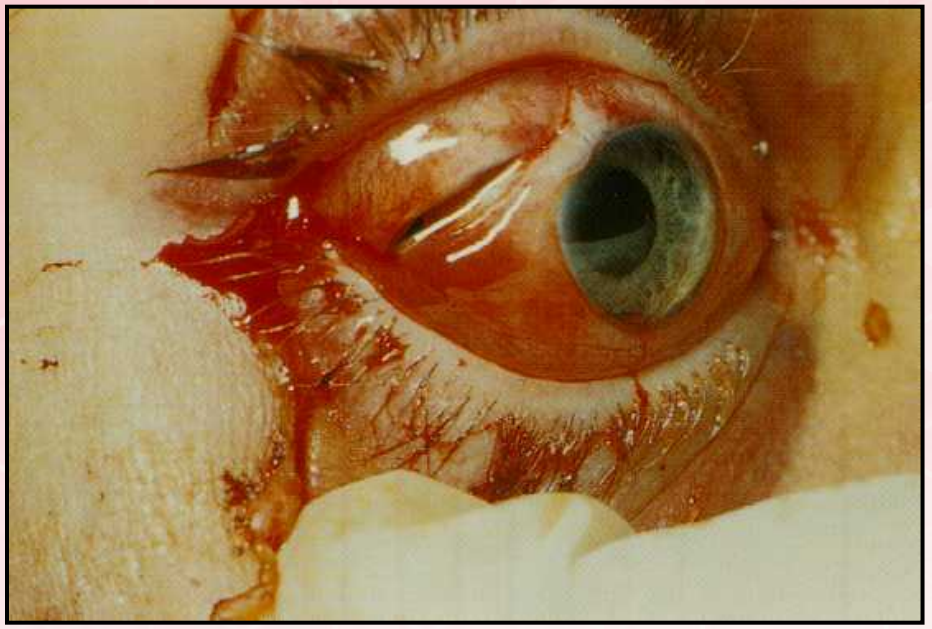
Direct Eye Trauma





Blast Injury: Thermal Injury

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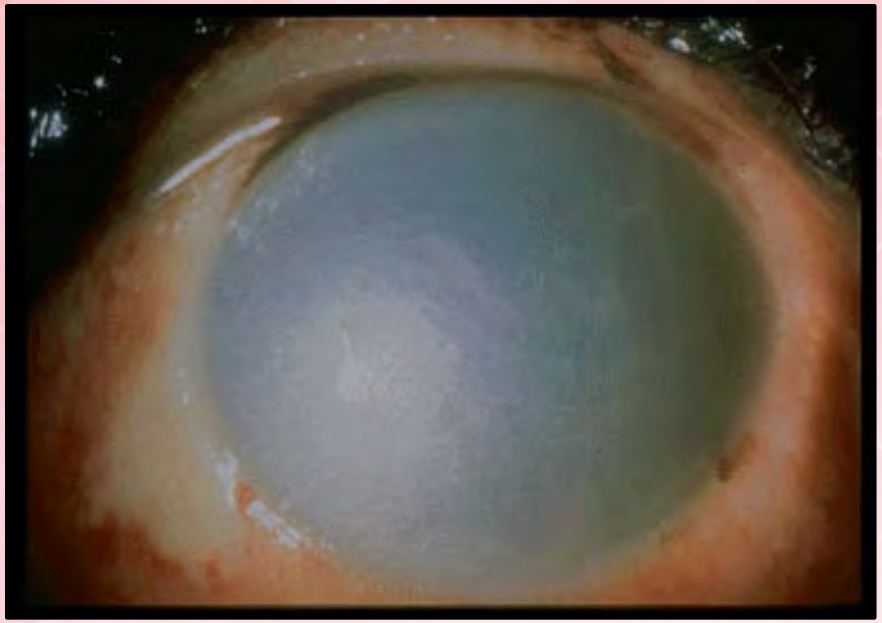
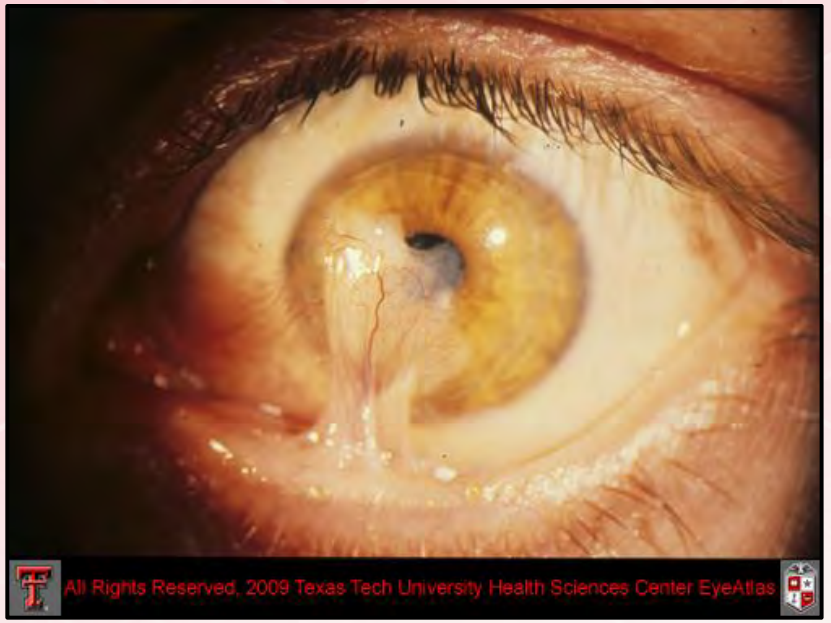
Thermal Injury

- Eye is usually spared
- Corneal exposure may occur as burn heals and skin contracts

Corneal Abrasion

Chemical Burns





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Traumatic Hyphema

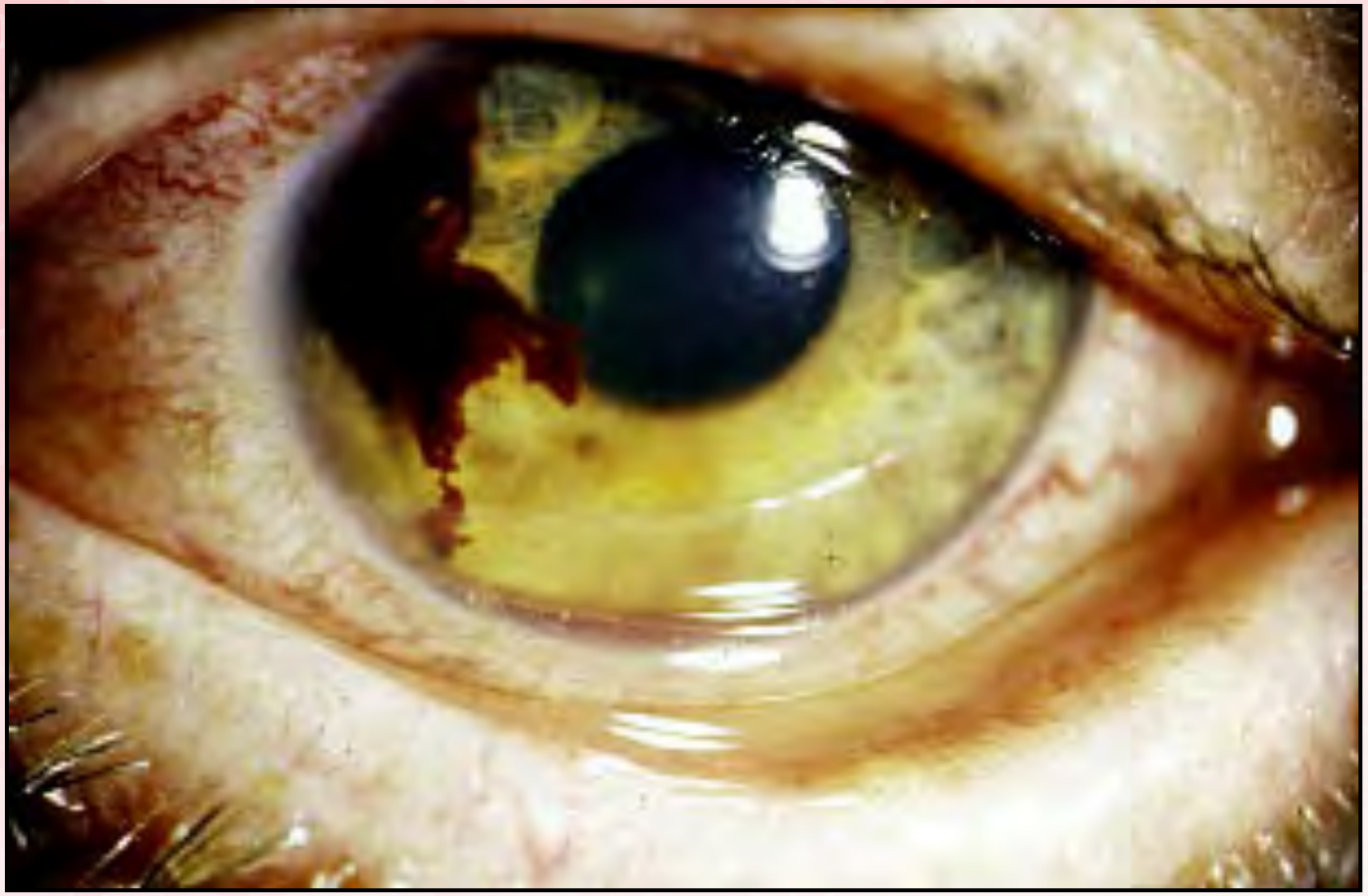

Image courtesy of EyeMac **Development**

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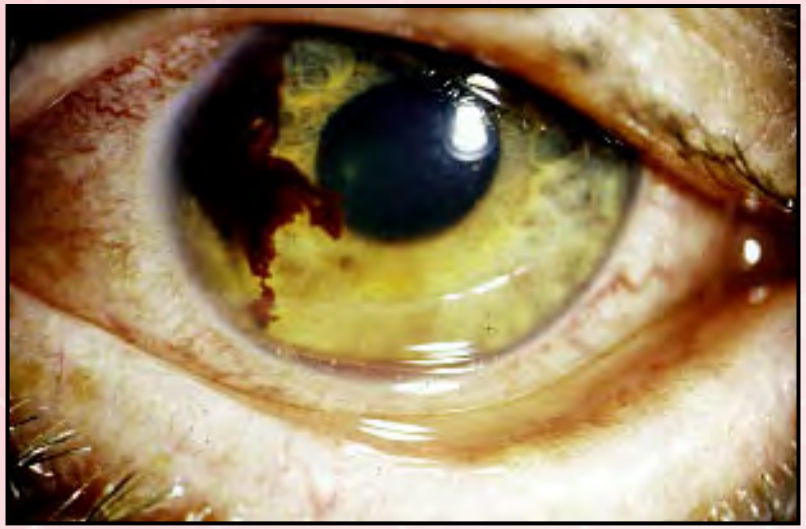
Traumatic Hyphema

- Limit activity
- Keep HOB elevated
- Protect the eye
- Cycloplegic agents
- Monitor for re-bleeding
- Avoid NSAIDS and anticoagulants
- Aminocaproic acid



(Gharaibeh et al, 2013)

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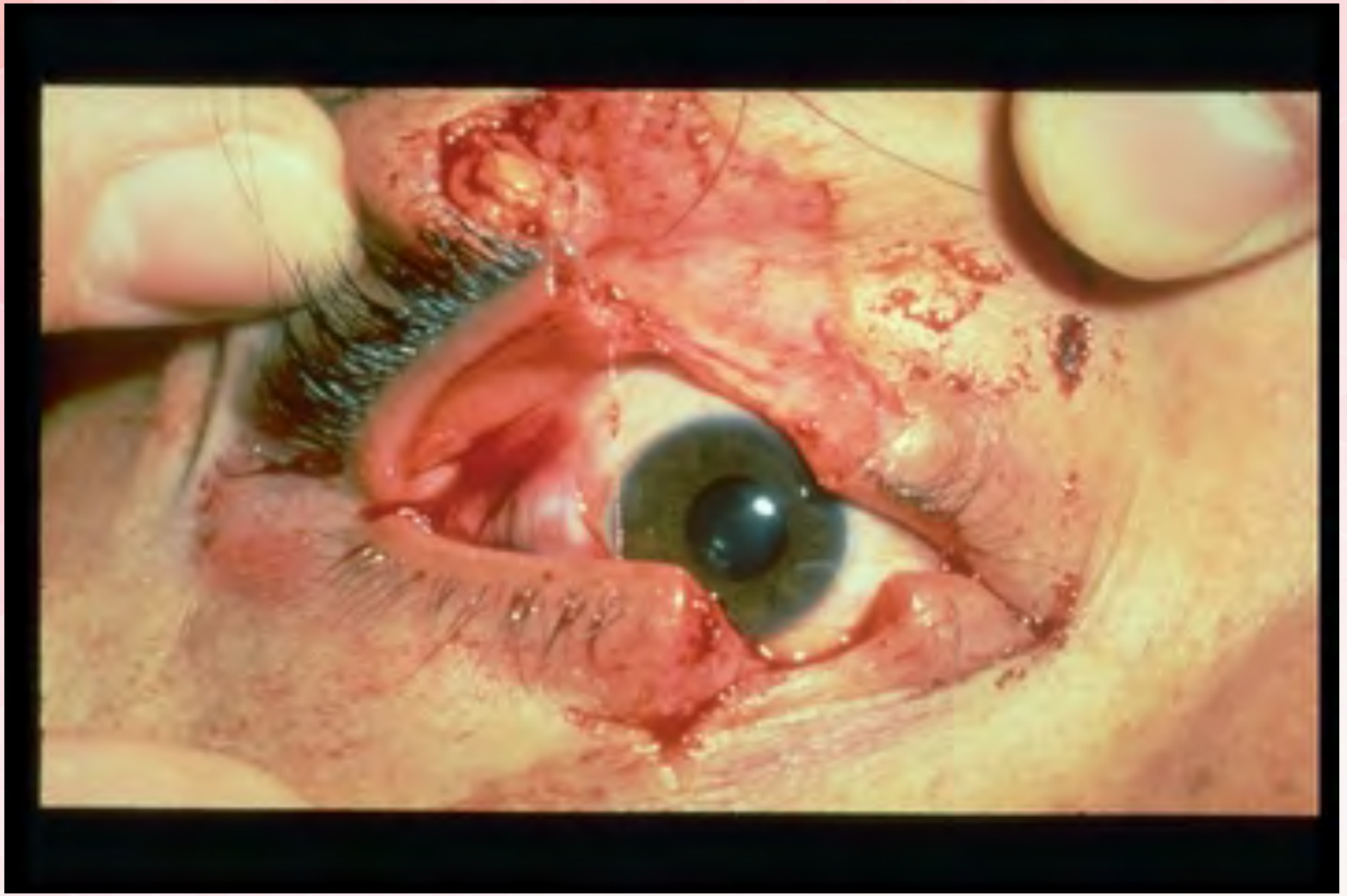
Lid Lacerations



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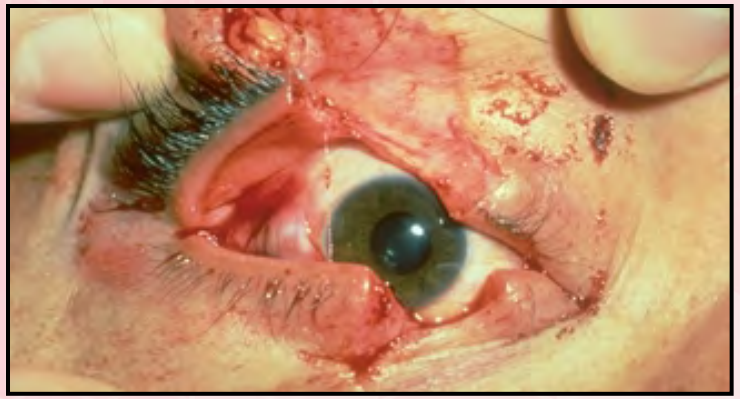
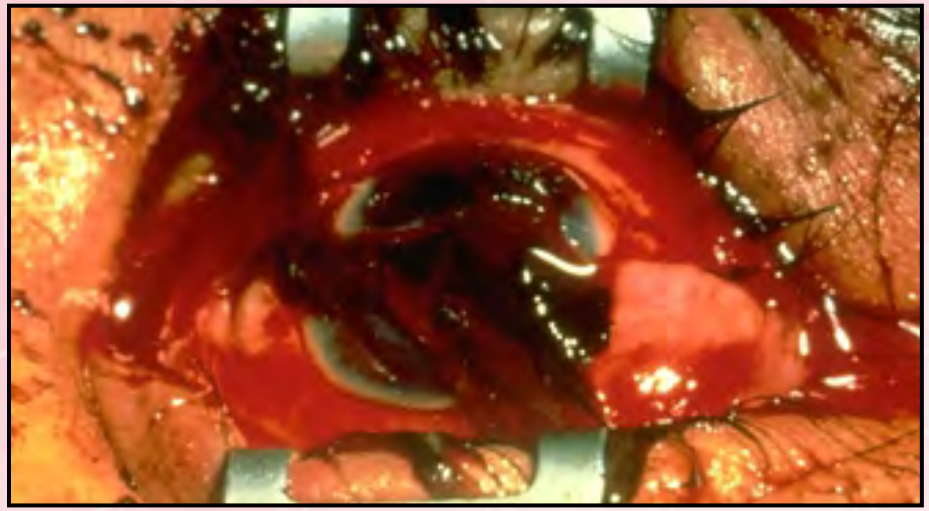
Lid Laceration

- REFER for
  - Depth
  - Extensive tissue loss
- REFER for location
  - medial
  - margin



Open Globe

- Globe laceration
- Tetanus
- Antibiotics
- REFER
  - 24 hours
  - no altitude restrictions



Open Globe

- Minimize additional damage
  - Make sure a shield is used
  - Do not use a patch which applies pressure
  - Avoid bearing down
  - Be prepared for patient to go to the OR
  - NPO

Complications

Sympathetic Ophthalmia

- Inflammatory condition
- Common after penetrating injury or ruptured globe
- Occurs 5 days to many years after injury
- Results in loss of vision of uninjured eye
- Prevented by early enucleation of injured eye

Psychosocial Support

- Provide communication aids
- Frequent positive reinforcement
- Early referrals to psychiatric liaisons or counselors
- Early referrals to community agencies for the blind
- Referrals for home safety evaluations
- Referrals to local and state agencies for financial assistance

Patient and Family Education

- Reinforce surgical plan of care
- Medications
- Nutrition management
- Wound care
- Tracheostomy care
- Avoid direct sunlight for 6-12 months
- Use of cosmetics

Summary

- Facial and ocular trauma requires a comprehensive multidisciplinary team to maximize outcomes
- Early incorporation of rehabilitation services is necessary for functional recovery
- Overall prognosis of reconstruction may take months or years

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TRAUMA LECTURES

STN

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Spinal Column and Spinal Cord Injuries

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Objectives

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

- Identify the components of the spine
- Assess for spine and spinal cord injury
- Discuss the initial management of the spinal cord injured patient
- Evaluate the long term needs of the spinal cord injured patient
- Describe effects of spinal cord injury on the rest of the body

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Epidemiology

- Approx 17,500 new cases per year
- Average age at injury is 42 years
- 81% male
- Increased incidence among African Americans (21.7%) and Asians (2.1%) since 2010
- Most common causes – Motor Vehicle Crashes (38.4%), Falls (30.5%) and Violence (13.5%)
- Bimodal distribution of occurrence
  - Adolescence/>65 years

(National Spinal Cord Injury Statistical Center, 2016)

Anatomy and Physiology

- Vertebrae
- Discs
- Ligaments
- Spinal cord
- Vessels

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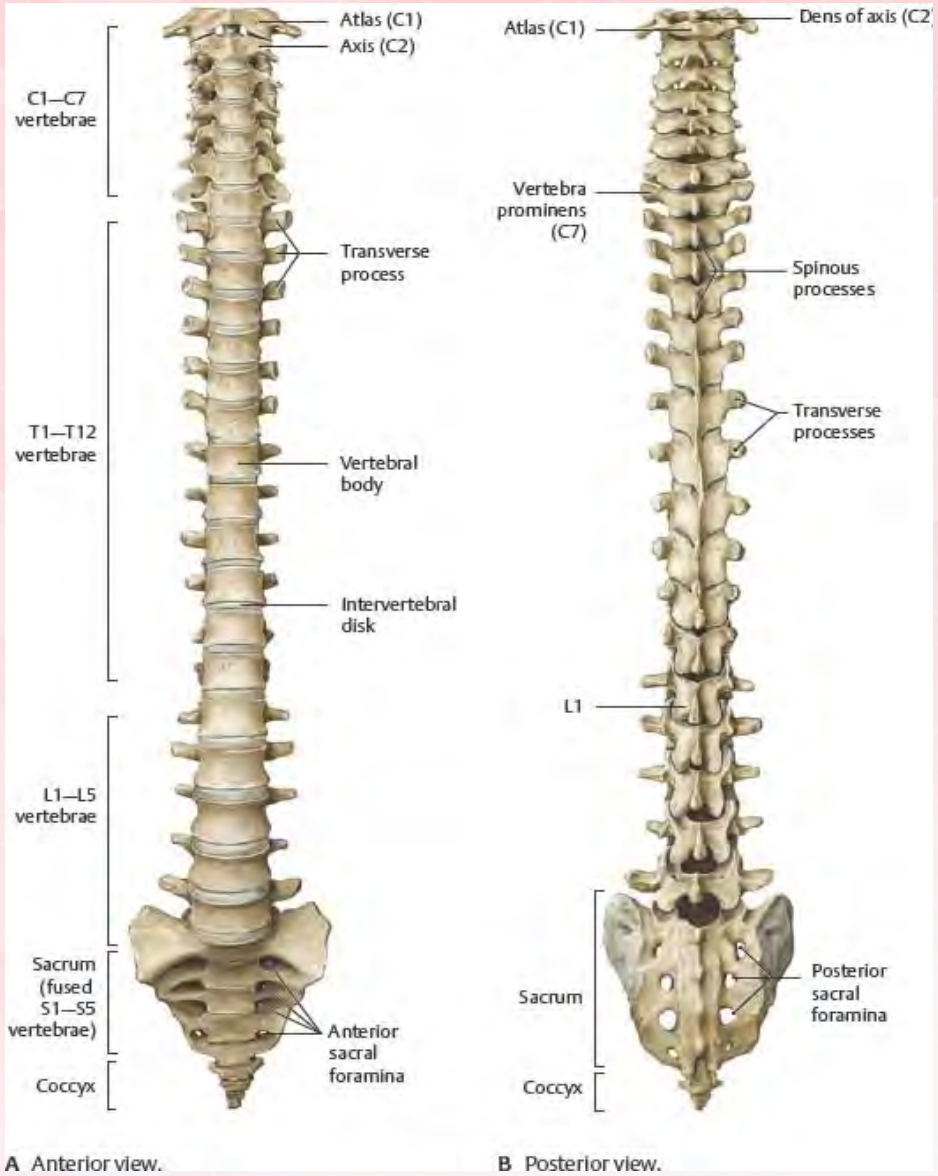
Vertebral Column



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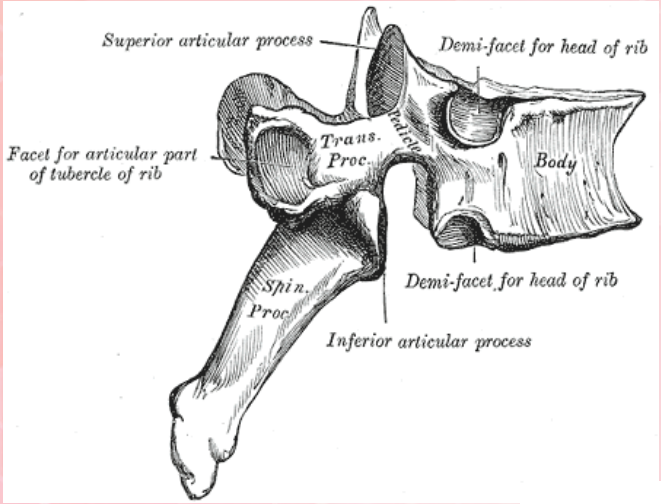
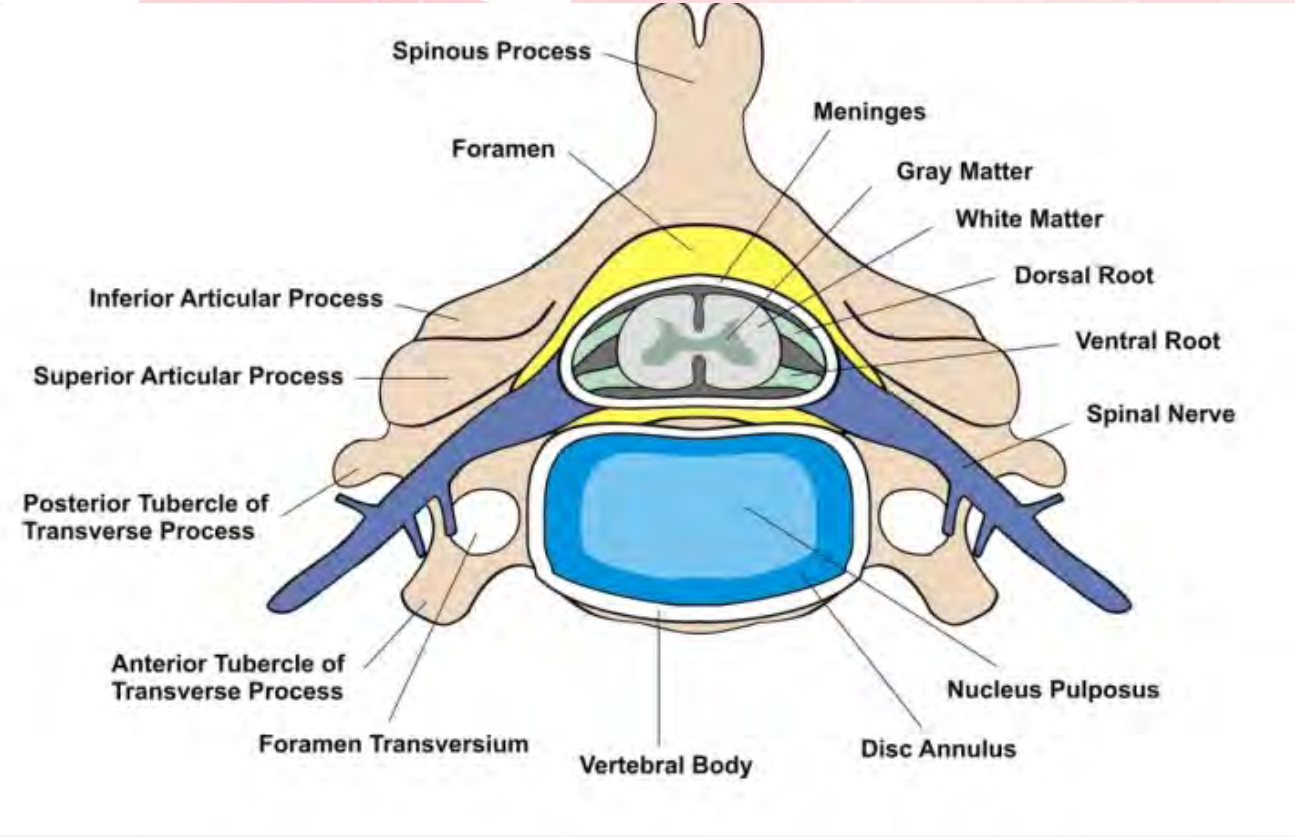


Thoracic vertebra

Wikimedia.com

Vertebra



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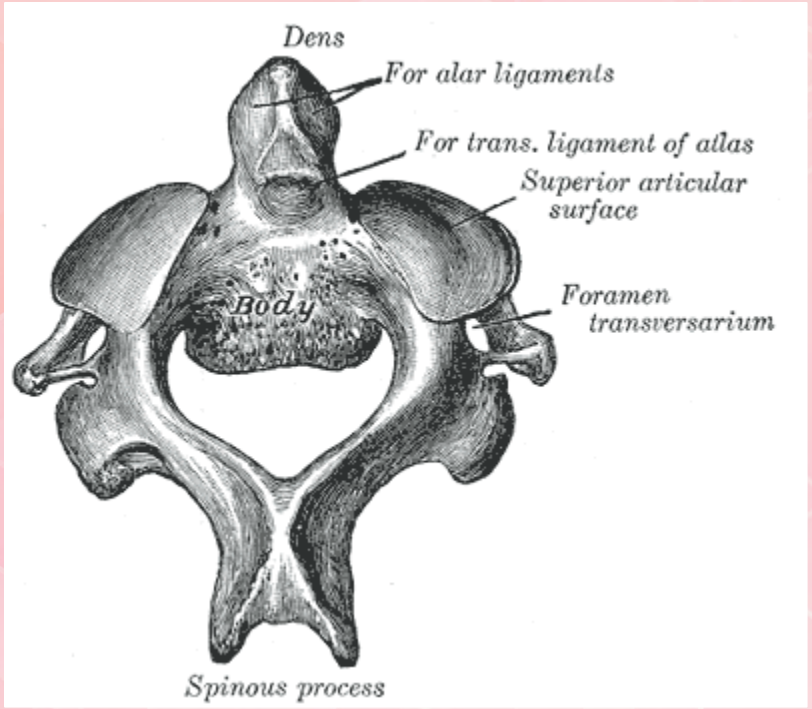
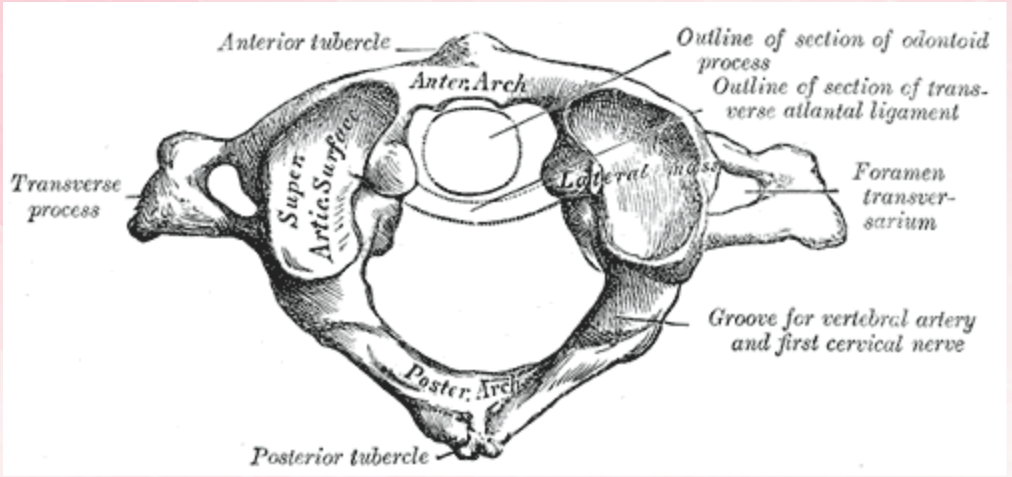
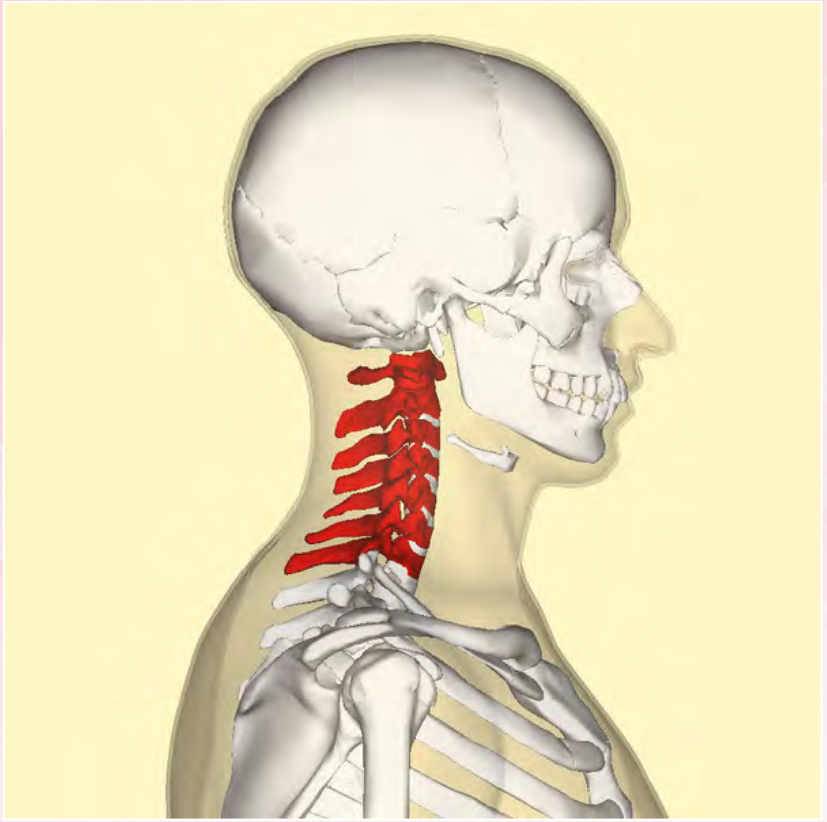
Cervical Vertebrae







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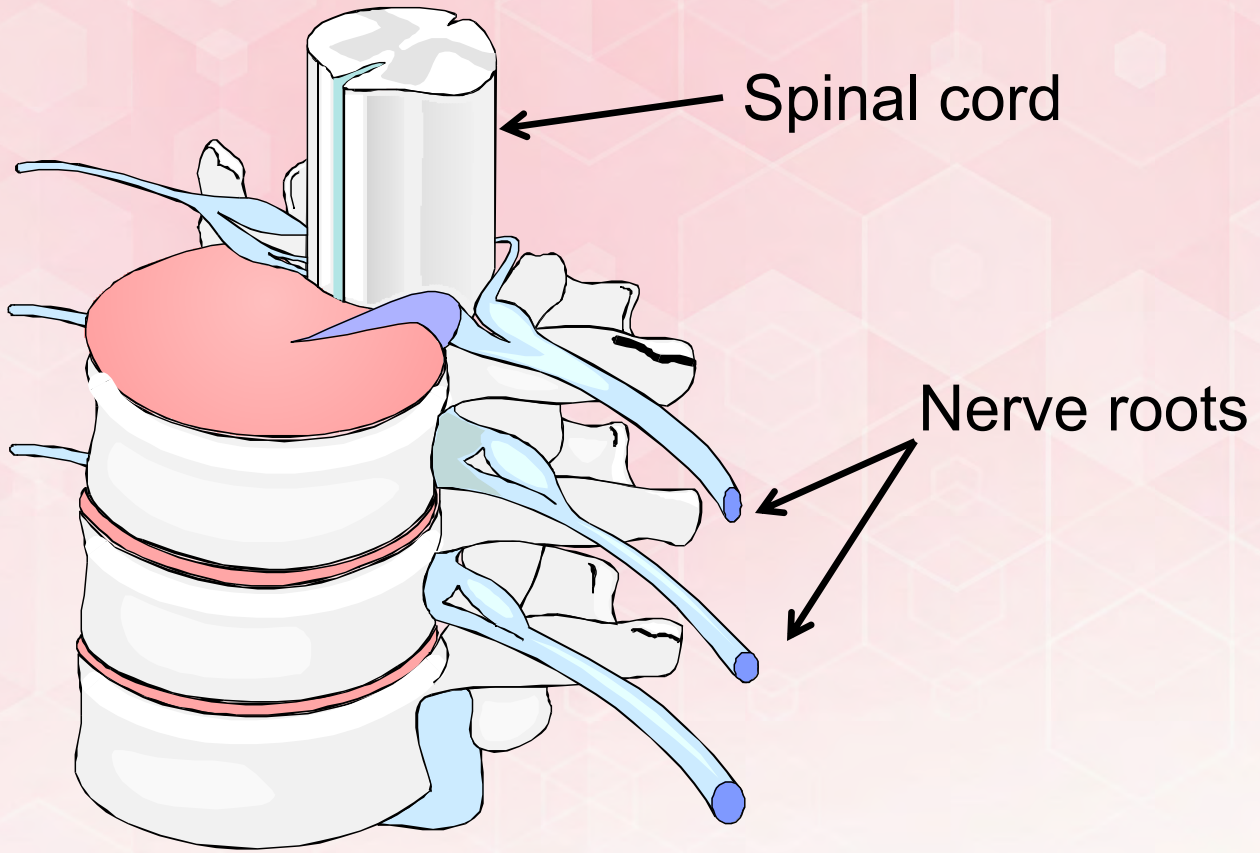
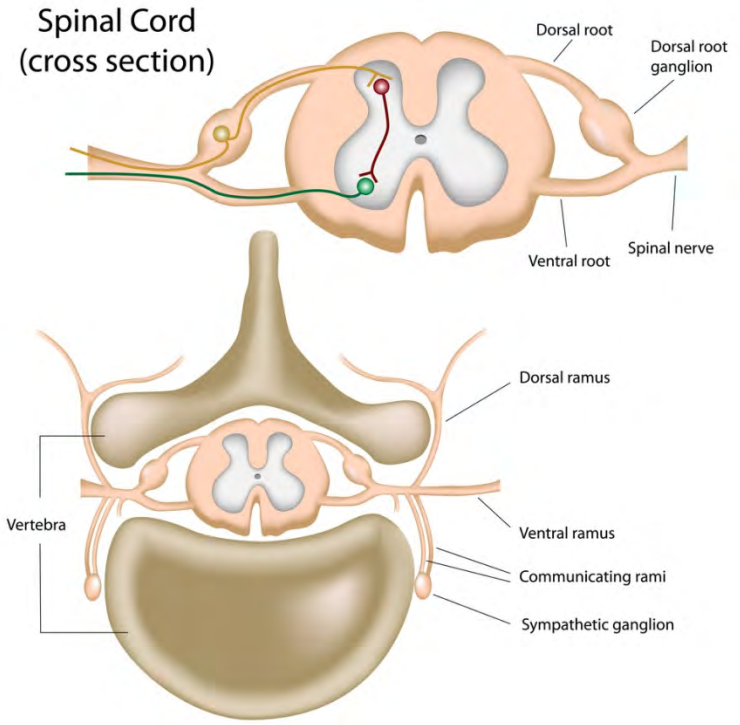
Spinal Cord



Anatomy and Physiology

- Gray Matter
  - Anterior - motor
  - Inter-mediolateral – sympathetic/ parasympathetic
  - Posterior - sensory
- White Matter
  - Anterior -motor
  - Lateral – 8 tracts
  - Posterior -position

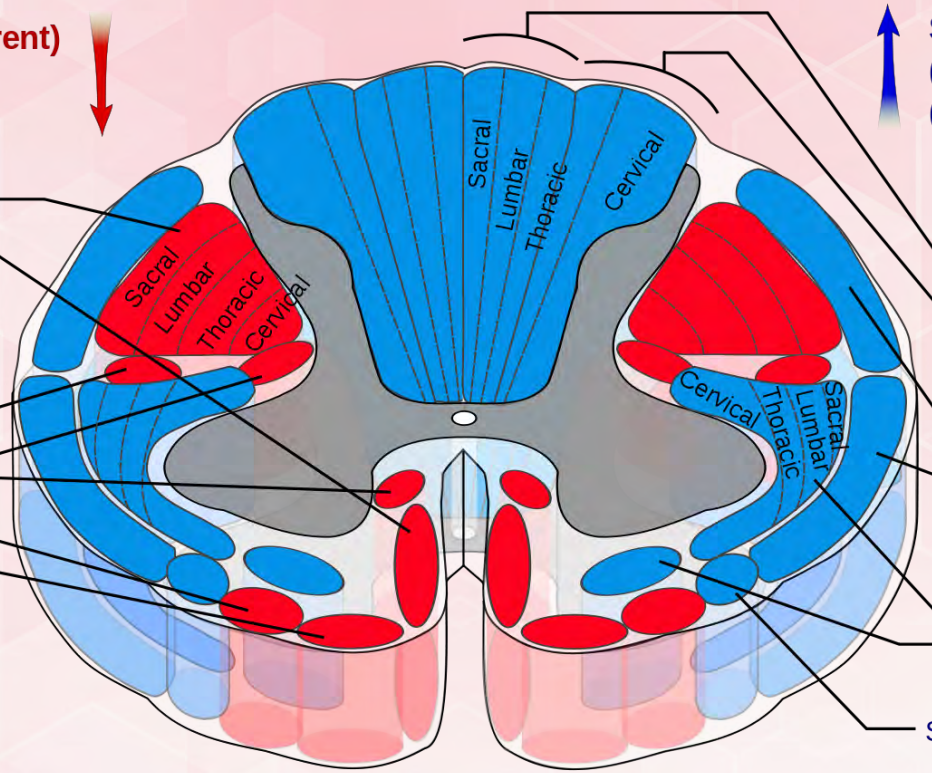


Spinal Cord

Motor and descending (efferent) pathways (red)

Pyramidal tracts
- Lateral corticospinal tract
- Anterior corticospinal tract

Extrapyramidal Tracts
- Rubrospinal tract
- Reticulospinal tracts
- Olivospinal tract
- Vestibulospinal tract



Sensory and ascending (afferent) pathways (blue)

Dorsal Column Medial Lemniscus System
- Gracile fasciculus
- Cuneate fasciculus

Spinocerebellar Tracts
- Posterior spinocerebellar tract
- Anterior spinocerebellar tract

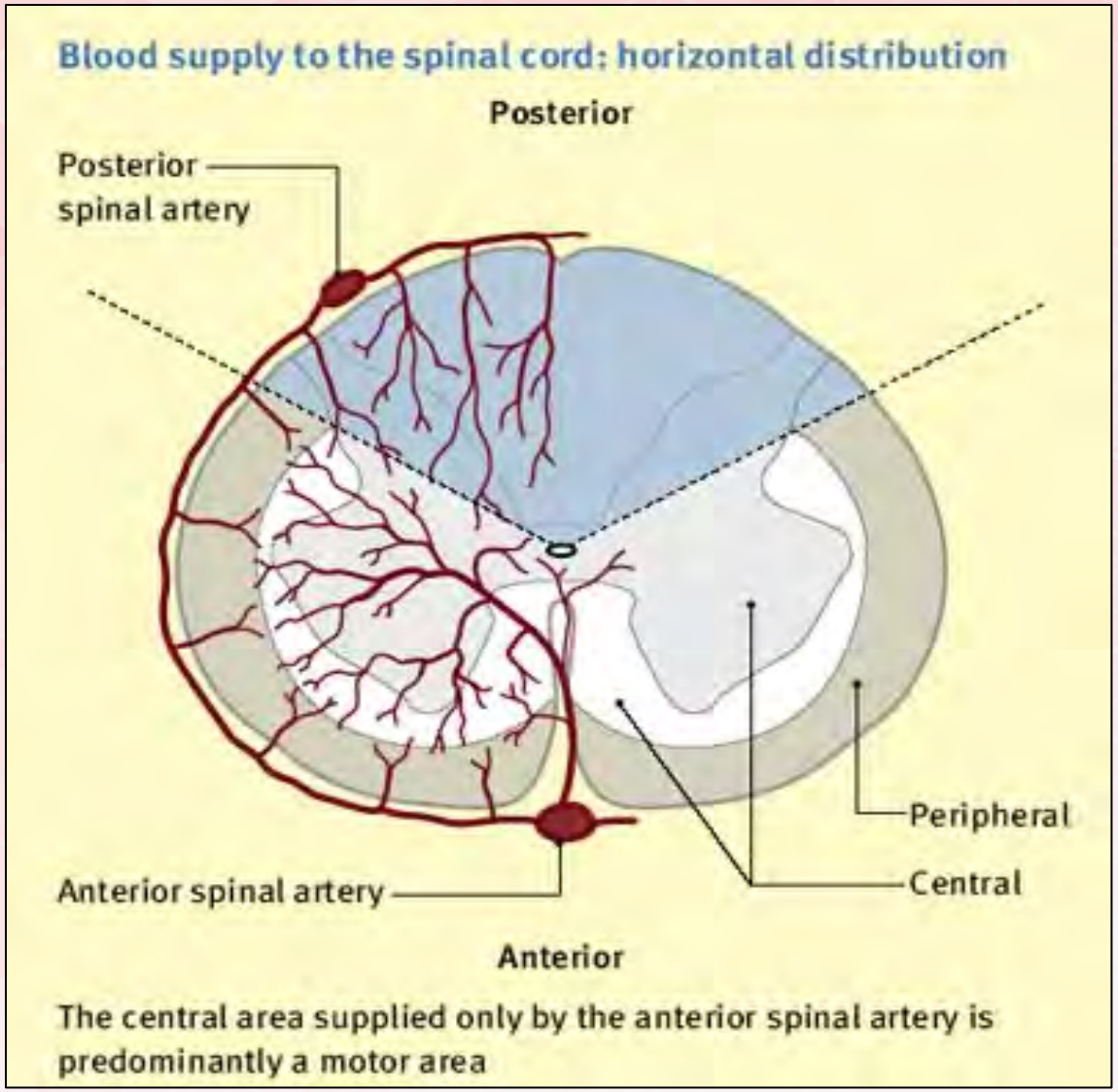
Anterolateral System
- Lateral spinothalamic tract
- Anterior spinothalamic tract

Spino-olivary fibers

Anatomy and Physiology

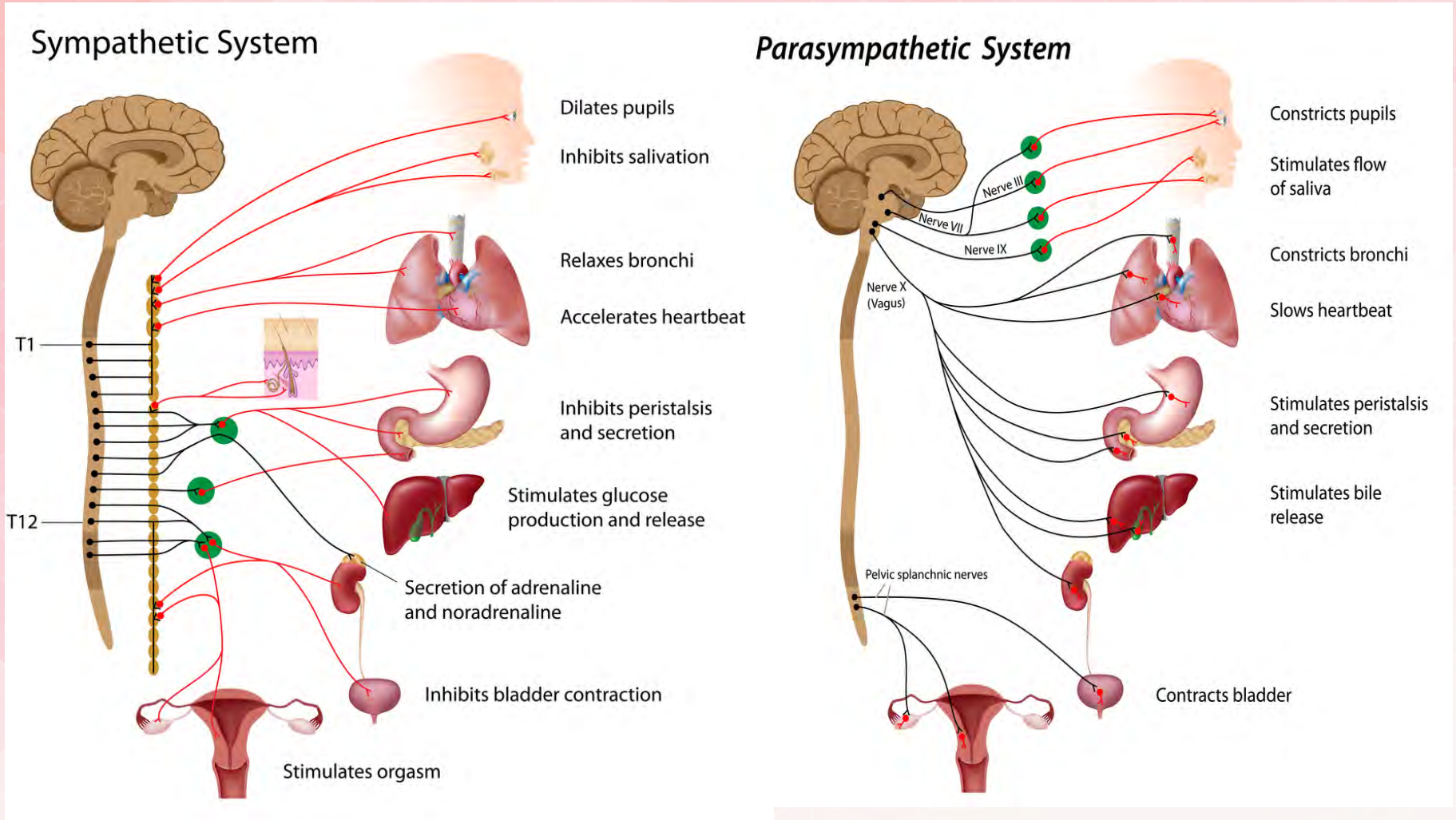
- Upper motor neuron (UMN)
  - Modulated by cerebrum, cerebellum, basal ganglia, reticular neurons
  - Injury = paralysis, hypertonicity, hyperreflexia
- Lower motor neuron (LMN)
  - Originated in CNS
  - Injury = flaccidity, hyporeflexia, fasciculations

Anatomy and Physiology



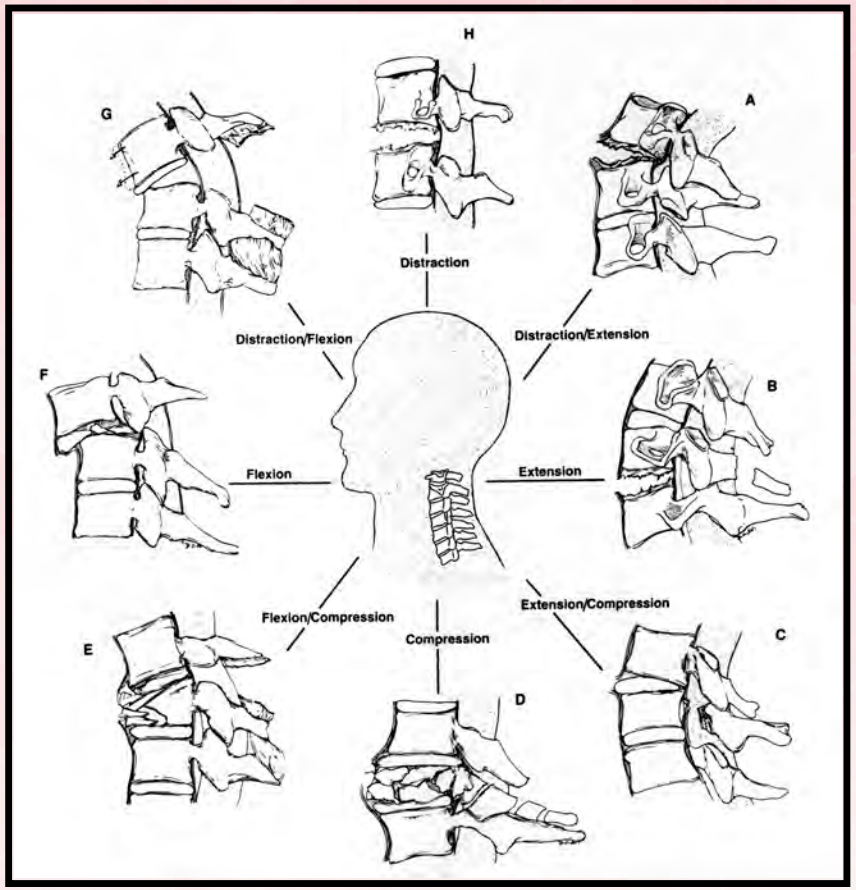
http://pt851.wikidot.com/spinal-cord-injury-cell-biology

Anatomy and Physiology



SOCIETY OF TRAUMA NURSES

Mechanisms of Injury



(McQuillan, Von Rueden, Hartsock, Flynn, & Whalen, 2002) Reprinted with permission

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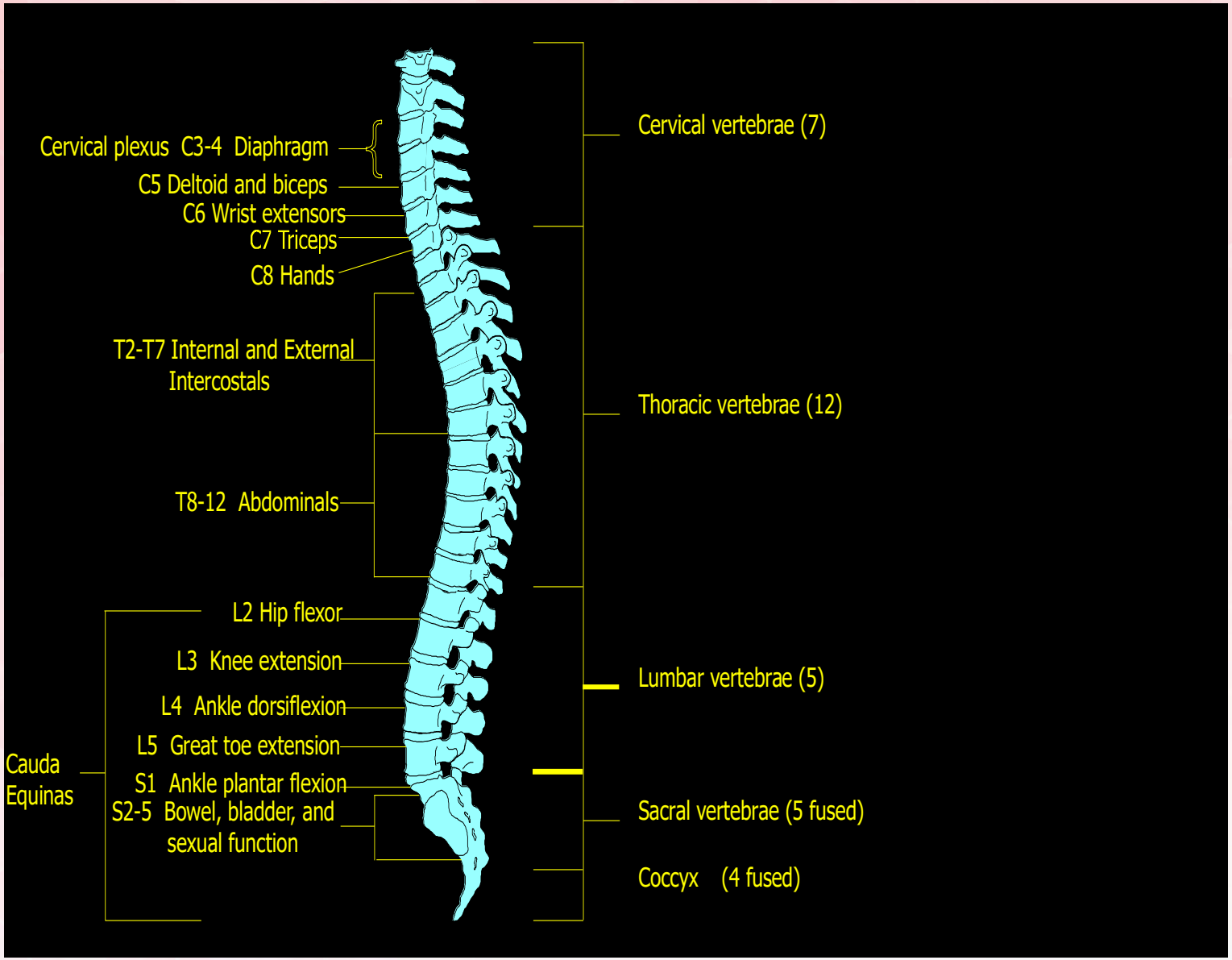
Initial Management

Pre-hospital

Resuscitation

Assessment



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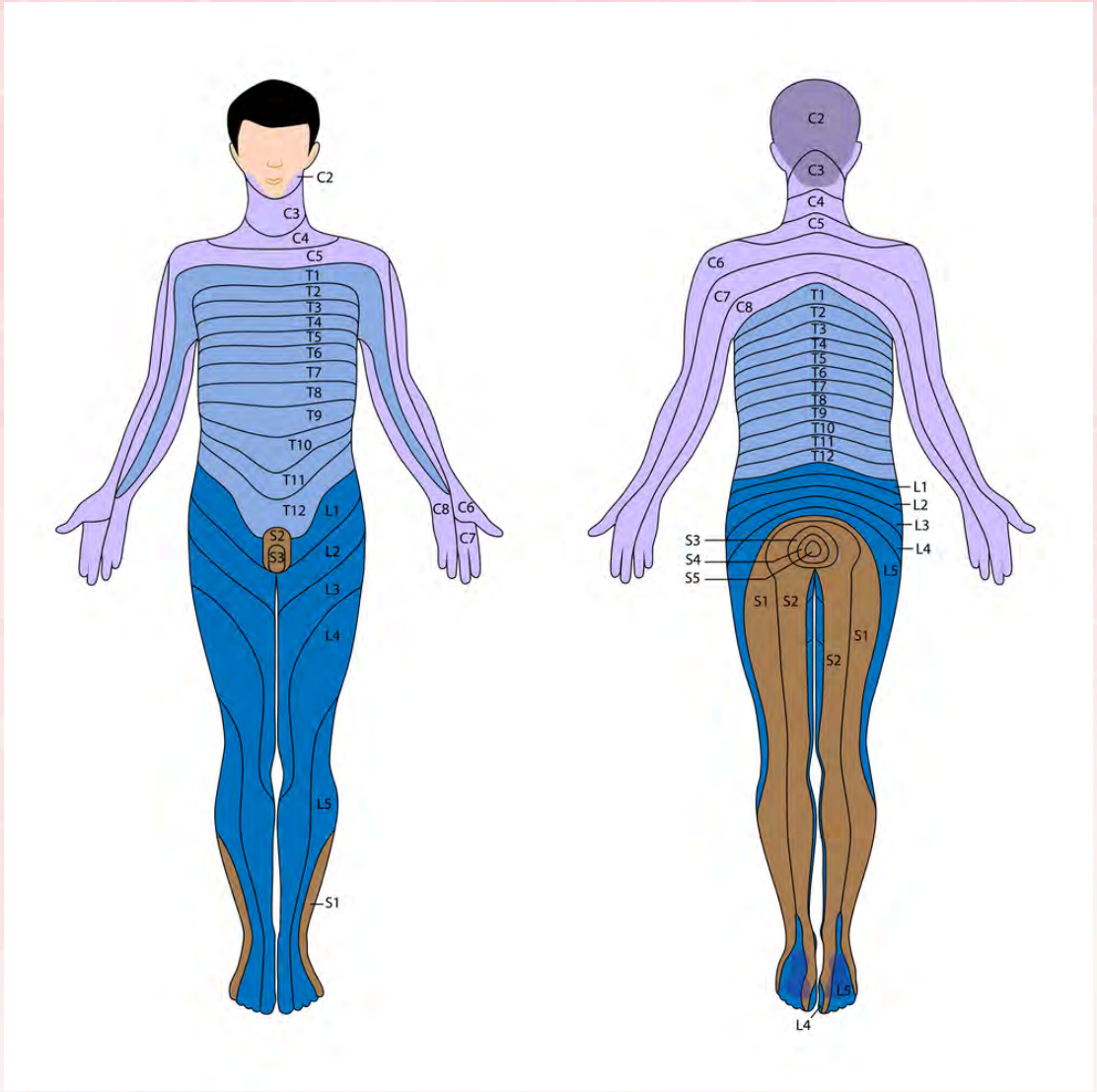
Dermatomes



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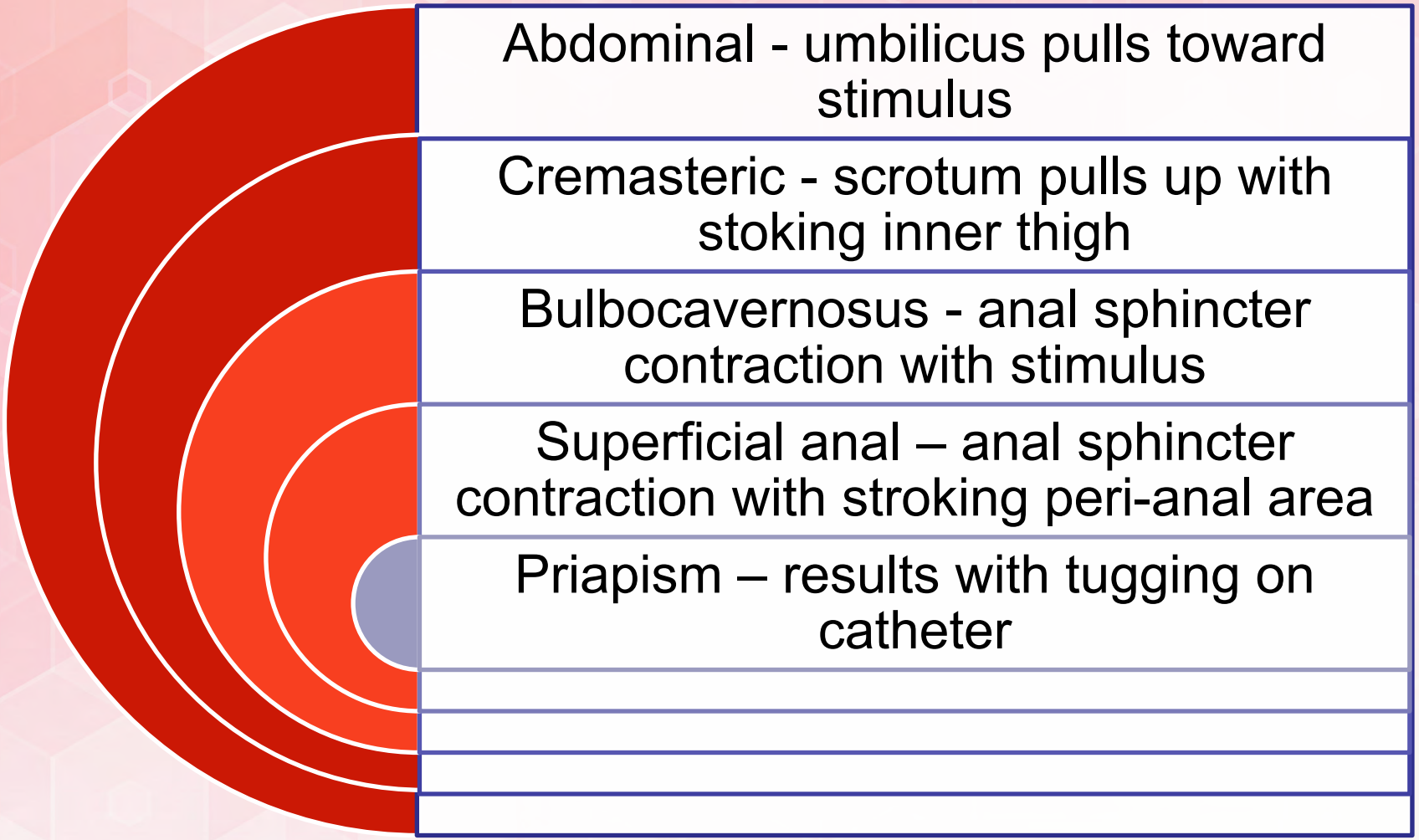
Sensorimotor Assessment

- Lateral corticospinal tract
- Lateral spinothalamic tract
- Dorsal column

Reflex Assessment

- Test for sensory/motor sparing
- Major deep tendon reflexes (DTR) assessed
  - Biceps (C5)
  - Brachioradialis (C5-6)
  - Triceps (C7-8)
  - Quadriceps (knee-jerk) (L3-4)
  - Achilles (S1-2)
- Scoring 0 to ++++

Superficial Reflex Assessment



Abdominal - umbilicus pulls toward stimulus
Cremasteric - scrotum pulls up with stoking inner thigh
Bulbocavernosus - anal sphincter contraction with stimulus
Superficial anal – anal sphincter contraction with stroking peri-anal area
Priapism – results with tugging on catheter

Spinal Cord Injury

- Primary
  - From the time of initial mechanism of injury

- Secondary
  - The cell damage that occurs as a result of decreased perfusion, hypoxia, inflammation and/or hemorrhage to the spinal cord.

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Spinal Cord Injury

- ASIA Impairment scale
  - Complete (A) – lack of motor/sensory function in sacral roots (S4-5)
  - Incomplete (B) – sensory preservation, motor loss below injury including S4-5
  - Incomplete (C) – motor preservation below injury, more than ½ muscle groups motor strength <3
  - Incomplete (D) - motor preservation below injury, at least 50% muscle groups motor strength ≥3
  - Normal (E) – all motor/sensory function present

Cord Syndromes

- Central Cord
  - Typically fall with hyperextension
  - Elderly
  - Presents with weak upper extremities, variable bowel and bladder dysfunction, disproportionately functional lower extremities

(Mataliotakis & Athanasios, 2016)

Cord Syndromes

- Anterior Cord
  - Primarily a hyperflexion mechanism
  - Anterior segment of spinal cord controls motor function below the injury

(Mataliotakis & Athanasios, 2016)

Cord Syndromes

- Brown-Sequard
  - Hemisection of the cord usually from penetrating injury
  - Loss of motor on same side as injury
  - Loss of sensation on the opposite side

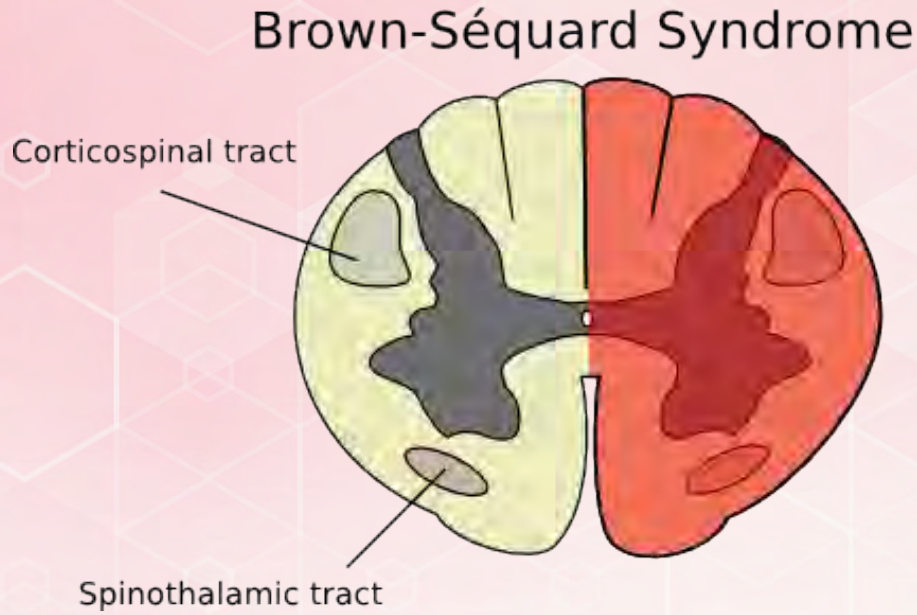


Image found on Wikimedia.org

(Mataliotakis & Athanasios, 2016)

Cord Syndromes

- **Conus Medullaris**
  - S4-5 exit at L1; may have L1 fracture
  - Areflexic bowel and bladder, flaccid anal sphincter
  - Variable lower extremity loss
- **Cauda Equina**
  - Lumbar sacral nerve roots, with or without fracture
  - Variable loss; areflexia; radicular pain

Complete Cord Injury

- **Quadriplegia (Tetraplegia)**
  - Loss of function below the level of injury
  - Includes sacral roots (bowel and bladder)
  - C1-T1
- **Paraplegia**
  - Loss of function below the level of injury
  - Below T1

Diagnostics

- **Plain Films**
  - Patients should be risk-stratified to low pre-test probability
- **CT Scan**
  - Preferred imaging modality according to EAST and the American College of Radiology
  - Comprehensive, cervical through sacral
  - Demonstrates degree of compression and cord canal impingement
- **MRI Scan**
  - Demonstrates ligamentous, spinal cord injury

(Stein & Knight, 2017; Como, Diaz, & Dunham, 2009)

Diagnostics

- Clearing the Cervical Spine
  - Awake, alert, and oriented
  - NO distracting injuries
  - NO drugs or alcohol that alter experience
  - NO pain or tenderness
  - NO focal neurologic deficits
- Clearing spine with films, CT, MRI
  - Complaints of neck pain
  - Neurologic deficit
  - Altered level of consciousness, ventilator

(Hoffman, Mower, Wolfson, Todd, & Zucker, 2000)

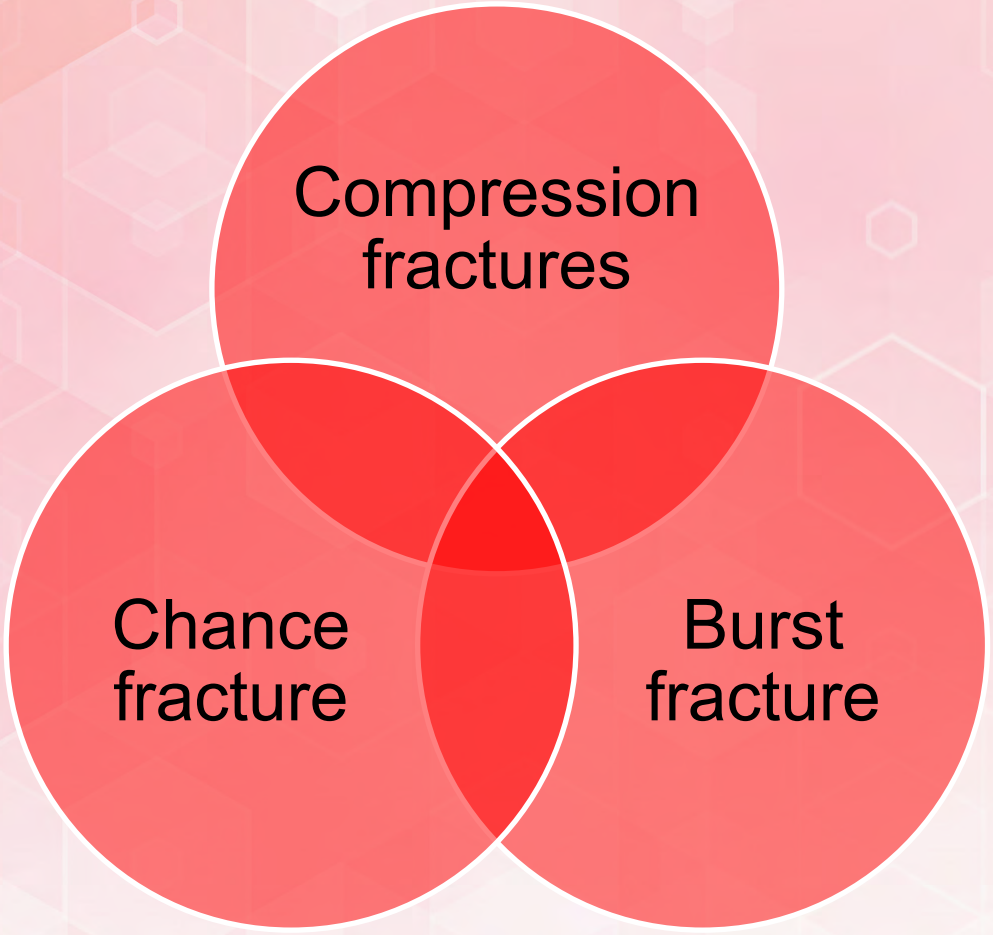
Fractures-Dislocations

- **Atlanto-occipital dissociation**
  - Complete injury; death
- **Atlanto-axial dislocation**
  - Complete injury; death
- **Jumped, Jump-locked facets**
  - Require reduction; may impinge on cord; unstable due to ligamentous injury

Fractures-Dislocations

- Facet fractures
  - High incidence of cord injury in cervical spine
- Odontoid (dens) fractures
  - Rarely cord injury

Fractures-Dislocations



SCIWORA

- Spinal Cord Injury without Radiographic Abnormality
  - Most frequently children
  - Dislocation occurs with spontaneous relocation
  - Cord injury evident
  - Radiographs negative

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Management

- **Airway**
  - C1-4 injuries require definitive airway
  - Injuries below C4 may also require airway due to
    - Work of breathing
    - Weak thoracic musculature
- **Breathing**
  - Adequacy of respirations
    - SpO2
    - Tidal volume
    - Effort
    - Pattern

Airway/Breathing

- **Indications for Intubation in TSI**
- **Absolute Indications**
- Complete TSI above C5 level
- Respiratory Distress
- Hypoxemia despite adequate attempts at oxygenation
- Severe Respiratory Acidosis
- **Relative Indications**
- Complaint of Shortness of Breath
- Development of "Quad Breathing"
- Vital Capacity < 10 ml/kg or decreasing VC
- **Consideration Should be Given**
- Need to "travel" remote from ED (i.e. MRI, transfer)

(Stein, & Knight, 2017)

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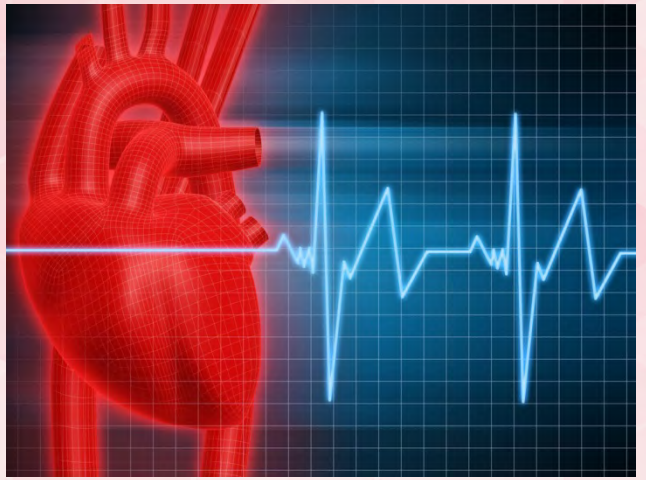
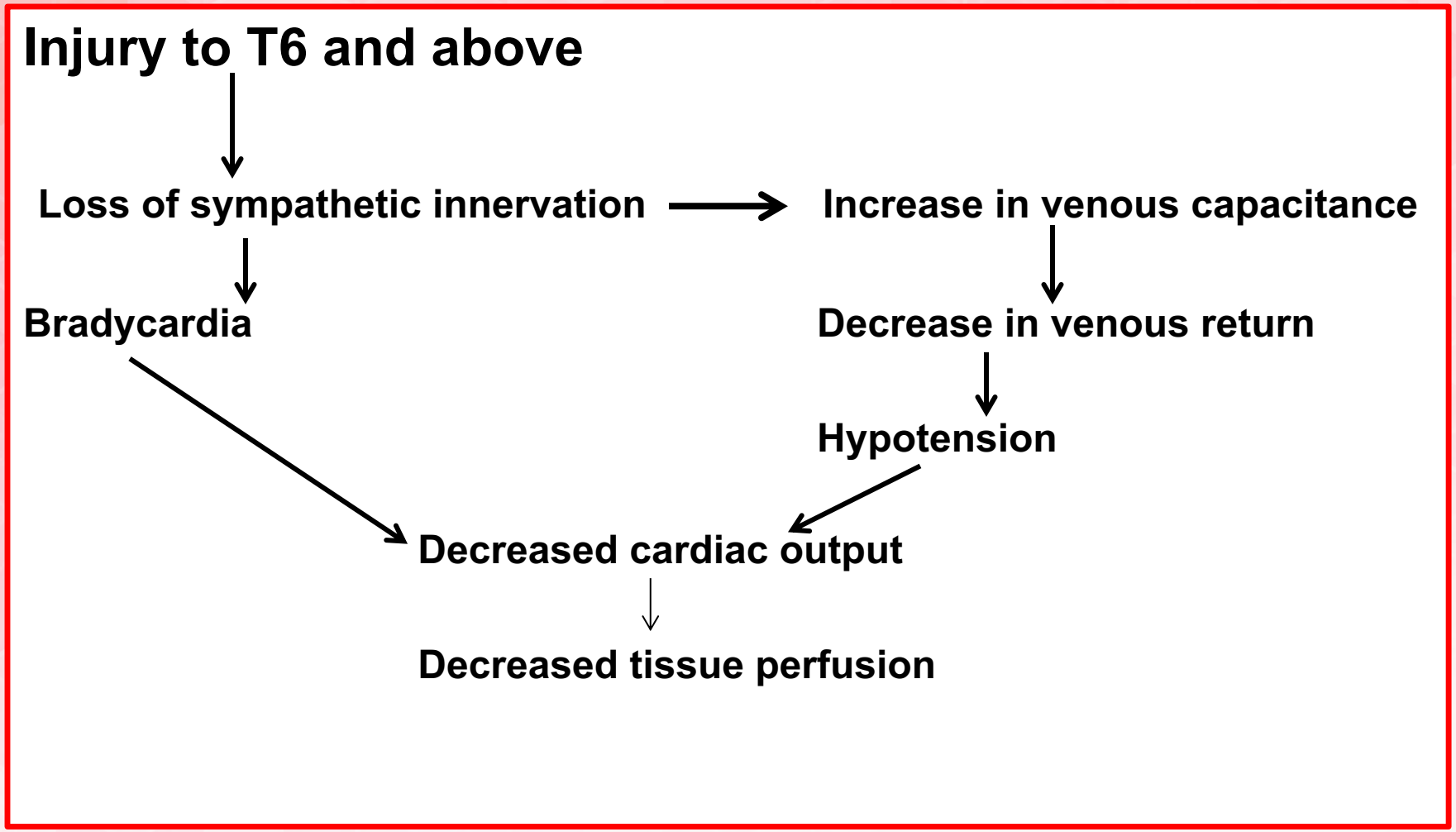
Management



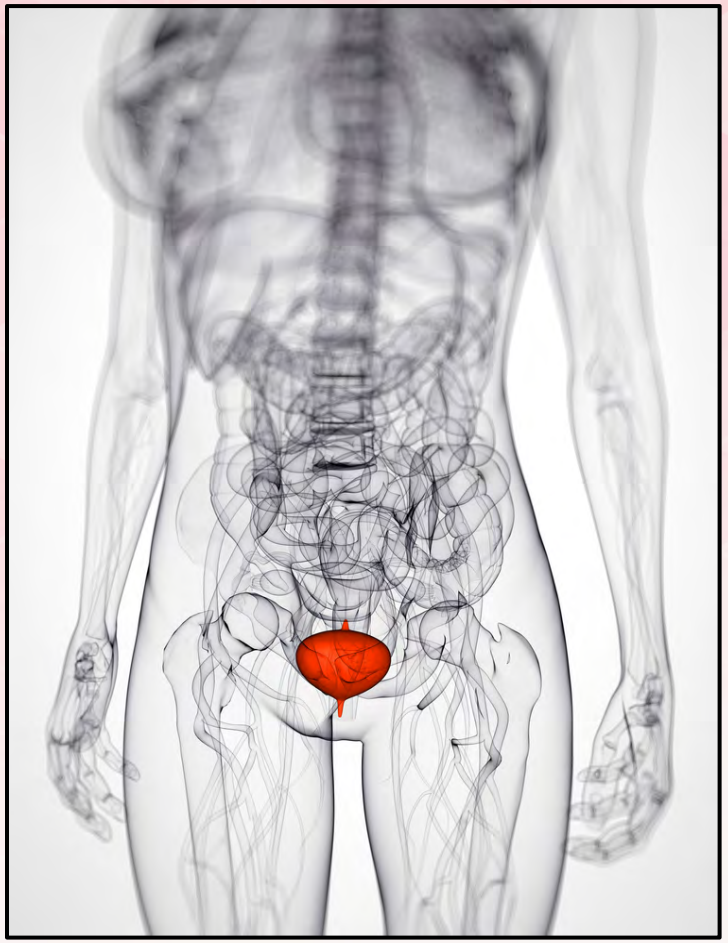
- **Circulation**
  - Neurogenic shock
    - Injuries above T6
    - Hypotension
    - Bradycardia –treat symptomatic only
    - Warm and dry
    - Poikilothermic – keep warm
  - Fluid resuscitation
  - Identify and control any source of bleeding
  - Supplement with vasopressors

Neurogenic Shock



Management

- Urine output
  - Urinary retention
    - Atonic bladder
  - Foley
    - Initially avoid intermittent catheterization
    - High urine output from resuscitation fluids



Management

- Deficit
  - Spinal shock
    - Flaccid paralysis
    - Absence of cutaneous and/or proprioceptive sensation
    - Loss of autonomic function
    - Cessation of all reflex activity below the site of injury
  - Identify level of injury

Management

- Pain
  - Frequent physical and verbal contact
  - Explain all procedures to patient
  - Patient-family contact as soon as possible
  - Appropriate short-acting pain medication and sedatives
- Foster trust

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Management

- **Communication**
  - Blink board
  - Adapted call bell system
  - Avoid clicking, provide a better option
  - Speech and occupational therapy
  - Prism glasses
  - Setting limits/boundaries for behavior

Management

- Special Treatment
  - Hypothermia
    - Recommends 33^{o}C intravascular cooling
    - Rapid application, Monitor closely
    - Anecdotal papers
    - No peer reviewed/ class I clinical research studies to substantiate
  - High dose methylprednisolone
    - No longer considered standard of care

(Tracy, Armola, & Micham, 2015)

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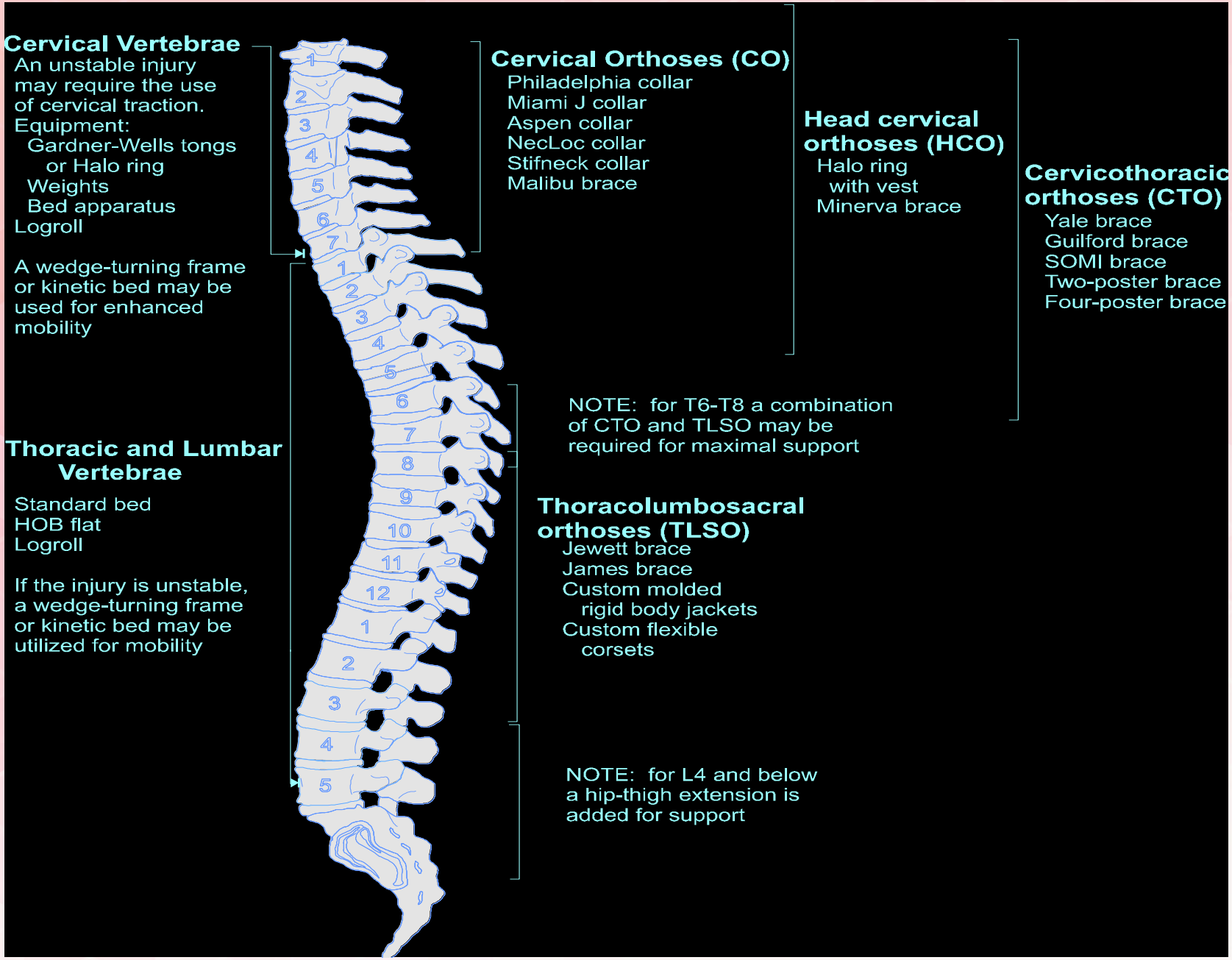
Management

- Pharmacologic agents
  - *Lazaroids (21-aminosteroids)*
  - *Opiate antagonists (Naloxone)*
  - *EAA receptor antagonists*
  - *Calcium channel blocker*
  - *Antioxidants and free radical scavengers*
  - Arachidonic acid inhibitors
  - More research is needed to validate effectiveness of neuroprotective therapy

Management

- **Reduction**
  - Cervical traction
    - Halo
    - Gardner-Wells tongs
  - Surgical
- **Stabilization**
  - Cervical collar – convert to padded collar as soon as possible
  - CTO or TLSO for low cervical, thoracic, lumbar injuries



(McQuillan, Von Rueden, Hartsock, Flynn, & Whalen, 2002) Image reprinted with permission.

Management

- **Surgical**
  - Decompression is the mainstay of treatment
  - Determined by
    - Degree of deficit, location of injury, instability, cord impingement
    - Anterior vs. posterior decompression/ both
  - Emergent
    - Reserved for neurologic deterioration when evidence of cord compression is present
  - SSEP –during procedure to monitor changes
    - Limited to ascending sensory tracts esp.. dorsal columns

Complication Prevention

- **Respiratory**
  - Most common complication
  - Monitor breathing effectiveness
  - Incentive spirometer
  - Adjunctive treatments (i.e. postural drainage, suctioning, intrapulmonary percussive ventilation)
  - Ventilator Bundle - Institute for Healthcare Improvement

(Bauman & Russo-McCourt, 2016; Institute for Healthcare Improvement, 2012)

Respiratory

- Ventilation
- Early intubation to prevent hypoxia and fatigue
- C1-4 injuries require tracheostomy and home ventilation training
- Quad cough training
- Communication tools
- Bronchoscopy

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Respiratory

- Pulmonary management
  - Weaning parameters
  - Monitor SpO2 and ABGs
  - Routine CXR
  - Aggressive pulmonary toilet
    - Postural drainage (PD)
    - Chest physiotherapy (CPT)
  - Suctioning

(Bauman & Russo-McCourt, 2016; Institute for Healthcare Improvement, 2012)

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Respiratory

- Non-ventilated patients
  - Pulmonary function tests
  - Incentive Spirometry
  - End Tidal CO2 monitoring
  - Non-invasive ventilation (CPAP, BiPAP)
  - Abdominal binder
  - Early OOB/ mobilization

(Bauman & Russo-McCourt, 2016; Institute for Healthcare Improvement, 2012)

Complication Prevention

- Cardiovascular
  - Neurogenic shock
  - IV fluids –includes vasopressors
  - Atropine or pacing ONLY when bradycardia symptomatic

(Bauman & Russo-McCourt, 2016)

Cardiovascular

- Maintain a MAP of 85-90mmHg for the first week post injury in order to maximize spinal cord perfusion.
- This recommendation is based on uncontrolled studies that demonstrated a benefit in maintaining the MAP at 85 for 7 days post injury.
- However, providers must also balance the bleeding risks of other injuries.

(Ryken et al, 2013)

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Mean Arterial Pressure goal 85-90 mmHg for 7 days following TSI

Agent	Alpha Activity	Beta Activity	Considerations
Norepinephrine	+++	++	Probably preferred agent
Phenylephrine	++	0	May worsen bradycardia
Dopamine			
Low dose (3-10 mcg/kg/min)	+	++	May lead to inadvertent diuresis at low doses
High dose (10-20 mcg/kg/min)	++	+++	
Epinephrine	+++	++	Rarely needed
Dobutamine	0	+++	May cause hypotension if not euvolemic

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Cardiovascular

- Orthostatic hypotension
  - Decreased BP, possibly increased heart rate, dizziness or lightheadedness, blurred vision, loss of consciousness
  - Provide physical support with hose, abdominal binder; salt tablets; Florinef; sympathomimetics
  - Slowly raise the head of the bed for mobilization
  - Turn slowly, prone to vasovagal response

(Bauman & Russo-McCourt, 2016)

Cardiovascular

- Poikilothermia
  - Inability to shiver/sweat and adjust body temperature
  - Keep patient warm
  - Warm the environment
  - Monitor skin to prevent burns or frostbite from exposure
    - Insensate skin

(Bauman & Russo-McCourt, 2016)

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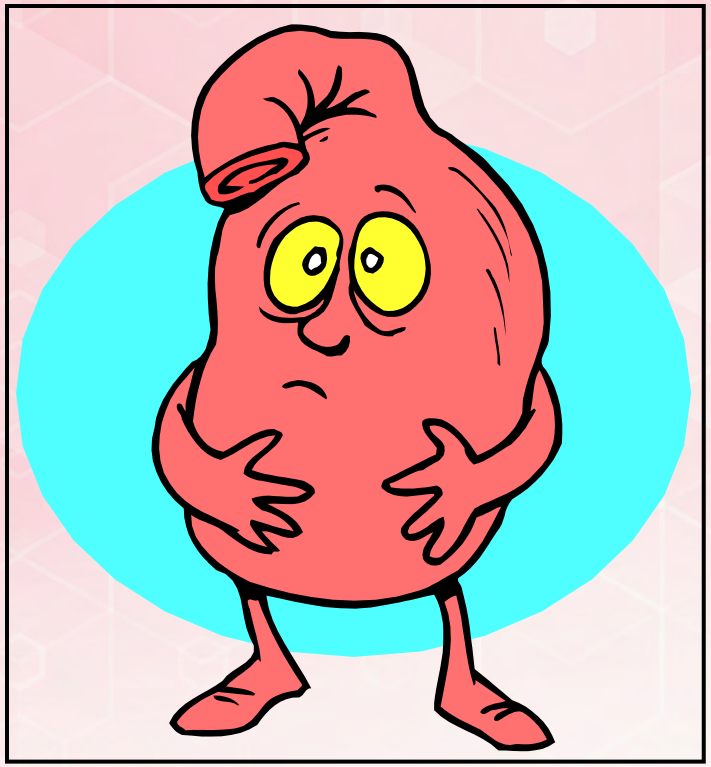
Complication Prevention

- Gastrointestinal
  - Ileus
  - Gastric/ intestinal ulcers
  - Pancreas dysfunction
  - Nutritional deficiencies
  - Constipation/ impaction
  - Cholecystitis



(Bauman & Russo-McCourt, 2016)

Gastrointestinal

- Abdominal distention
  - Nasogatric tube to decompress stomach
  - Monitor bowel sounds
  - Monitor N/G output for bleeding
  - Gastric prophylaxis-
    - Histamine blockers, proton-pump inhibitors, antacids
- Bowel routine
  - Stool softeners, suppositories; high fiber diet
  - Digital stimulation, fluids, mobilization

(Bauman & Russo-McCourt, 2016)

Gastrointestinal

- **Nutrition**
  - Early enteral nutrition
  - PO or tube feeding if ventilated
  - Transpyloric tube if slow gastric emptying
  - Hypermetabolic rate
    - Feed as with any critically injured patient

Complication Prevention

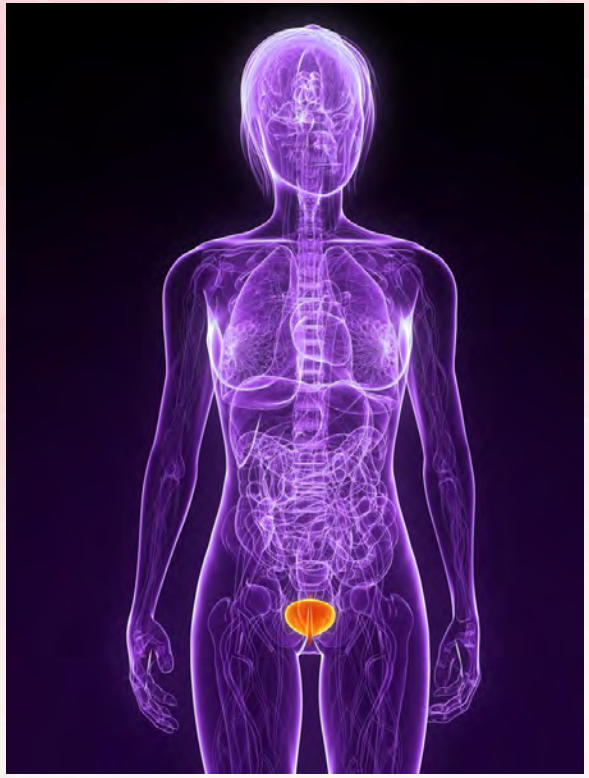
- Venous thromboembolism
  - Slightly higher risk the first 2-3 months post injury
  - Duplex ultrasonography evaluation
  - Prevention (x 3months)
    - LMWH
    - Apply sequential compression devices
    - Vena cava filter (in patients who cannot be anti-coagulated or have failed anti-coagulation)-evidence supporting this is weak.
  - Monitor for signs and symptoms
  - Early mobilization, hydration

(Dhall et al, 2013)

Complication Prevention

Reflexive bladder – involuntary contraction

- Fluid restriction transition to straight cath
- Condom catheters, SPT
- Palpate for fullness (approx 500-600ml/4-6hr)



(Bauman & Russo-McCourt, 2016)

Urinary

- **Areflexive bladder**
  - Valsalva or crede
  - Prone to incontinence/ skin issues
  - Condom catheters, incontinence pads, conduit
- **DSD**
  - Results in elevated voiding pressures
  - Annual urodynamic evaluation
  - Pharmacologic management, Surgical intervention (sphincterotomy)

Urinary Tract Infection

- **Signs and symptoms**
  - Fever, spontaneous voiding between catheterizations, Autonomic Dysreflexia, hematuria, cloudy- foul-smelling urine, vague abdominal discomfort, pyuria
- **Prevention**
  - Remove indwelling catheter as soon as clinically possible, intermittent cath, hydration

(Centers for Disease Control and Prevention, 2017)

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Urinary

Renal calculi

- Chronic bacteriuria and sediment, long-term indwelling catheters, urinary stasis, chronic calcium loss
- Signs and symptoms – persistent UTI, hematuria, unexplained Autonomic Dysreflexia
- KUB x-ray, IVP with cystogram, passage of stone
    - Interventions - increased fluid intake, dietary modifications, lithotripsy

(Welk, Fuller, Razvi, & Denstedt, 2012)

Complication Prevention

Skin breakdown

- Pressure, insensate, dampness
- PREVENTION – frequent turning, specialty beds, remove backboard asap; proper fitting braces
- Nutrition, mobilization, cushions, massage
- Early wound care specialist
- Surgery if deep
- Can cause delays in stabilization, rehabilitation

(Bauman & Russo-McCourt, 2016)

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Complication Prevention

Musculoskeletal

- Spasticity – flexor, extensor, alternating
  - Reduce venous pooling, stabilize thorax, aids in dressing and stand-pivot transfer
  - Chronic pain, contractures, heterotrophic ossification, skin breakdown
  - ROM, positioning, weight-bearing, splinting, pharmacologic management, surgery- neural severing (permanent)

(Bauman & Russo-McCourt, 2016)

Musculoskeletal

Heterotrophic ossification

- Ectopic bone within connective tissue
- Below spinal lesion
- More often complete injuries with spasticity
- Redness, swelling, warmth, pain, decreased ROM, fever, positive bone scan

Musculoskeletal

Contractures

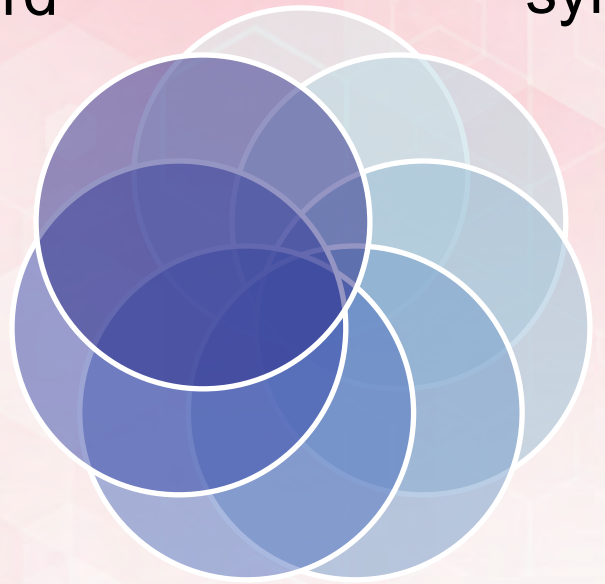
- Imbalance of muscle innervation
- High level cord injury, skin breakdown, concomitant head injury, spasticity, HO, fractures
- PREVENTION – aggressive ROM, mobilization, PT/OT, splinting, positioning, serial casting, anti-spasmodics
- Rehabilitation Services consults

Complication Prevention

Neurologic - Post traumatic Syringomyelia

A fluid filled cavity which develops within the spinal cord

Most common symptom is pain



Surgical decompression

Serial monitoring via MRI

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Complication Prevention

Autonomic dysreflexia

- An uncontrolled, massive sympathetic reflex response to noxious stimuli, below the level of the lesion
- Precipitating factors
  - Full bladder
  - Distended bowel
  - Skin irritation, ingrown toenail
  - UTI
  - Uterine spasms, penile stimulation
  - Tight clothing, wrinkled sheets

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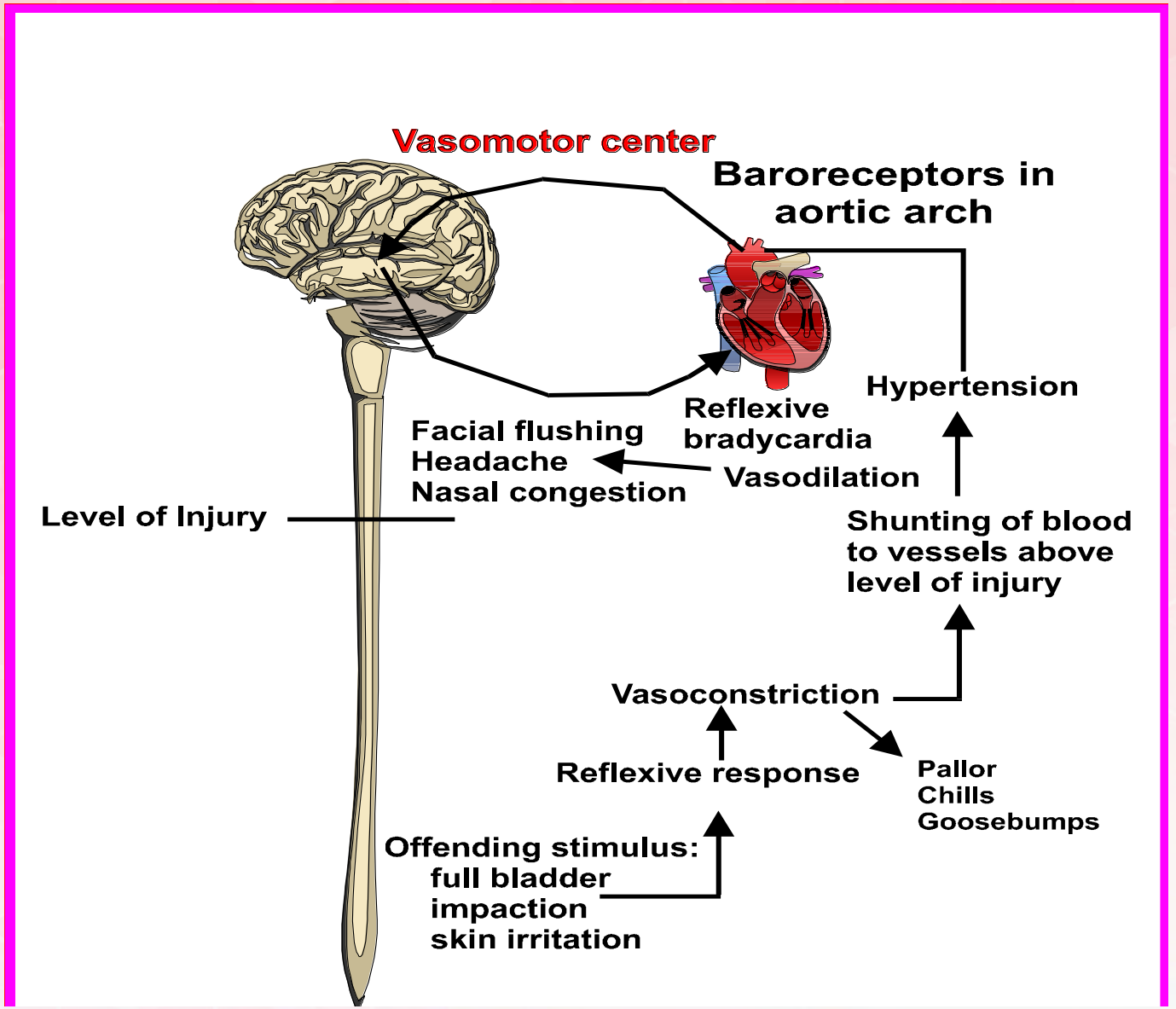
Autonomic Dysreflexia



Autonomic Dysreflexia

- Sit patient upright to produce orthostatic hypotension
- Monitor BP every 5 minutes
- Monitor neurologic status (GCS)
- Eliminate the offending stimulus
  - Empty bladder, bowel; identify skin lesion
- Administer anti-hypertensives if the above fails
- Education –family and patient

Psychologic

Pain/Depression

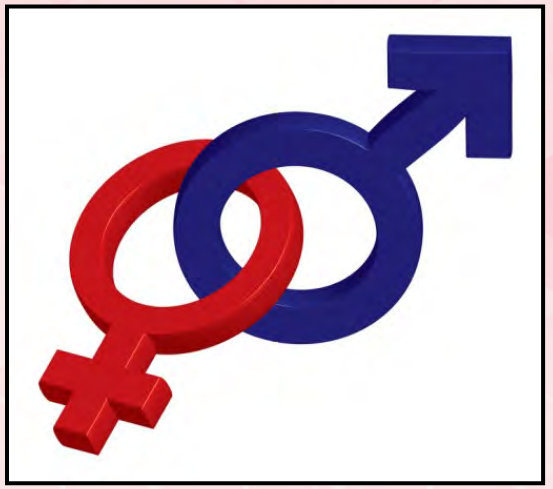
- Nocioceptive – noxious stimuli to normally innervated parts
- Neurogenic – nerve tissue injury in CNS or PNS
- Evaluate for depression associated with pain
- Counseling, ROM, pharmacologic treatment, TENS

(Consortium for Spinal Cord Medicine, 2008)

Sexuality

Male sexuality

- Erection – parasympathetic
- Requires intact sacral reflexes, short-lived
  - Technical aides, pharmacology, prosthesis
- Ejaculation – sympathetic
  - Intrathecal injection, electroejaculation, vibroejaculation
- Fertility – decreased sperm motility and quality
  - Serial ejaculation, in vitro fertilization



Sexuality

Female

- Lack innervation to pelvic floor
- Maintain reflex lubrication/ congestion
- Loss psychogenic/ fantasy response
- Fertility normal
  - Pregnancy – loss of sensation, increased BP, may precipitate AD
  - Decreased respiratory excursion
  - Alter GI/GU management

Rehabilitation

- Mobility
  - Tendon transfer
  - Functional electrical stimulation
  - Lower level of injury, more functional
- Bowel and Bladder Management
- Prevention of complications

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Summary

- Spinal cord injury occurrence is decreased with safety equipment use
- Prevent secondary injury to result in optimal neurologic recovery
- Spinal column fractures can occur without long term effects
- Spinal cord injury requires diligence in complication prevention

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Neck Trauma

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Objectives

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

- Examine the spectrum of neck trauma, the mechanisms of injury and associated injury patterns
- Define the three zones of the neck used as classifications of injury
- Identify the appropriate diagnostic modalities used to evaluate patients with neck trauma
- Explain the therapeutic interventions in the management of neck trauma
- Identify nursing interventions important in caring for patients with neck trauma

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Epidemiology

- Penetrating neck injury makes up ~5-10% all traumatic injuries
- ~5% mortality from penetrating neck injury
- Zone I injuries are the most lethal
- A small percentage of neck trauma is blunt mechanism, generally caused by MVCs
- Delayed diagnosis of blunt cerebral vascular injury has a mortality approaching approximately 40%
- Less than 10% of injuries to neck involve major arterial structures

Epidemiology

- Commonly injured vessels
  - Internal jugular vein
  - Internal carotid artery
- Laryngeal and tracheal injury more common than pharyngeal and esophageal injuries

Blunt Mechanism of Injury

- Steering wheel
- Assault
- Strangulation/Hanging
- “Clothes line” injuries
- Other (sports, industrial, etc.)

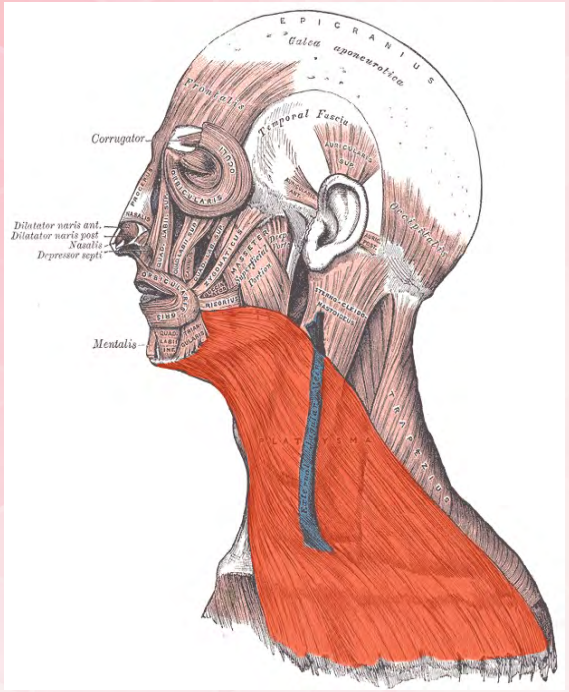
Penetrating Mechanism of Injury

- Missile injury (bullet, knife, or other)
- Stabbing or lacerations
- Impalement
- Animal bites

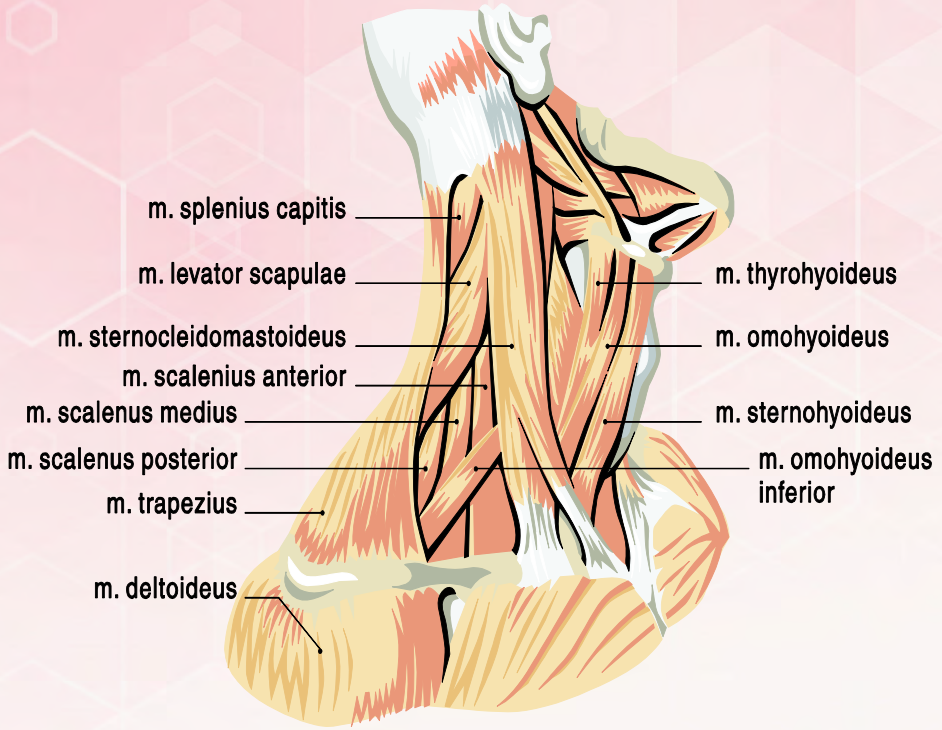
Anatomical Review

Fascia

Superficial fascia



Deep cervical fascia



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Structures at Risk

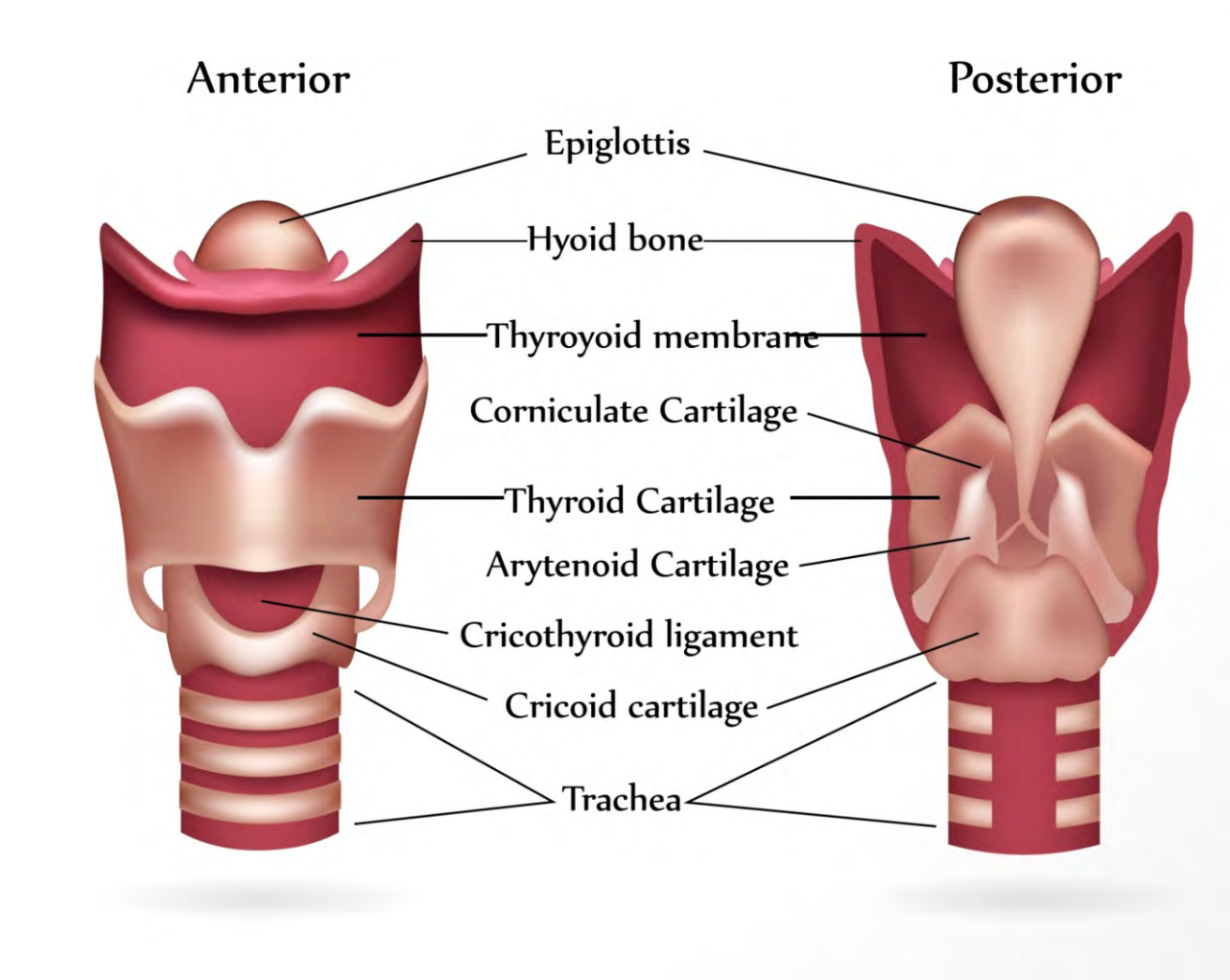
Musculoskeletal

- Vertebral bodies
- Cervical muscles and tendons
- Clavicles, 1st and 2nd ribs
- Hyoid bone

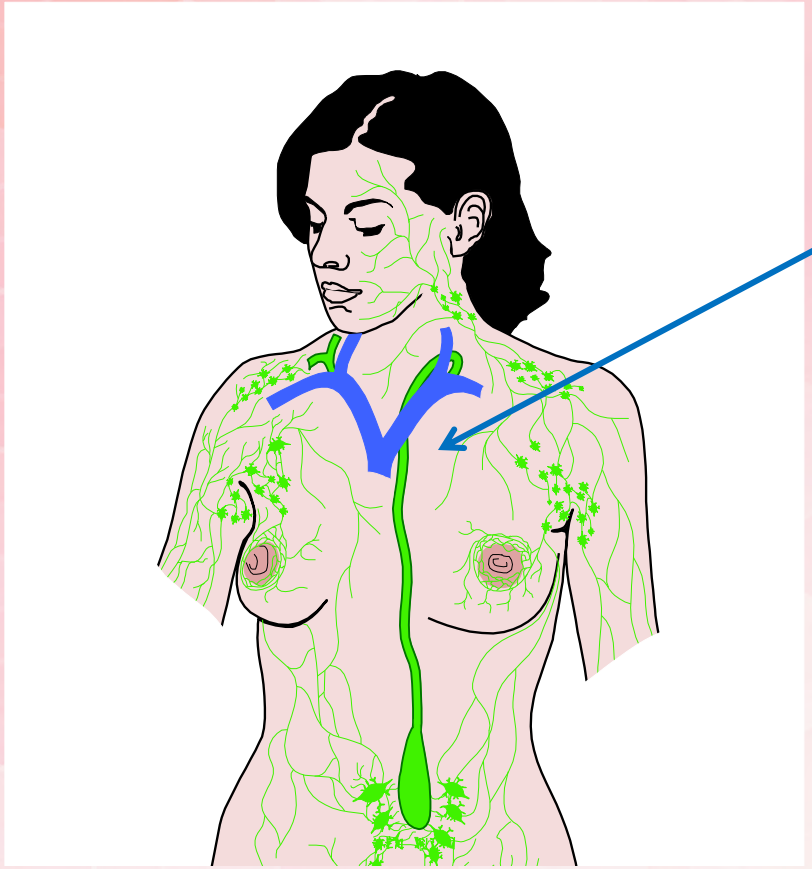
Glandular

- Thyroid
- Parathyroid
- Submandibular
- Parotid glands

Anatomical Review



Structures at Risk



Visceral structures

- Thoracic duct
- Esophagus
- Pharynx
- Larynx
- Trachea

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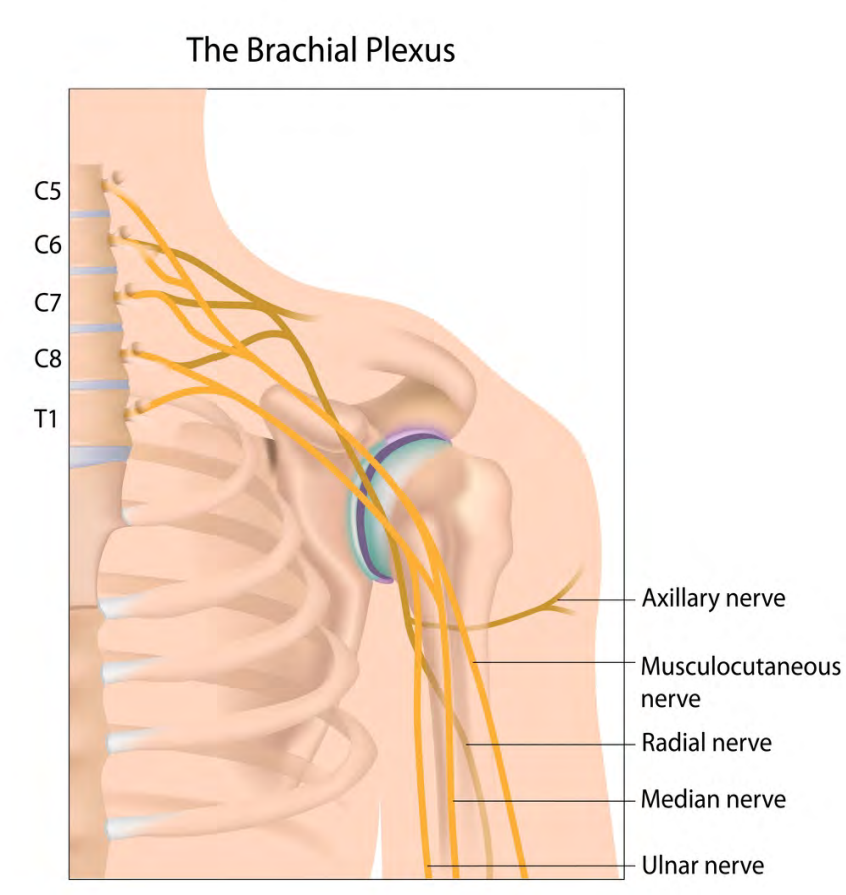
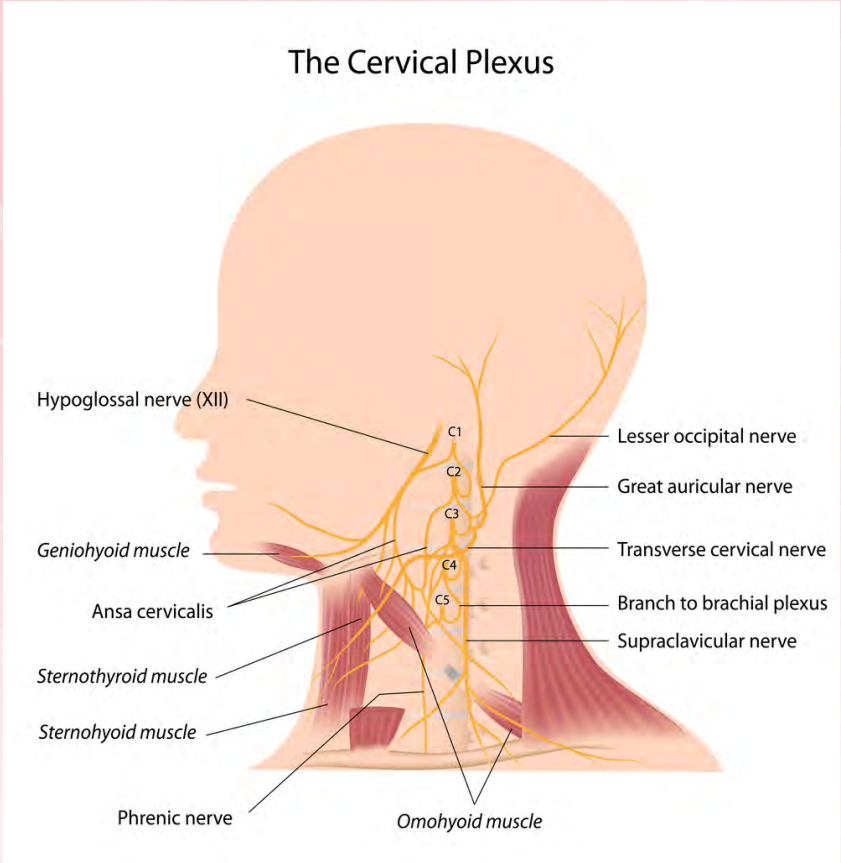
Structures at Risk





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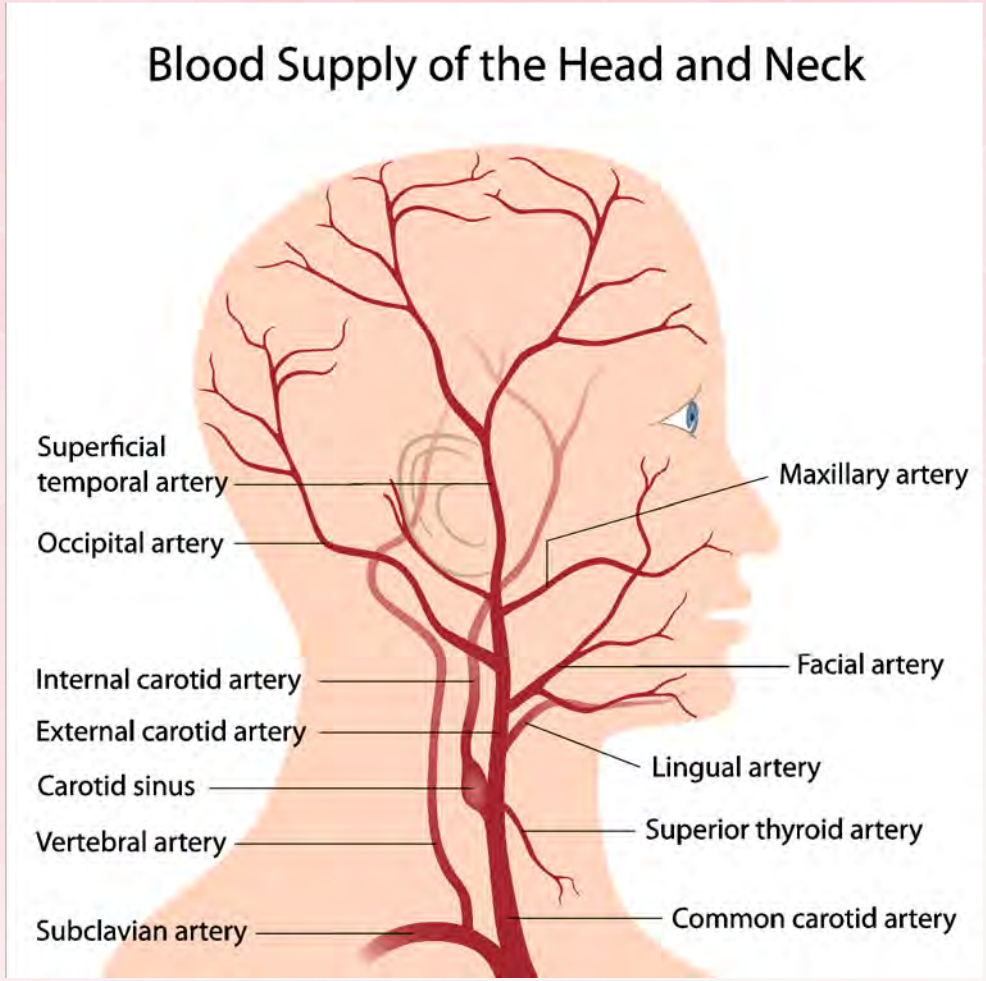
Structures at Risk: Blunt and Penetrating Cerebral Vascular Injury (BCVI)



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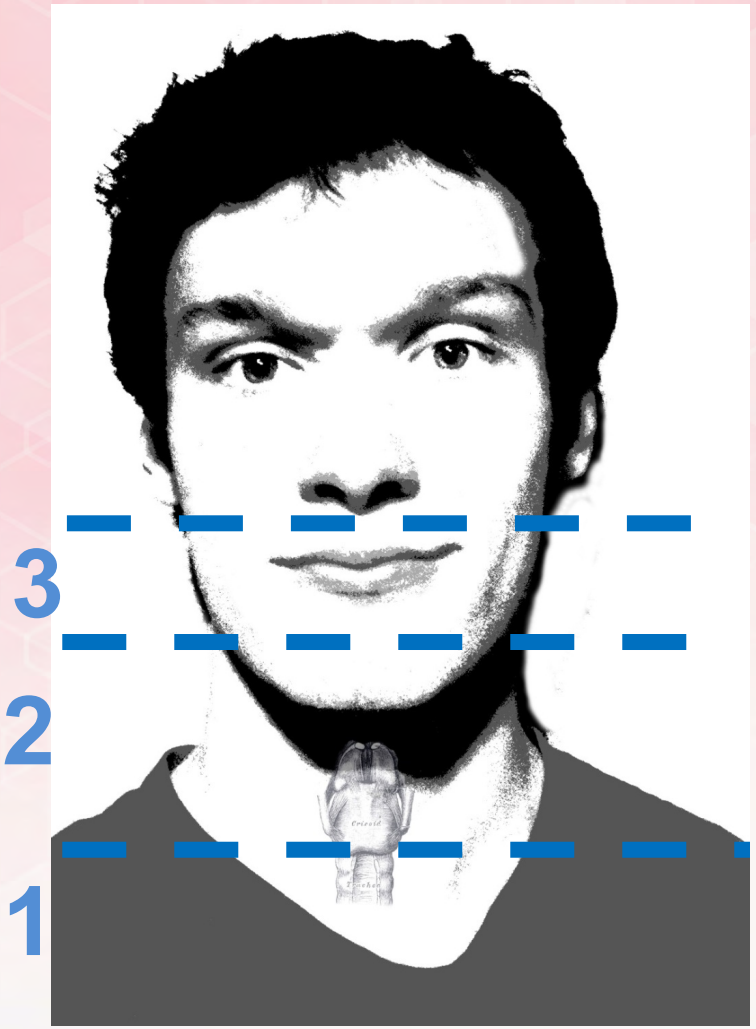
Zones of the Neck

- **Zone 1 -** Clavicles and sternal notch to cricoid cartilage
- **Zone 2 –** Cricoid cartilage to the angle of mandible
- **Zone 3–** Angle of mandible to base of skull



(Monson, Saletta,& Freeark, 1969)

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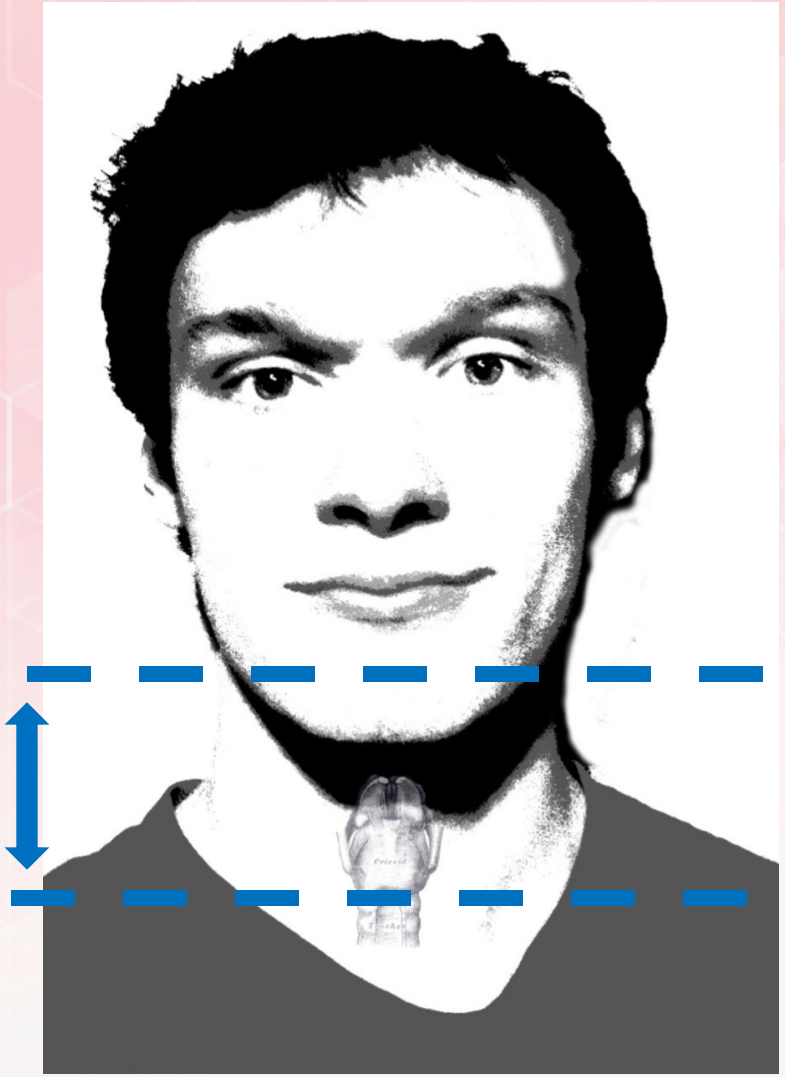
Zones of the Neck

Zone 1

- Subclavian vessels
- Common carotid arteries
- Aortic arch
- Jugular veins
- Esophagus
- Lung apices
- C- spine/cord
- Cranial nerve roots
- Thoracic duct

Zone 2

- Common carotid and vertebral arteries
- Jugular veins
- Pharynx
- Larynx
- Trachea
- Esophagus
- C-spine/cord
- Vagus/recurrent laryngeal nerves



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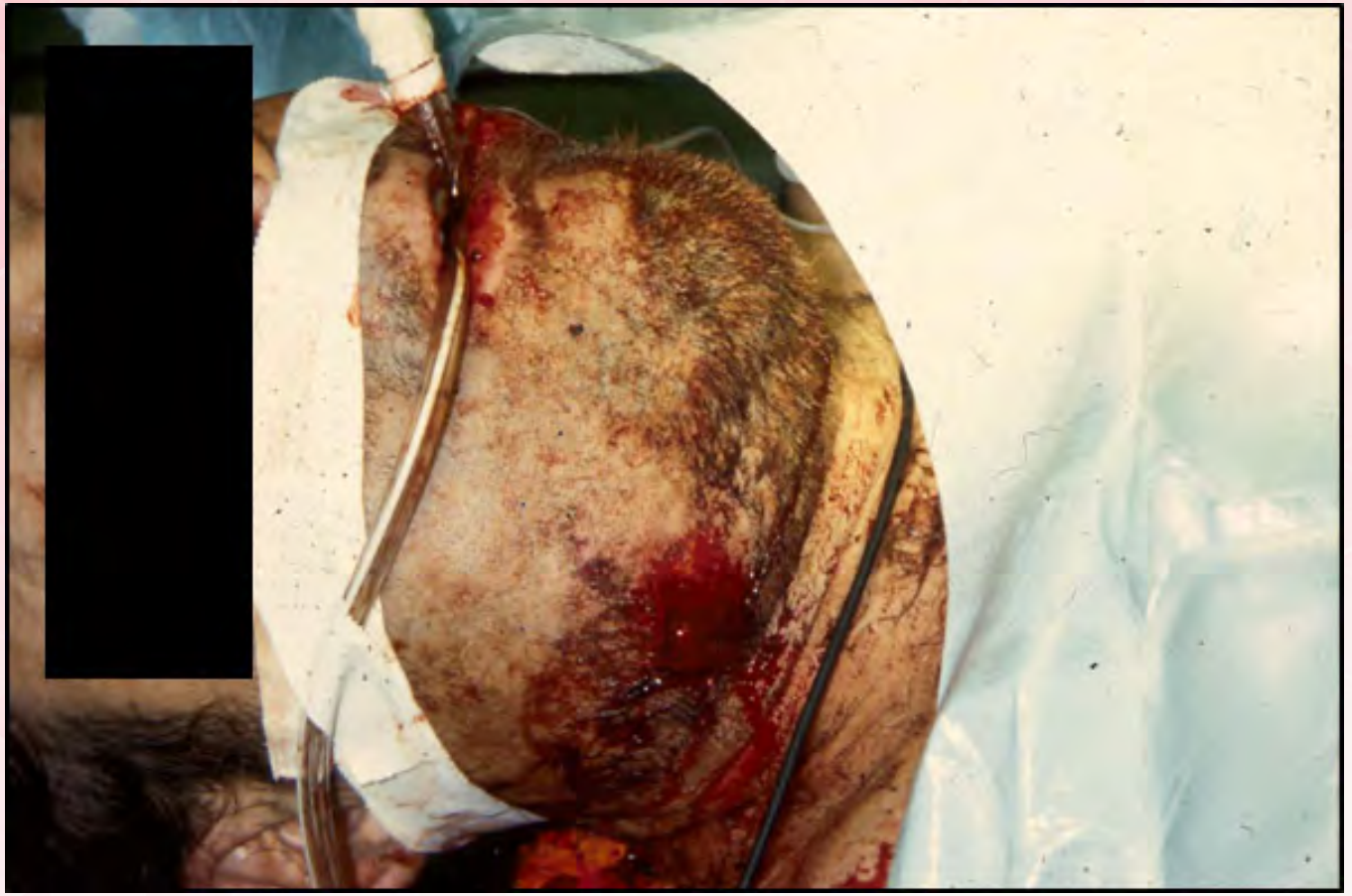
Zone 3

- Salivary and parotid glands
- Esophagus
- Trachea
- Vertebral bodies
- Distal portion carotid arteries
- Jugular veins
- Cranial Nerves IX-XII

History and Physical to Identify Neck Injury



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History and Physical

- Gun
  - Caliber, distance
- Knife
  - Length, angle
- Amount of blood loss
- Baseline mental status
- Baseline motor status
- Drug or alcohol ingestion
- Self inflicted or inflicted by other

Key Findings for Neck Trauma

Hard signs

- Airway obstruction
- Pulsatile bleeding
- Expanding hematoma
- Unresponsive to resuscitation
- Extensive subcutaneous emphysema

Soft signs

- Voice change
- Wide mediastinum
- Hemoptysis
- Hematemesis
- Dysphonia/dysphagia

Management - Primary Survey

- ABCs
- Ensure airway is patent
- Ensure patient is adequately oxygenating
- Control any obvious hemorrhaging
- IV access

Airway Considerations

Who requires immediate intubation?

- Apneic
- Comatose
- Respiratory compromise
- Expanding neck hematoma
- Massive subcutaneous emphysema
- Massive bleeding in airway

Airway Considerations

- “Wait and See”
- Avoid excessive bag-valve-mask
- Exercise caution with paralytics and sedation
- Surgical airway last resort
- Cricothyrotomy vs. tracheostomy

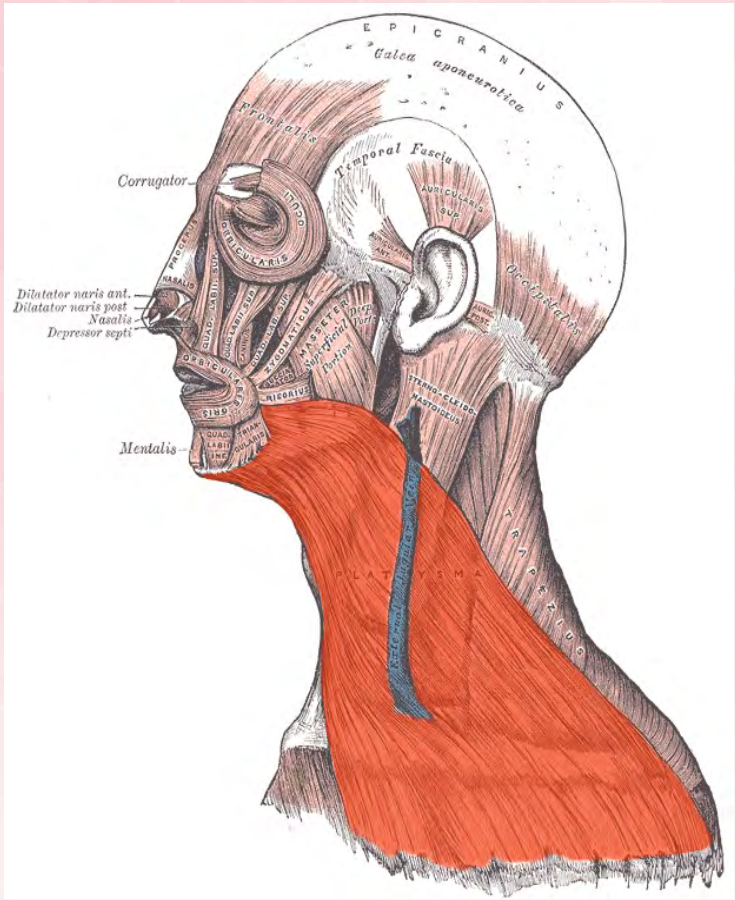
Control Bleeding

http://chestofbooks.com

- Local pressure only
- **No** tourniquets
- **No** pressure dressings
- **No** probing or blind clamp placement

Physical Exam

- Violation of the platysma muscle
- CNS exam
- Obvious hematoma, bleeding



Physical exam

- Contusions, lacerations, abrasions to the neck, etc.
- Expanding hematomas, obvious bleeding
- Hoarseness, stridor,
- Subcutaneous emphysema
- Hemoptysis, drooling
- Dyspnea
- Distortion of the normal anatomic landmarks
- Mandibular/midface instability

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Diagnostic Studies

- Chest radiograph
- CT and CT angiogram
  - Laryngeal injury
  - Tracheal injury
  - Cerebral Vessels
  - Blunt esophageal injury

Diagnostic Studies

CT Scan

- Can aid in identifying weapon trajectory and structures at risk
- Should only be used in stable patients
- Use of CT scan in stable patients
- Saved patients from arteriogram indicated by older protocols 50% of the time
  - Avoided esophagoscopy in 90% of patients who might otherwise have undergone it

(Gracias, Reilly, & Philpott, 2001)

Diagnostic Studies

- Laryngoscopy
- Bronchoscopy
- Esophagoscopy; esophagram
- Rigid vs. flexible esophagoscopy
- Color flow doppler, duplex ultrasonography
- MRA

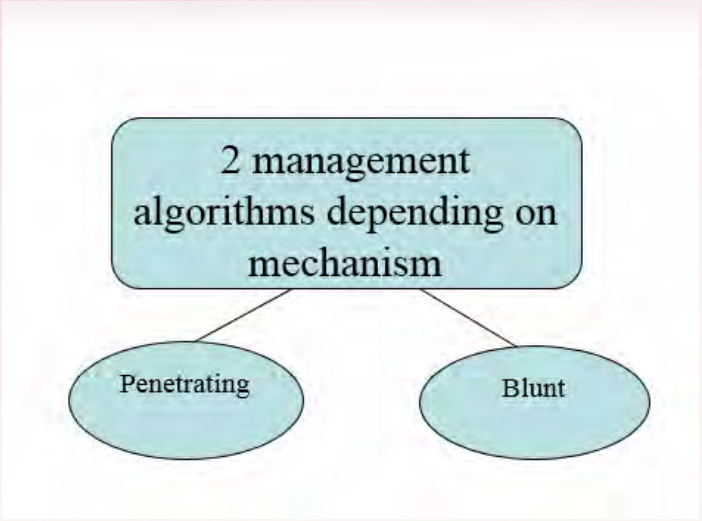
Diagnostic Studies

Arteriogram

- Gold standard
- Invasive
- Complications
- Availability varies
- Expensive
- Contrast load
- Simultaneous intervention

Specific Injuries

- Vascular
- Aerodigestive
- Cranial nerves
- Thoracic duct



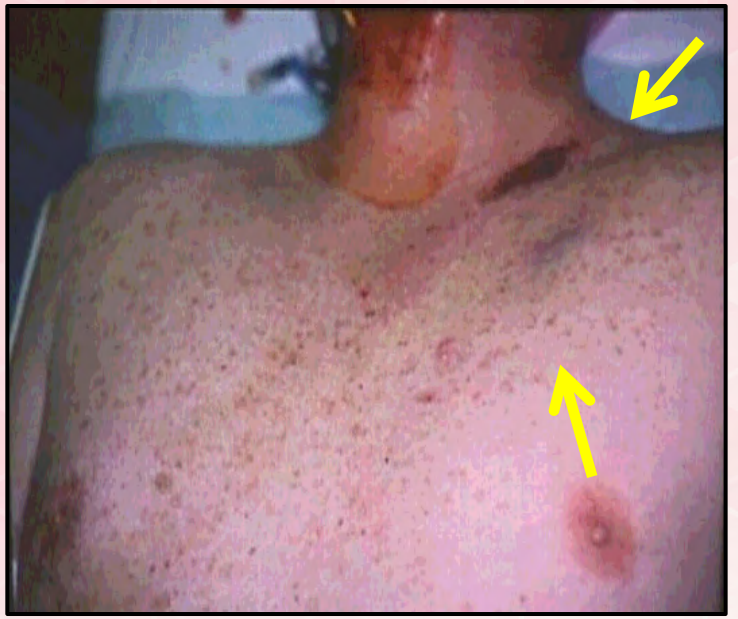
Vascular Injuries in the Neck

Physical Exam

- External marks
- Decreased LOC
- Hemiparesis
- Hematoma
- Hypotension
- Dyspnea
- Thrill, bruit, pulse not present

Injuries that should heighten your suspicion for blunt cerebral vascular injury (BCVI)

- Le Fort II or III fractures
- Basilar skull fracture involving the carotid canal
- Mandible fracture
- Diffuse Axonal Injury with GCS < 6
- Cervical vertebral body fracture
- Near hanging with anoxic brain injury
- Seatbelt abrasion of anterior neck with significant swelling/altered mental status
- Thoracic injury - rib fracture and thoracic injury (Franz et al, 2012)



(Bromberg et al., 2010)

Primary Diagnostics

- CT angiogram of the neck
- Chest x-ray indicated in Zone I injuries because of their proximity to the chest
- Consider complete blood count, basic metabolic panel, toxicology and blood alcohol content

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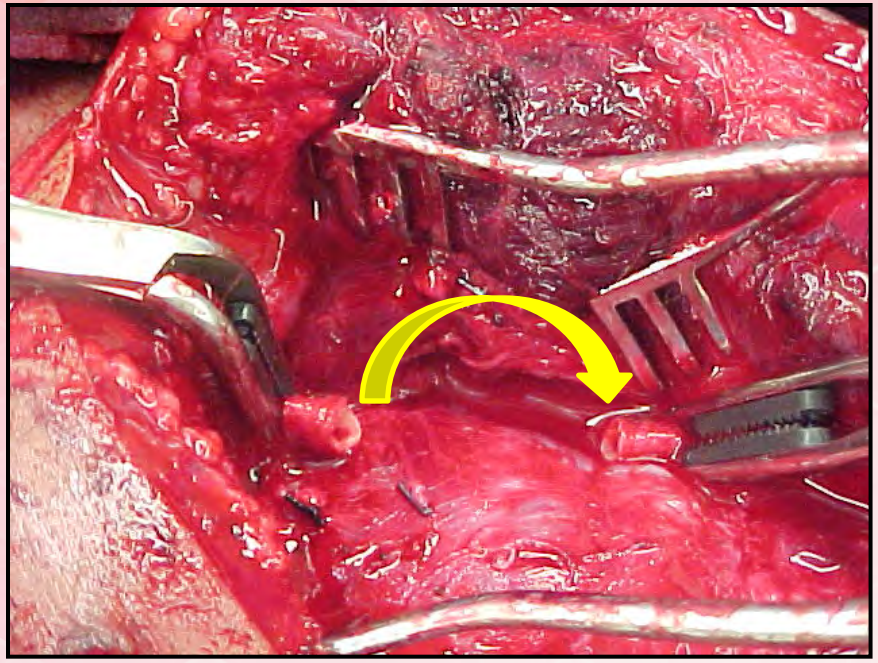
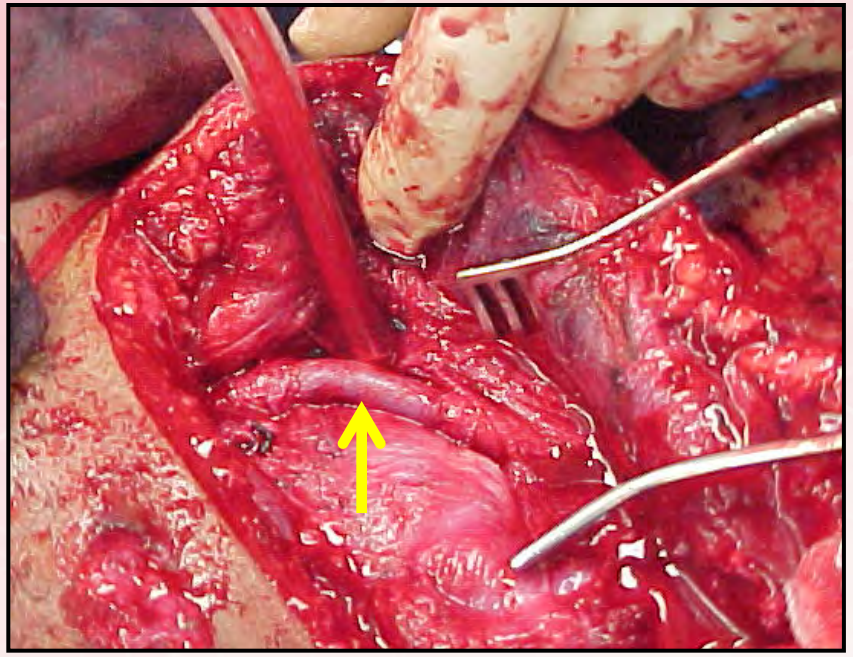
Vascular Injury Management: Penetrating

- Common carotid: repair preferred over ligation in almost all cases
- Internal carotid: Shunting is usually necessary
- Vertebral: Angiographic embolization or proximal ligation can be used if the contralateral vertebral artery is intact
- Internal Jugular: Repair vs. ligation

Carotid Artery Interposition Repair

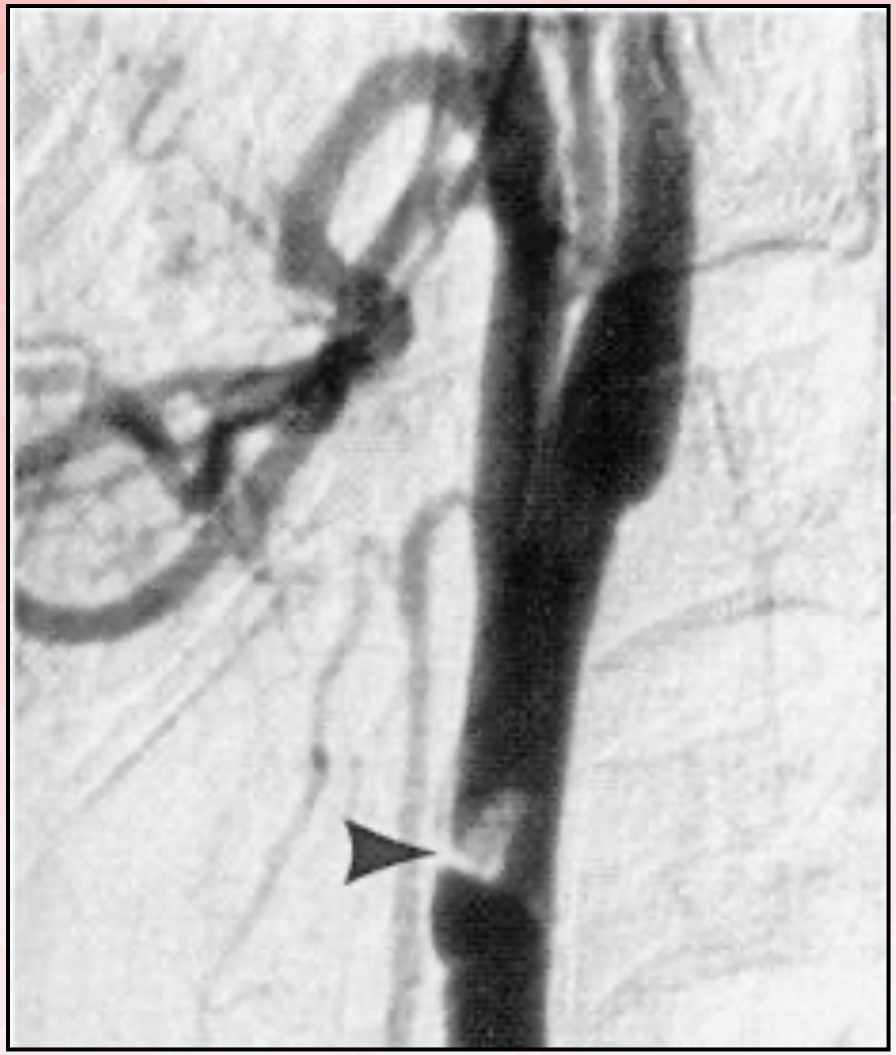




Blunt Cerebral Vascular Injuries (BCVI)

- Management dependent on the grade of injury – Grade I - V
  - Grade I: Irregular appearance of vessel wall or dissection/intramural hematoma with less than 25% luminal narrowing
  - Grade II: Intimal flap or intramural hematoma with > 25% narrowing
  - Grade III: Pseudoaneurysm
  - Grade IV: Occlusion
  - Grade V: Transection or hemodynamically significant injuries

Carotid Intimal Flap: Example of Grade II Injury



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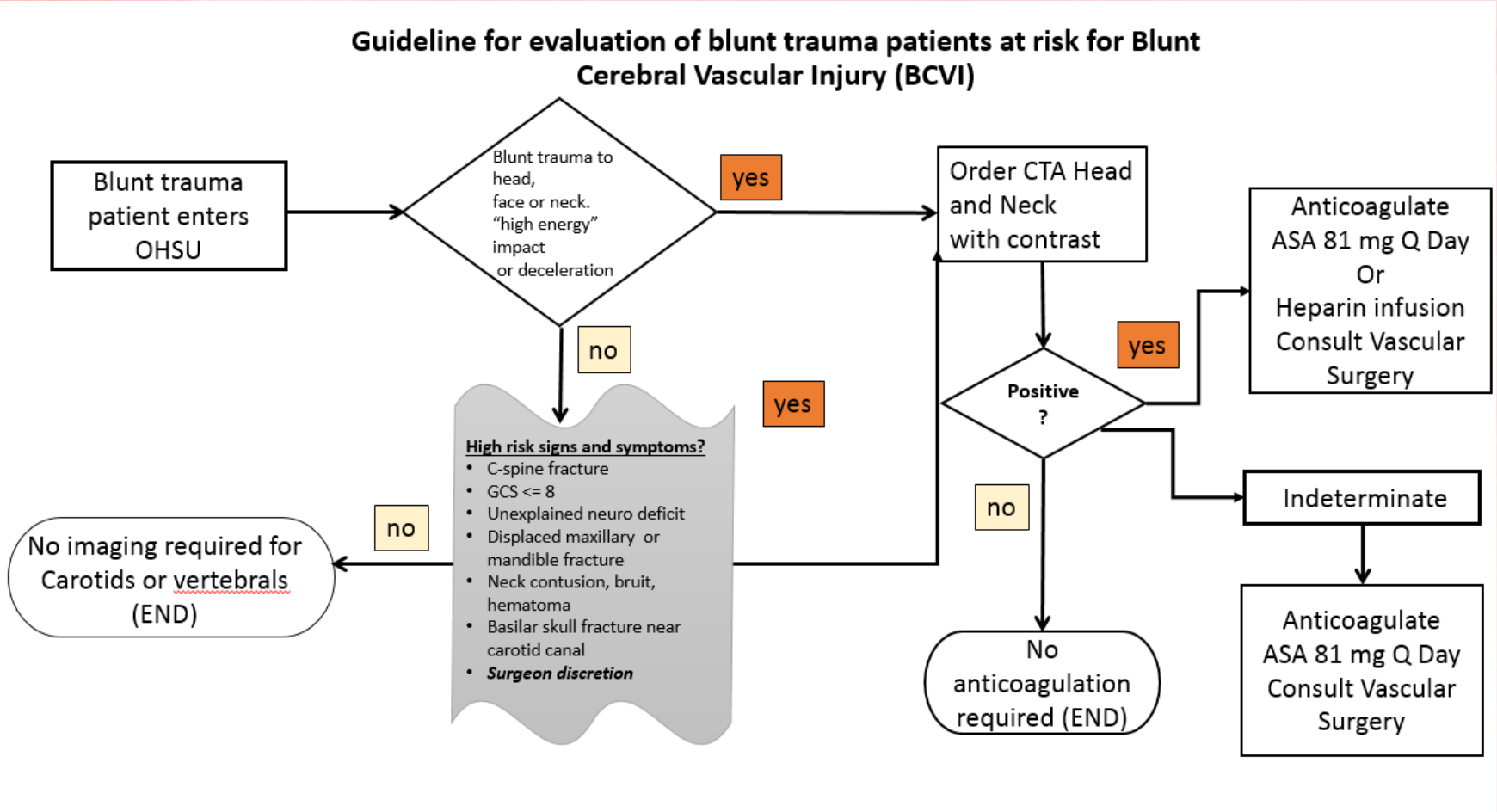
Example BCVI management protocol



Protocol from Oregon Health Sciences University Hospital- used with permission

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Management Summary

Vascular Injury

- Surgical exploration unstable and stable Zone II
- Angiography for Zone I and III
- Selective, nonoperative management stable Zone II
- Embolization high carotid or vertebral artery
- Endovascular stent (pseudoaneurysms)
- Anticoagulation blunt carotid/vertebral artery

Aerodigestive Injuries

- Airway structures
  - Trachea
  - Larynx
  - Thyroid cartilage
- Esophagus
  - If diagnosis < 24 hours
  - Poor outcome if diagnosed > 24 hours
- Pharyngeal

Tracheal and Laryngeal Injuries

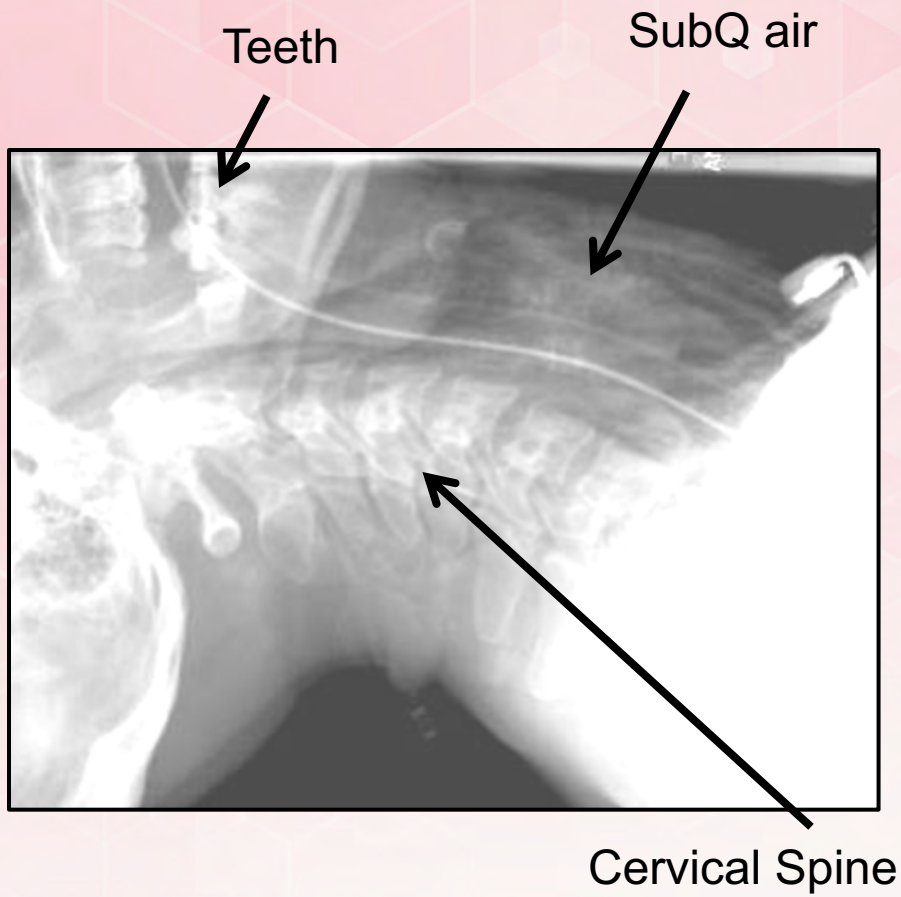
Signs of injury

- Hoarseness and dysphonia
- Hemoptysis
- Subcutaneous emphysema in the neck and trunk
- Tenderness over the trachea

Primary Diagnostics

Laryngotracheal Injury

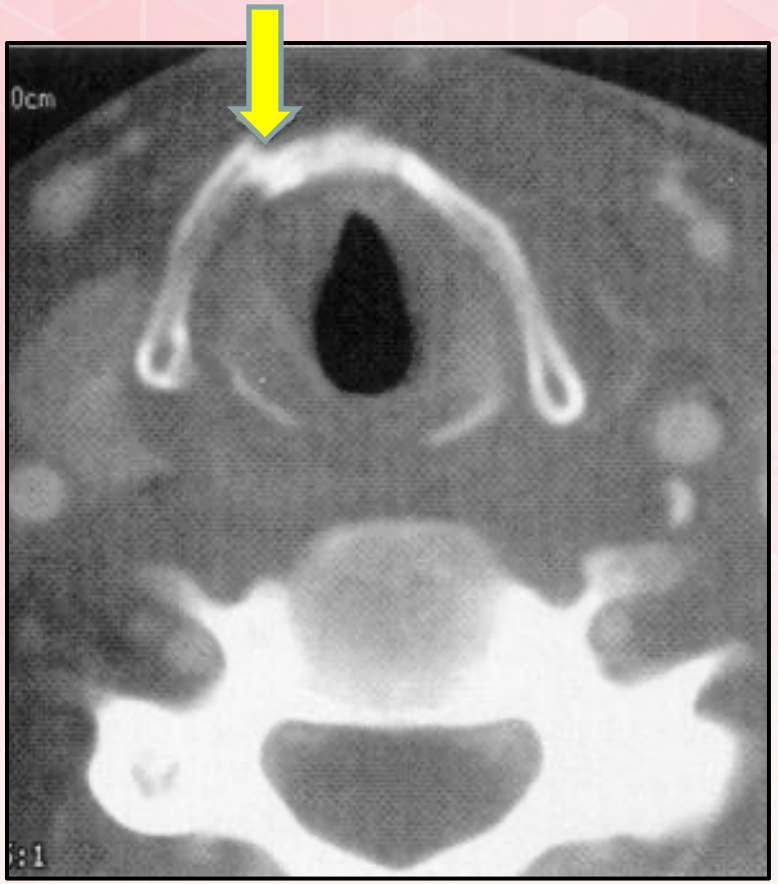
- Plain x-rays
  - Soft tissue emphysema
  - Airway compression
  - Fracture of laryngeal cartilages
- CT scan
  - 3D reconstruction
- Endoscopy
  - Flexible vs. rigid
  - Bronchoscopy/laryngoscopy



Management

Laryngotracheal Injury

- Secure the airway
- Early repair
- Laryngeal fractures
  - Thyroid fracture most common
  - Delay of reduction makes it more difficult and return of normal function unlikely



Esophageal Injury

Penetrating

- Sharp weapon (knife)
- High speed projectile (bullet)
- Iatrogenic laceration
- Lumen outward injury (ingestion of sharp object)

Esophageal Injury

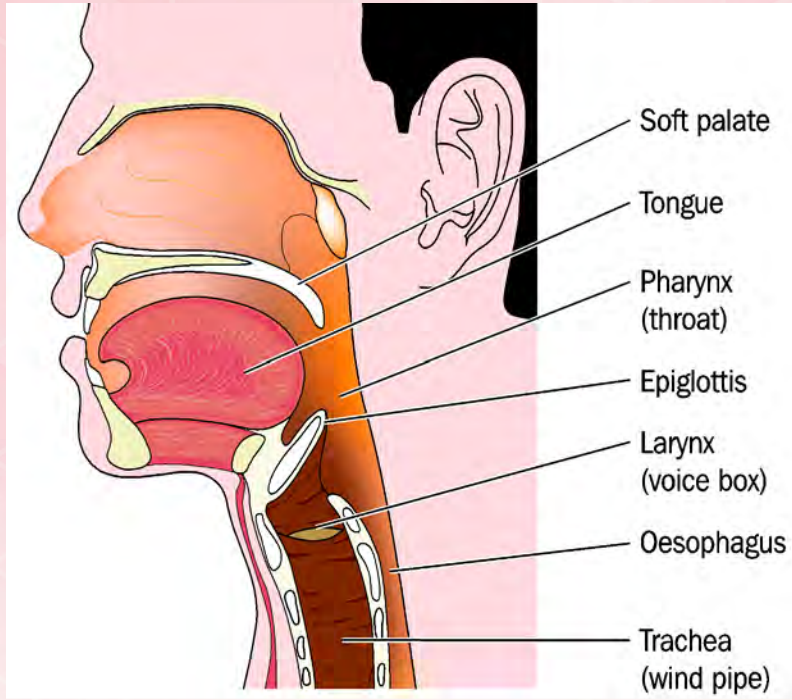
Blunt

- Barotrauma
- Blast injuries
- Crush injuries
- Blow to the neck

Esophageal Injury

Signs of Injury

- Hematemesis
- Odynophagia
- Dysphagia
- Drooling, hypersalivation
- Tracheal deviation
- Sucking neck wound
- Subcutaneous emphysema
- Pain with turning neck



Esophageal Injury Diagnostics

Radiographic Findings

- Plain films
  - Air in soft tissue planes
  - Pneumomediastinum
  - Leakage of fluid into right pleural space
- Contrast swallow
  - Extravasation is diagnostic
- CT scan

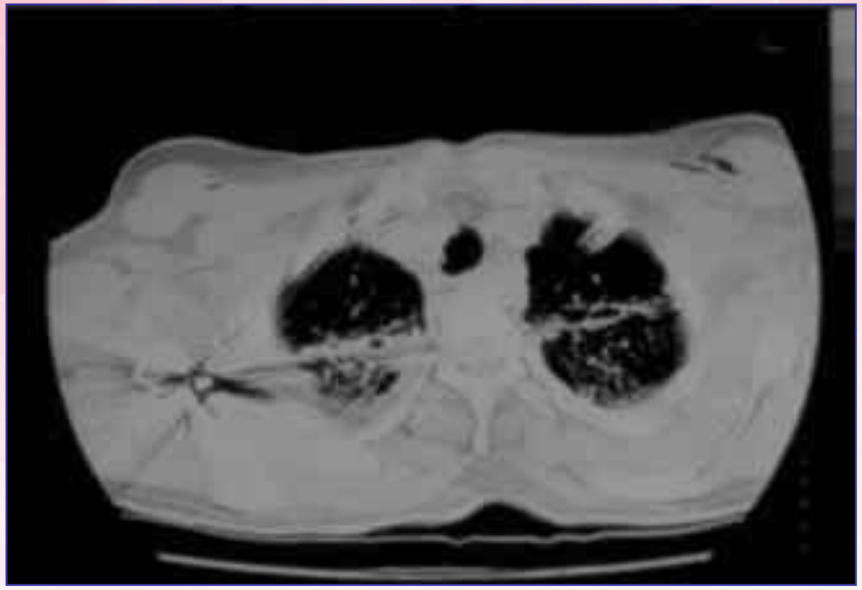
Laboratory Findings

- Markers of inflammatory response
  - Leukocytosis with left shift
  - Low oxygen saturations
  - Acidosis on ABG

Esophageal Injury Diagnostics

Helical CT

- Expedites diagnosis
- Trajectory of missile
- Associated injuries



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Diagnostics Esophageal Injuries

Normal

Thoracic Leak

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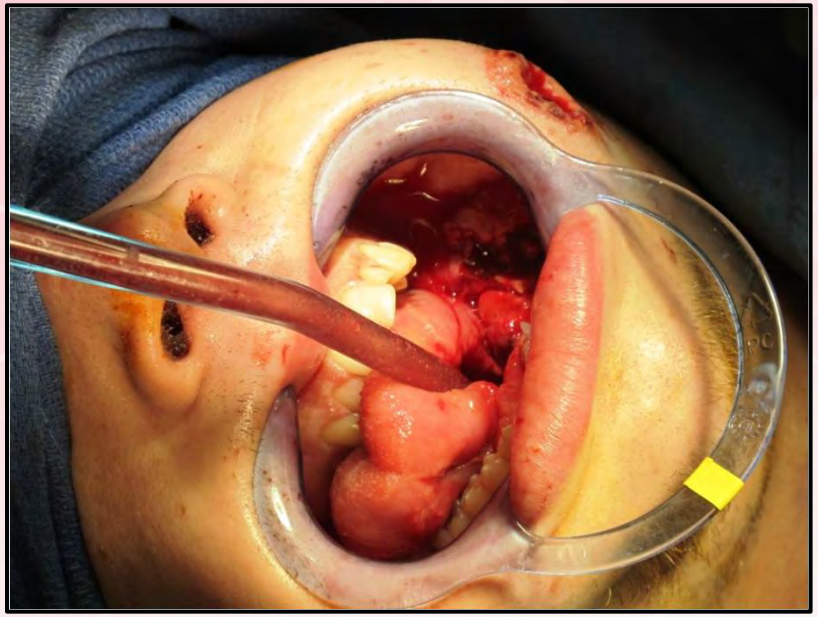
Esophageal Injury

Management Summary

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

Pharyngeal/Oral Injury

Similar presentation as esophageal injury



Practice Guidelines

- Few published practice guidelines for the management of neck injuries
- Eastern Association for the Surgery of Trauma (EAST)
  - Penetrating neck injuries only
  - Blunt cerebrovascular injury

(Tisherman et al, 2008; Bromberg et al, 2010)

EAST Guidelines Key Points

- Selective operative management vs. mandatory exploration
- CT Angiography and duplex ultrasound can be used to identify Zone II arterial injuries
- Contrast esophagography or esophagoscopy can be used to evaluate for perforation.
- Serial physical examination is 95% sensitive for detecting arterial and aerodigestive tract injuries that need repair

(Tisherman et al, 2008)

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EAST Guidelines Summarized

- Selective management is common now in asymptomatic patients;
- CT angiography is a very good tool to rule out vascular injuries
- The role of physical exam, esophagography, and esophogoscopy remains controversial

(Tisherman et al, 2008)

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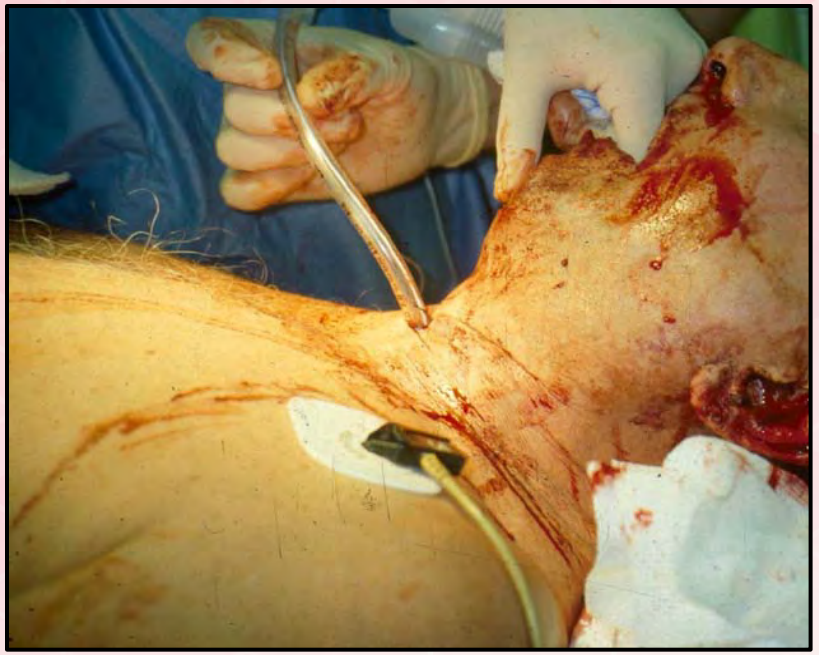
Do all patients have to lay flat?

- Position patient in manner that is most comfortable
- Patients with anterior neck trauma may want to lean forward or sit upright
- Patients with copious secretions can be rolled on their side



(Lustenberger et al, 2011)

What about Cervical Spine Immobilization?

- Immobilization in penetrating injury only necessary when neurologic deficit is present or physical exam cannot be performed and mechanism suspicious for spinal cord injury
- Unnecessary immobilization may actually obscure recognition of other injuries or visualization of the airway

(Tisherman et al, 2008)

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Possible Complications

- Loss of airway
- Swallowing problems with aspiration
- Stroke in unrecognized vascular injuries
- Soft tissue necrotizing infections, including mediastinitis due to delayed diagnosis of esophageal injuries
- Air embolism
- Pneumothorax, tension pneumothorax

Nursing Considerations

Be alert for:

- Mental status changes and motor deficits
- Changes in airway patency
- Onset of stridor, drooling
- Difficulty laying supine
- Other injuries that are highly associated with cerebral vascular injuries

Nursing Assessment

- Frequent neurologic and motor checks
- Frequent assessment for expanding hematomas in the neck
- Careful history documentation
- Reassurance
- Adequate pain assessment
- Anxiety reduction

Summary

- Penetrating and blunt neck trauma occurs in 5-10% of patients with serious injuries
- Maintenance of an adequate airway is paramount to survival
- Maintain a healthy respect for initially benign appearing injuries
- Unrecognized vascular or aerodigestive injuries have a high mortality

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Thoracic Injuries

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Objectives

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

- Describe resuscitative interventions for patients with thoracic trauma
- Explain clinical manifestations associated with life-threatening injuries
- List life-threatening injuries that should be identified during the primary survey
- Identify general treatment for patients with thoracic trauma

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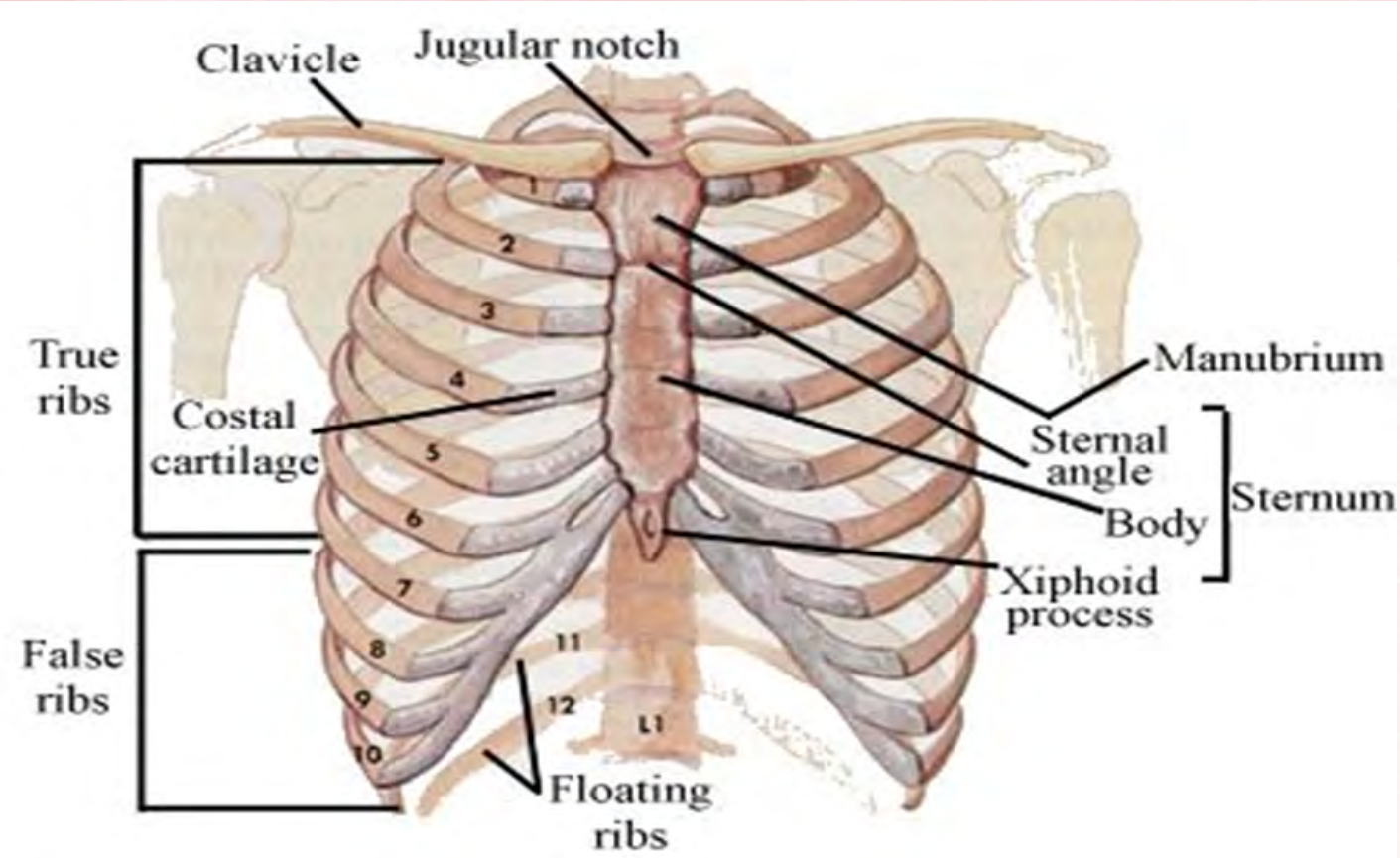
Incidence

- Common in blunt and penetrating trauma
- Some of the most deadly and dramatic injuries
- Early recognition and treatment are crucial
- Basic interventions can save lives

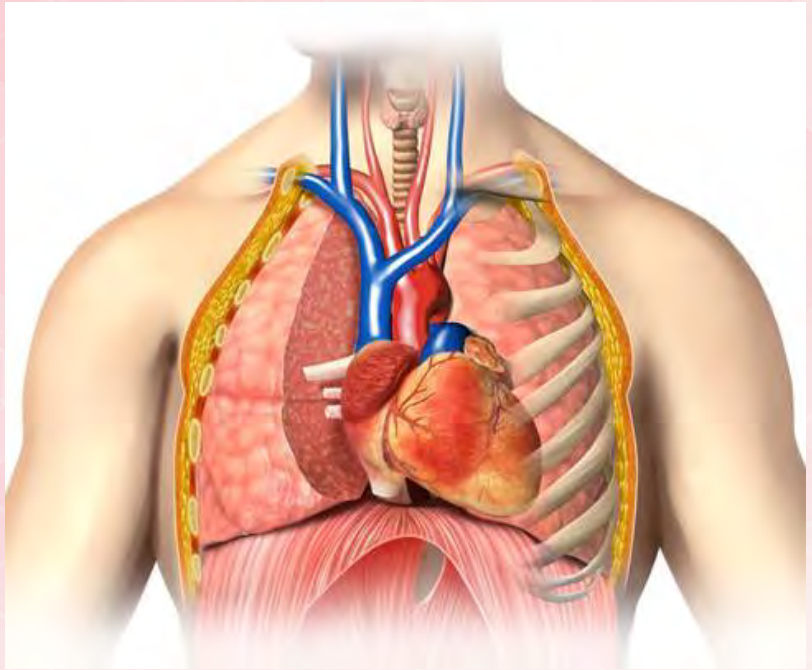
Thoracic Anatomy



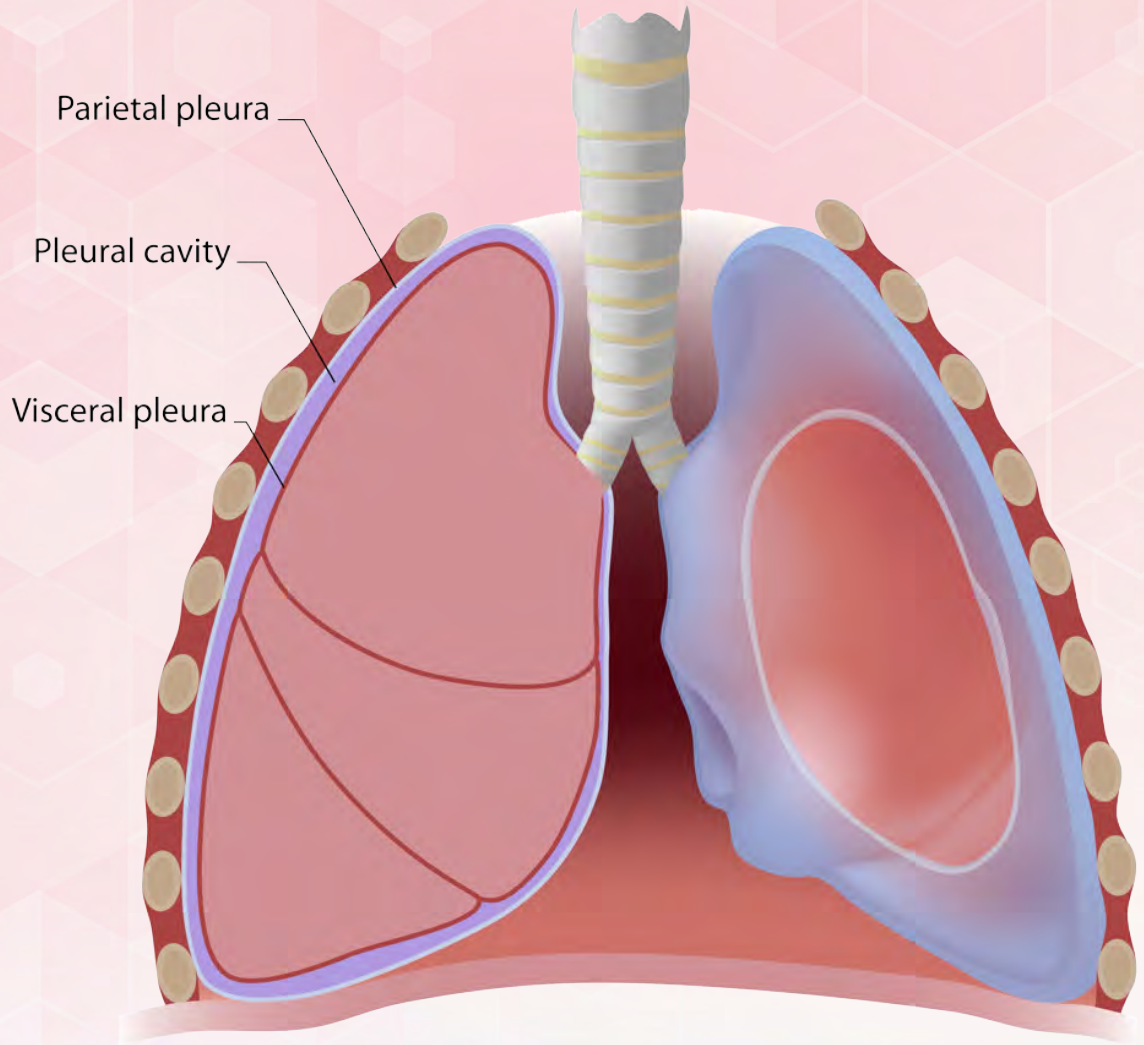
http://www.daviddarling.info/encyclopedia/R/rib-cage.html

Lungs

- Cone shaped organs
- Separated by heart and pulmonary vessels
- Hilum is entry point for bronchi and blood vessels



Pleura



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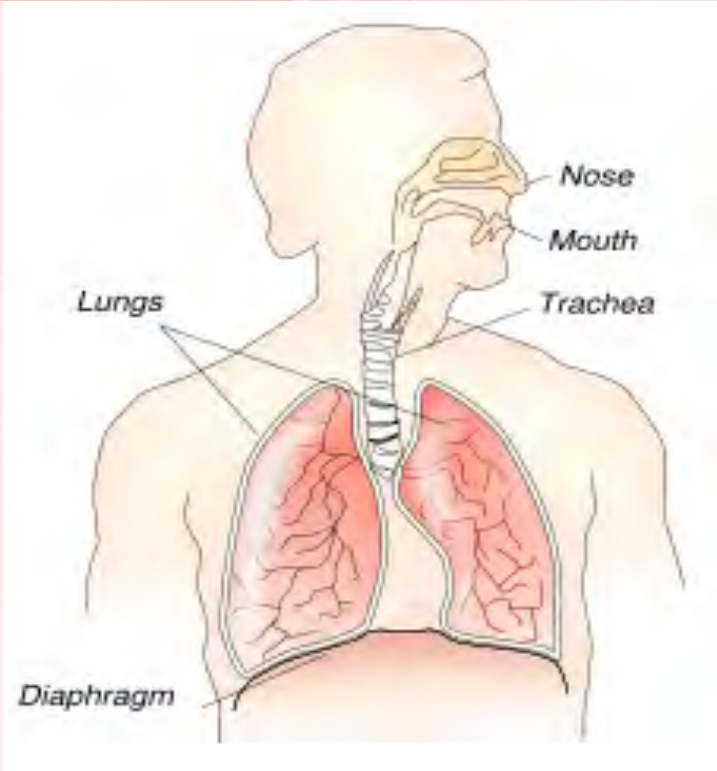
Muscles of Ventilation



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Diaphragm

- Dome-shaped skeletal muscle
- Separates thoracic and abdominal cavities
- Innervated by phrenic nerve

Muscles of Ventilation

Intercostal Muscles

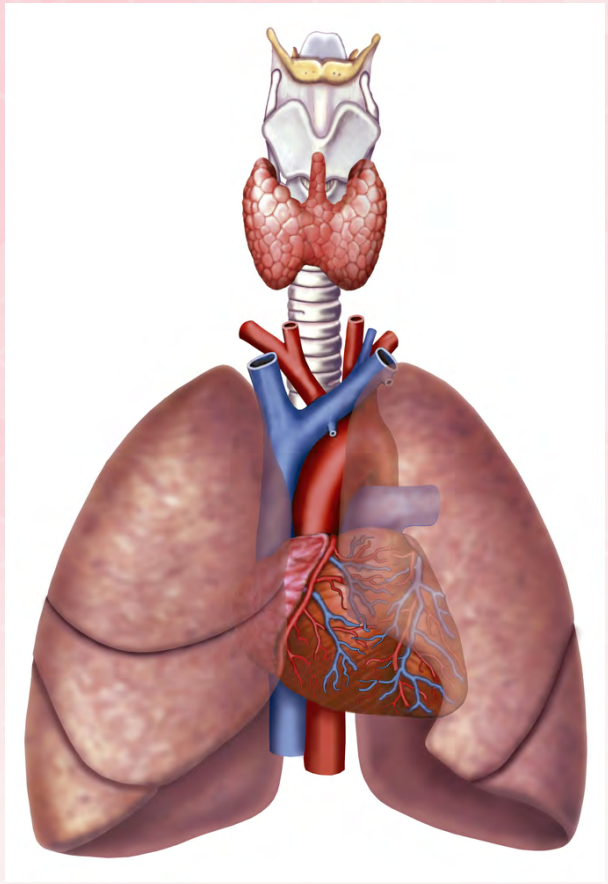
- External & Internal
- Lift ribs to enlarge thorax
- Innervated by intercostal nerves

Accessory Muscles

- Chest wall movement
- Neck
  - Sternocleidomastoids
  - Scalenes
- Abdominal

Mediastinum

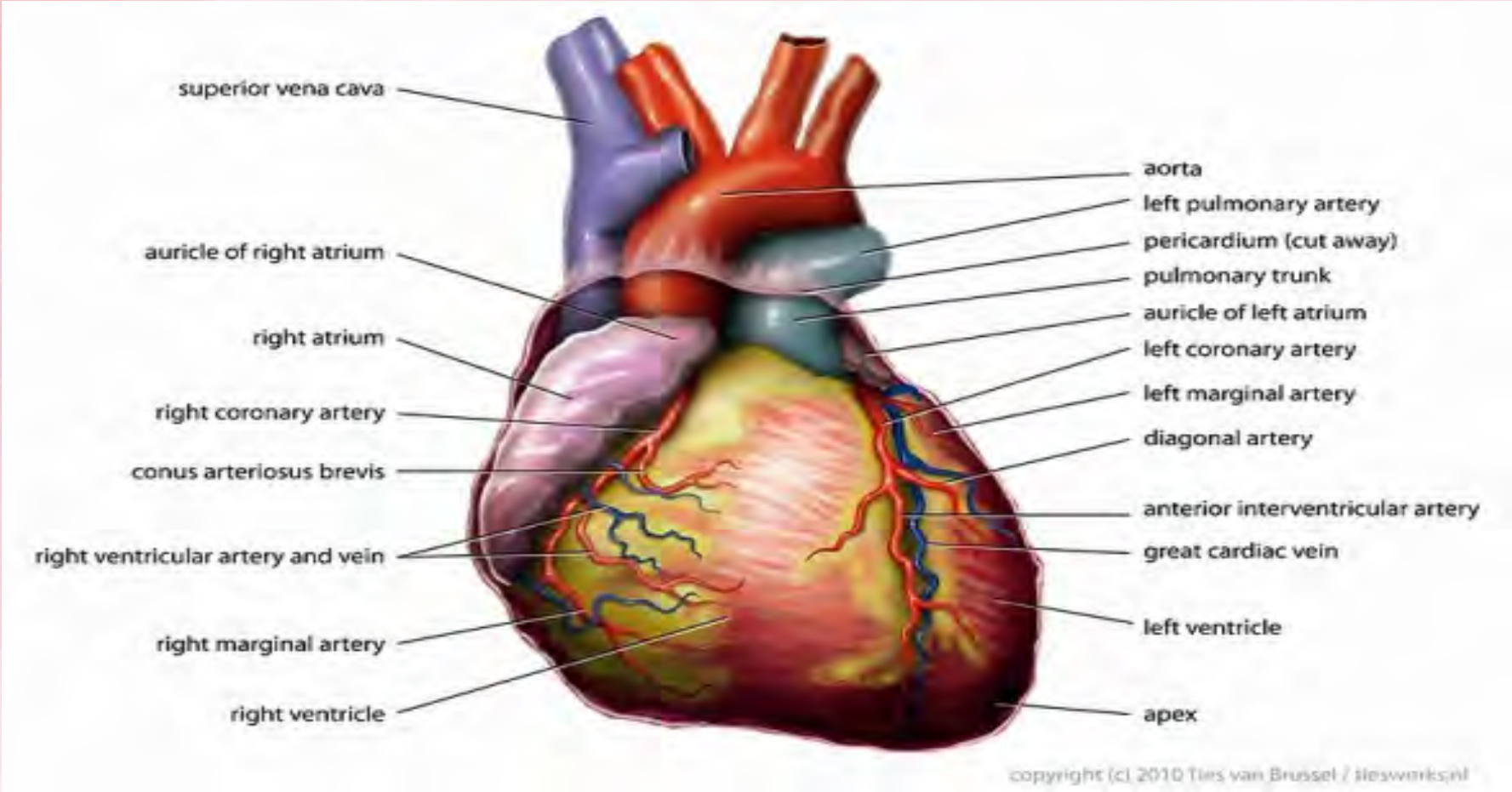
- Heart
- Thymus
- Great Vessels
- Trachea
- Thoracic duct
- Lymph nodes
- Vagus & phrenic nerves
- Sympathetic trunks



Heart and Great Vessels

- Heart
- Aorta
- Subclavian
- Jugular

Heart



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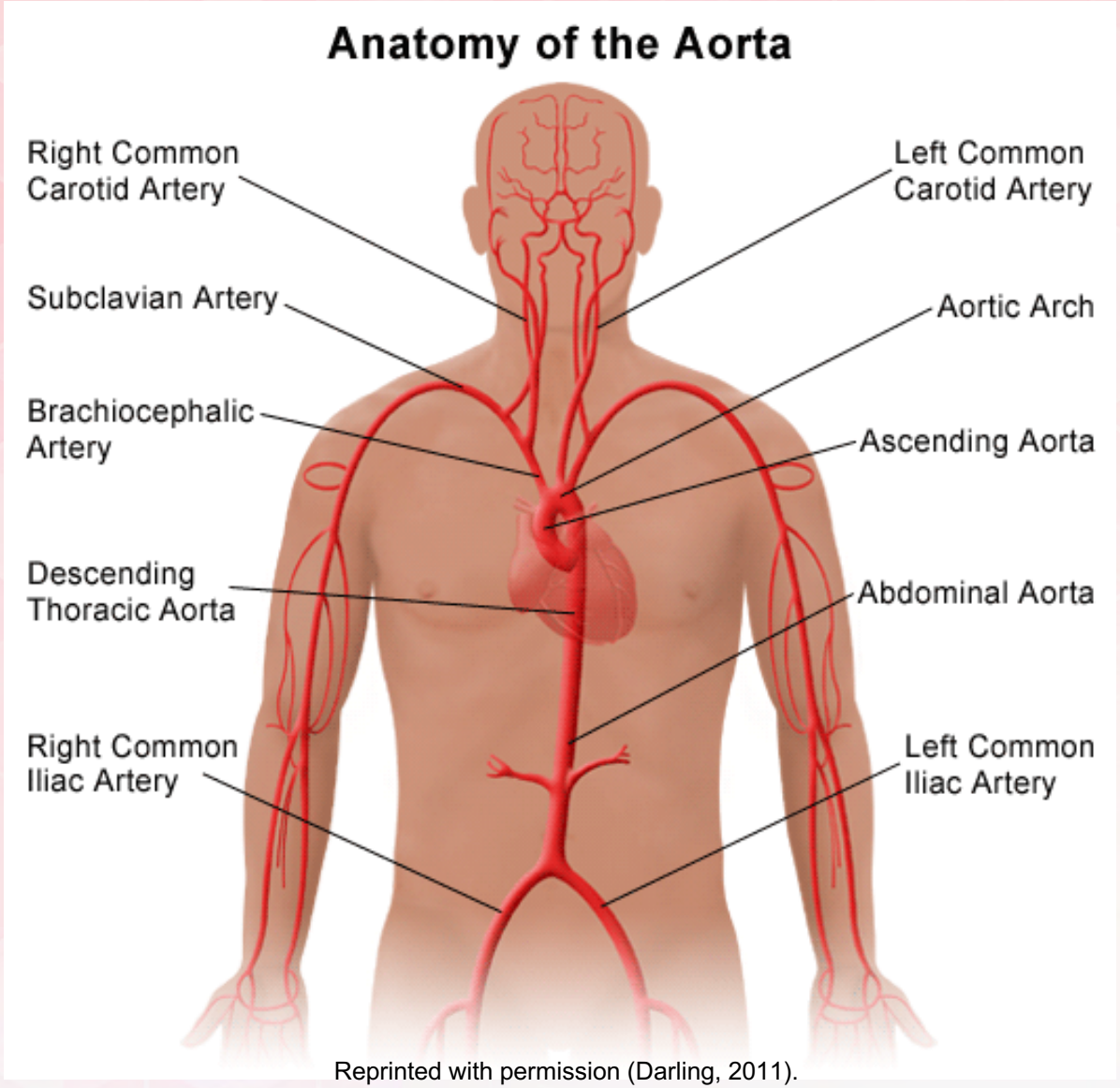
Aorta



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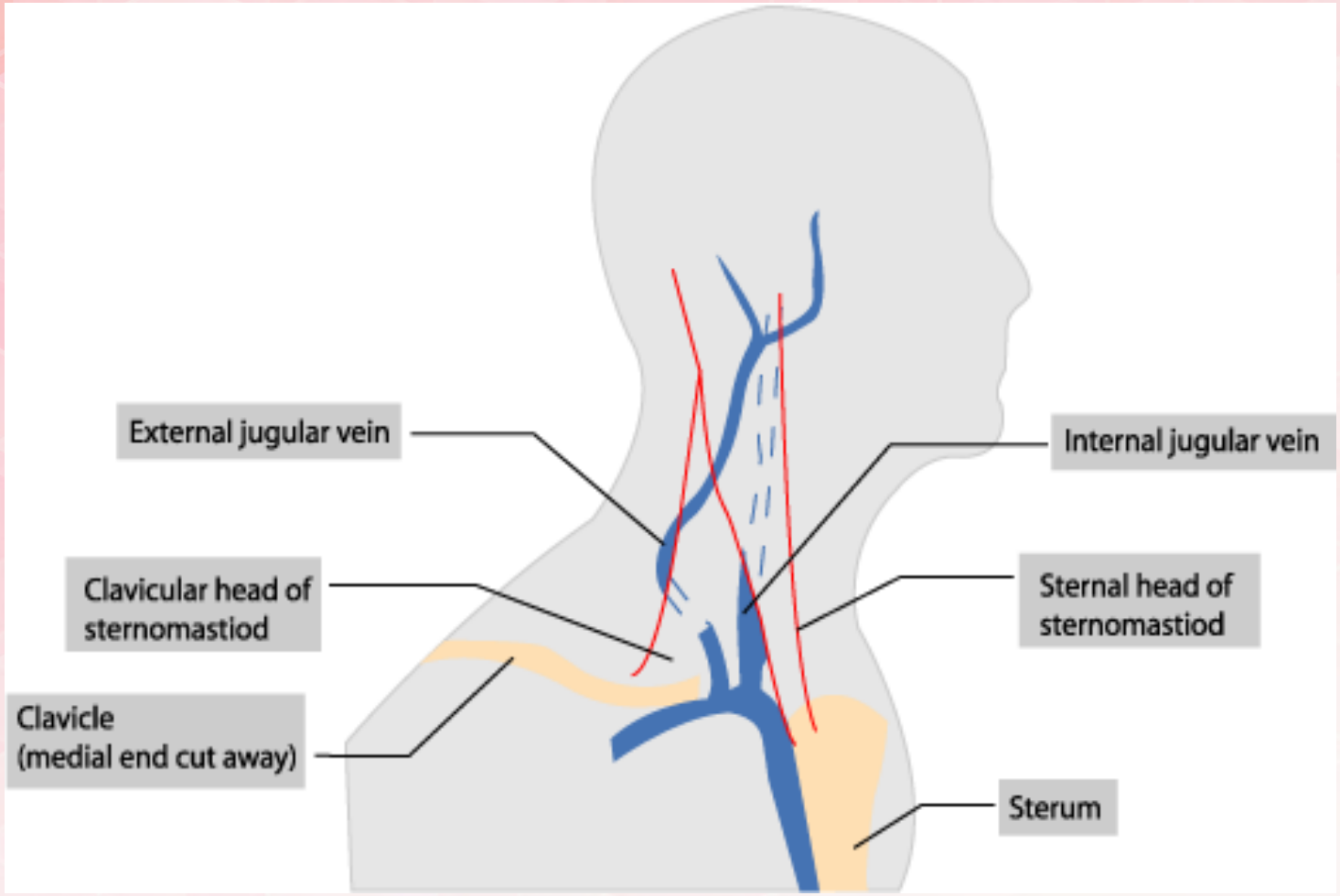
Jugular Veins



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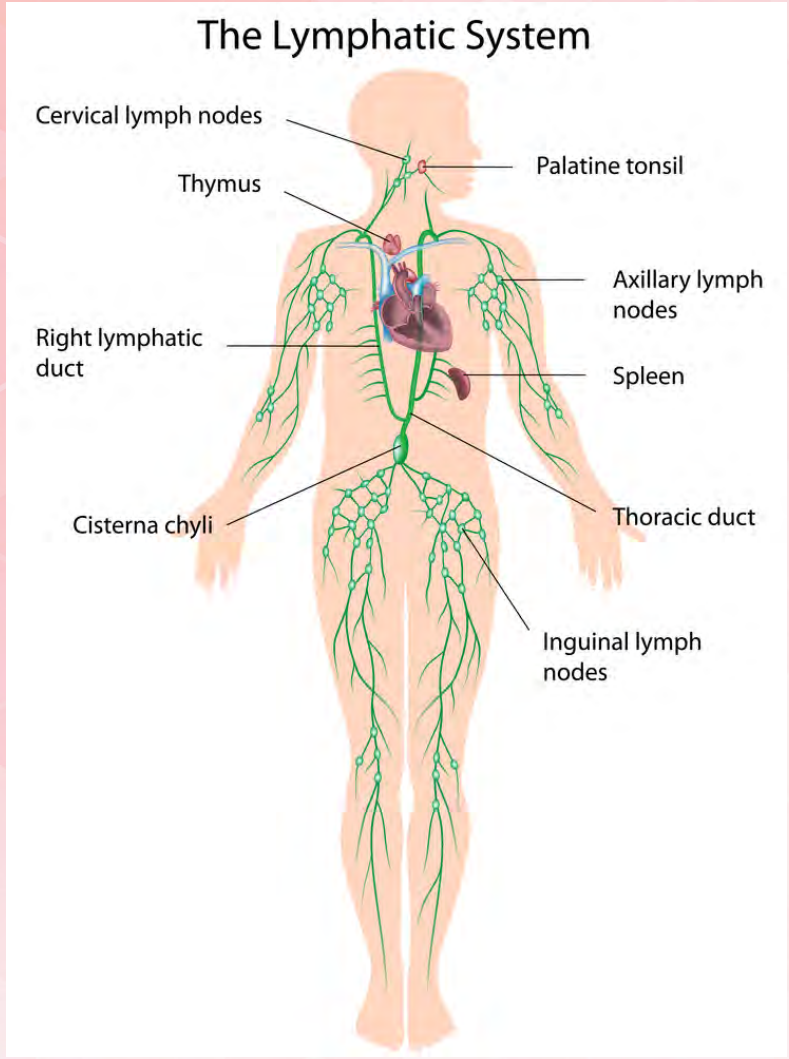
Thoracic Duct



- Protected by spine posteriorly
- Mediastinum anteriorly
- Part of lymphatic system
- Empties into venous system

Thoracic Assessment

- Primary & Secondary Survey with ABC's
- Interventions for any life-threatening injuries
- Immediate diagnostic testing when necessary
- Unreliable exam
  - Altered LOC
  - TBI
  - ETOH/Drugs
  - Distracting injuries
  - SCI

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Thoracic Assessment

Common findings in patient with chest trauma:

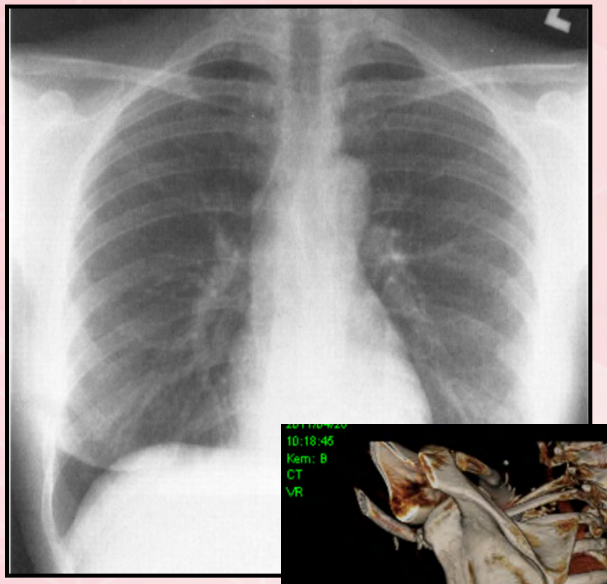
- Diminished breath sounds
- Shortness of breath
- Pleuritic chest pain
- Hypoxia
- Hypotension
- Tachycardia
- Tachypnea
- Hypoventilation
- Subcutaneous emphysema
- Agitation
- Inadequate tissue perfusion
- Acidosis: respiratory and/or metabolic

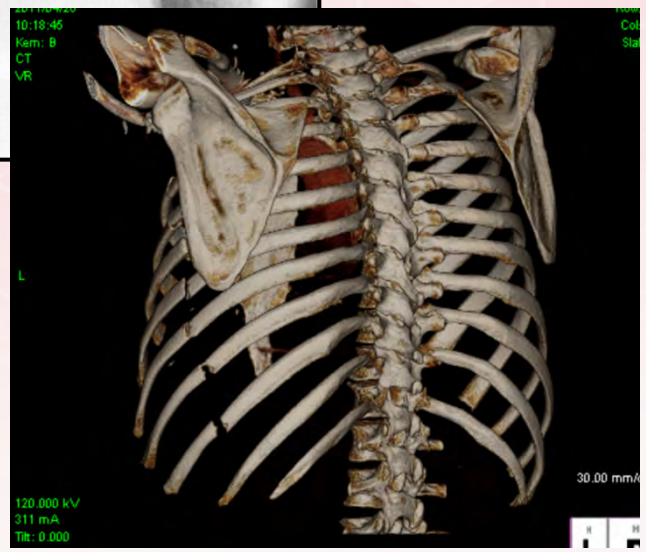
Physiology of Chest Trauma

- Altered physiology of the chest can lead to:
  - Hypovolemia
  - Ventilation/Perfusion Mismatch
  - Changes in Intra-thoracic pressure
- These affect the ability to oxygenate and/ or ventilate adequately leading to **tissue hypoxia**

Diagnostics

- Chest X-Ray
- Focused Assessment with Sonography for Trauma (FAST)
- Computed Tomography
- Arteriography and other diagnostics





SOCIETY OF TRAUMA NURSES

SOCIETY OF TRAUMA NURSES

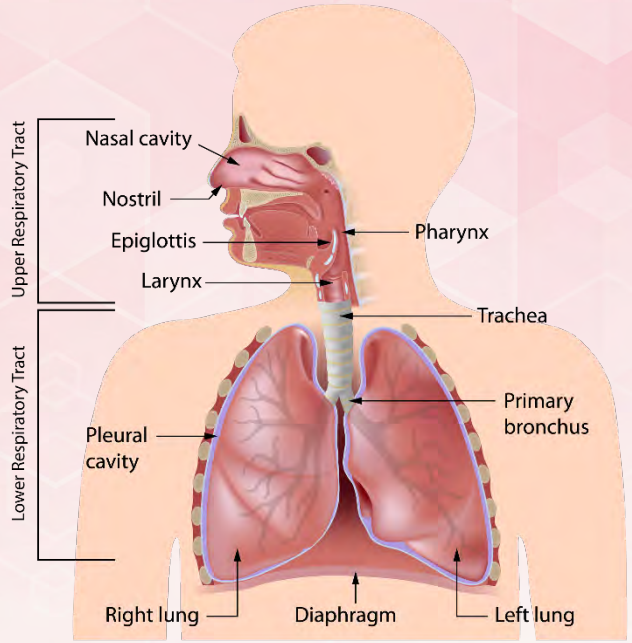
Immediately Life Threatening

- Airway obstruction / Laryngeotracheal Injury
- Tension pneumothorax
- Open pneumothorax
- Massive hemothorax
- Flail chest
- Cardiac tamponade

STN
SOCIETY OF TRAUMA NURSES

Laryngeotracheal Injury/ Airway Obstruction

- Rare injury in both blunt or penetrating
- High index of suspicion if:
  - Facial trauma
  - Burns
  - Secretions/blood in airway
  - Direct laryngeal/neck trauma
  - Expanding neck hematoma



SOCIETY OF TRAUMA NURSES

Laryngeotracheal Injury/ Airway Obstruction

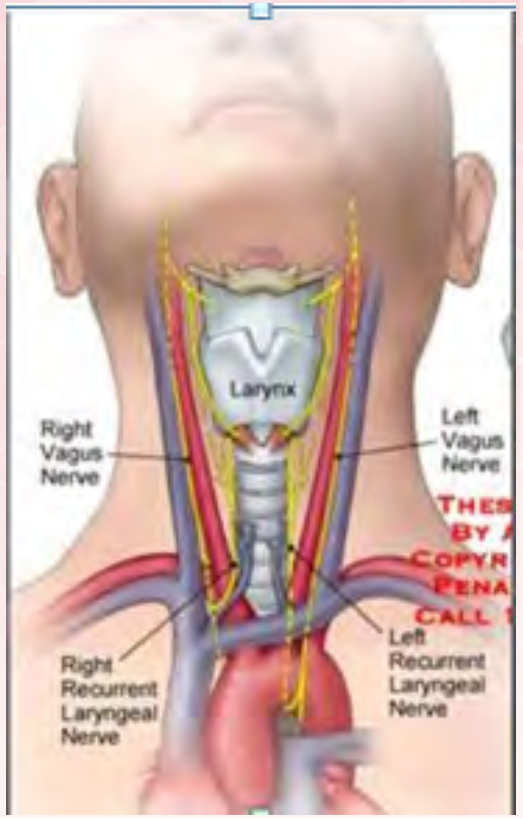
Symptoms

- Tachypnea
- Hypoxia
- Agitation
- Hoarseness and Dysphonia
- Stridor
- Subcutaneous emphysema
- Palpable fracture crepitus
- Low oxygen saturation (late sign)

Laryngeotracheal Injury/ Airway Obstruction

Treatment

- Control airway in primary survey
- Utilize adjuncts
- Intubate cautiously or perform a tracheostomy



SOCIETY OF TRAUMA NURSES

Tension Pneumothorax

Increase in intrapleural pressure

↓

Collapsed lung on affected side

↓

Shift mediastinum to opposite side

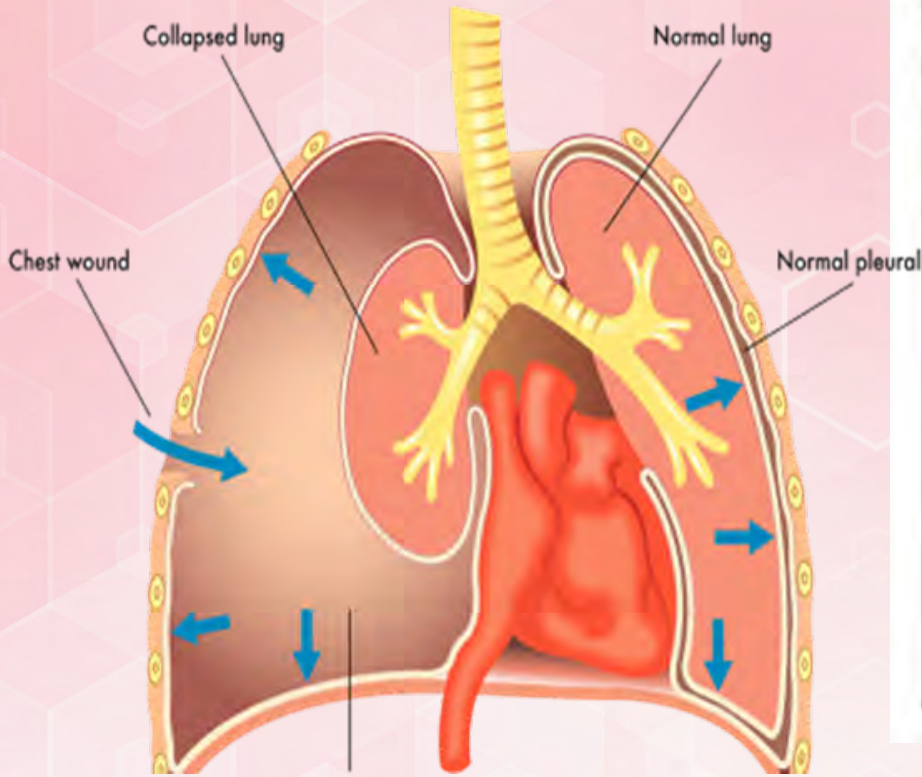
↓

High intrathoracic pressures

Risk for Tension Pneumothorax

- Extension from simple pneumothorax
- Tracheobronchial tree injuries
- Rib fractures
- Lung parenchyma injury
- Barotrauma
- Clogged/clamped chest tube

Simple vs. Tension PTX



SOCIETY OF TRAUMA NURSES

Tension Pneumothorax

Symptoms

- Respiratory distress
- Absent/decreased breath sounds on affected side
- Asymmetric chest movement
- Jugular vein distention
- Tracheal deviation (late sign)
- Shock (late sign)
- Diagnosis should be made on clinical presentation

(American College of Surgeons, 2018)

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SOCIETY OF TRAUMA NURSES

Tension Pneumothorax

Treatment

- Immediate needle decompression
  - Large-caliber needle
  - Between 2nd & 3rd intercostal space above 3rd rib, mid-clavicular line
- Chest tube insertion
  - Tube thoracostomy
  - Insert at 4^{th} or 5^{th} intercostal space between the anterior and midaxillary line

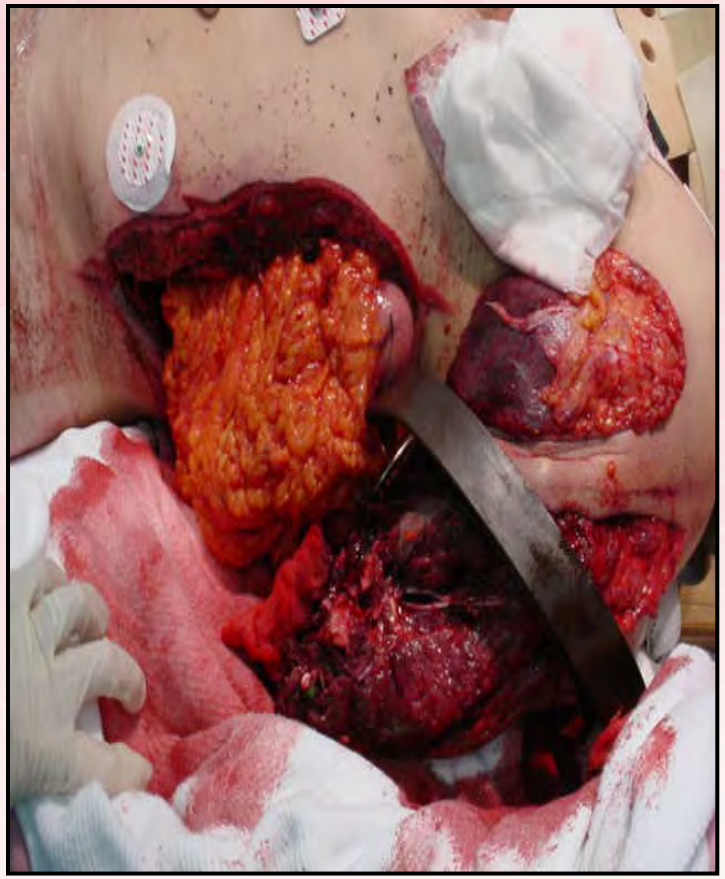
(American College of Surgeons, 2018)

SOCIETY OF TRAUMA NURSES

Open Pneumothorax

“Sucking Chest Wound”

- Visible chest wound bubbling with frothy blood
- Sucking sound near wound
- Subcutaneous air
- Respiratory distress



SOCIETY OF TRAUMA NURSES

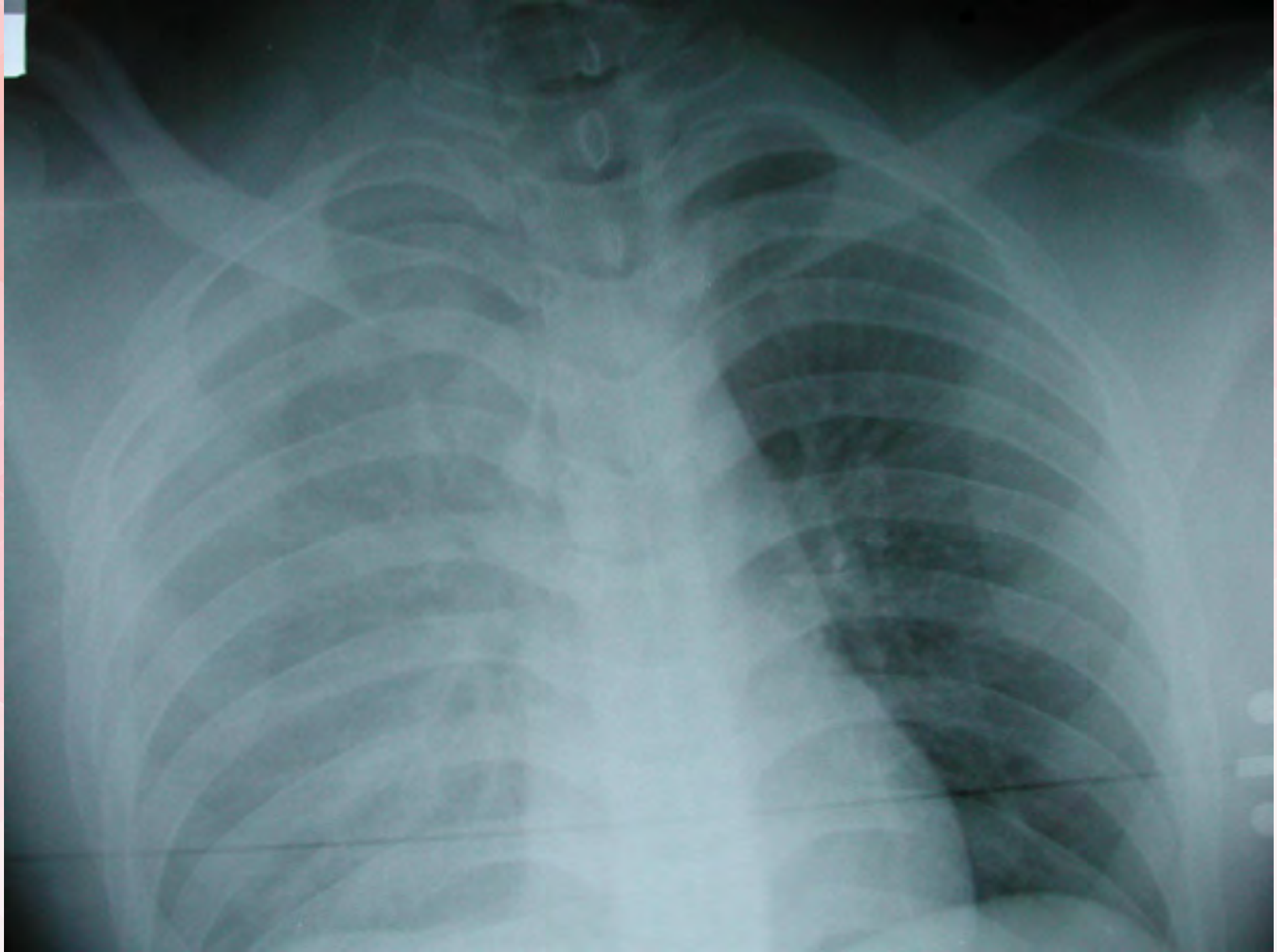
Open Pneumothorax

Treatment

- Promptly close entire wound with sterile dressing
  - Secure on 3 sides
- Chest tube
- Intubation may be necessary if in respiratory distress

Massive Hemothorax

- Accumulation of a large amount of blood (> 1.5 L) in the pleural space
  - Usually accompanied by signs of shock
- Common in penetrating trauma with hilar or systemic vessel disruption
  - Each hemithorax can hold up to 3L of blood
- Unilateral decreased or absent breath sounds
- CXR will show unilateral “white out”



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Massive Hemothorax

Treatment

- Intubate if respiratory distress
- Early blood administration
- Chest tube placement (using autotransfusion collection system)
  - Autotransfusion
- Potential thoracotomy

(Asensio, Mazzini, & Vu, 2013)

Flail Chest

- Usually results from direct, high-energy impact
- Two or more adjacent ribs fractured at two (or more) points
- Paradoxical motion
- Labored breathing
- Ventilation and perfusion mismatch

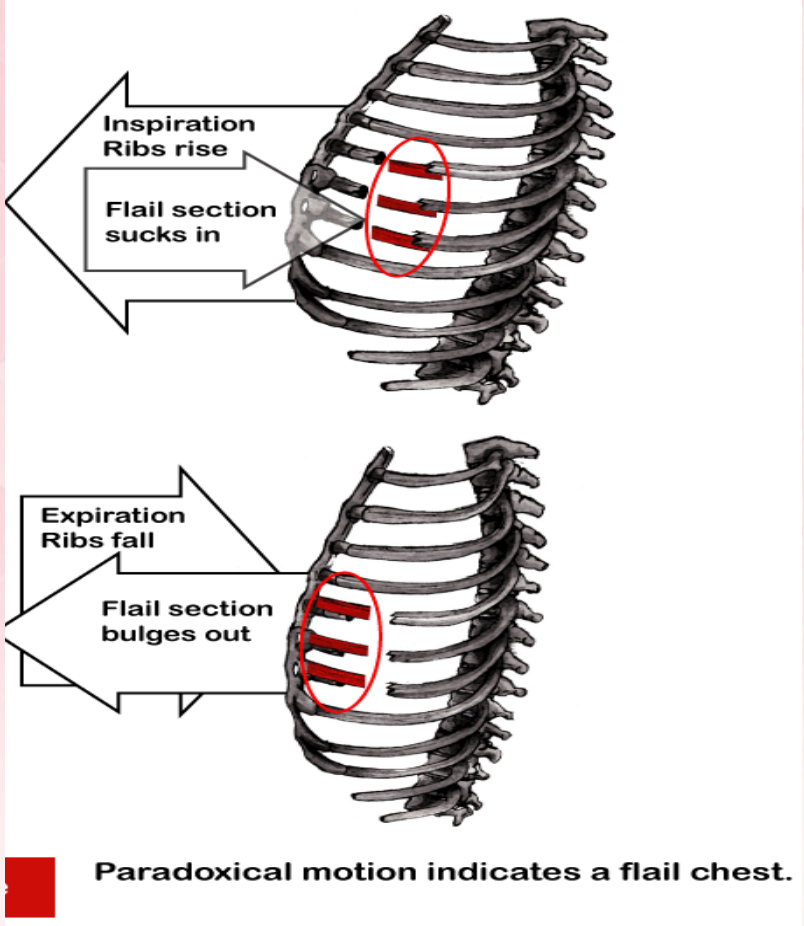


Photo used by permission – on Q pump; I Flow, LLC

(American College of Surgeons, 2018; Asensio, Mazzini, & Vu, 2013; Feliciano, Mattox, & Moore, 2017)

SOCIETY OF TRAUMA NURSES

Flail Chest

Treatment

- Intubate if respiratory distress
- Admit to SICU
- Control pain
- Potential for operative fixation
  - Rib plating

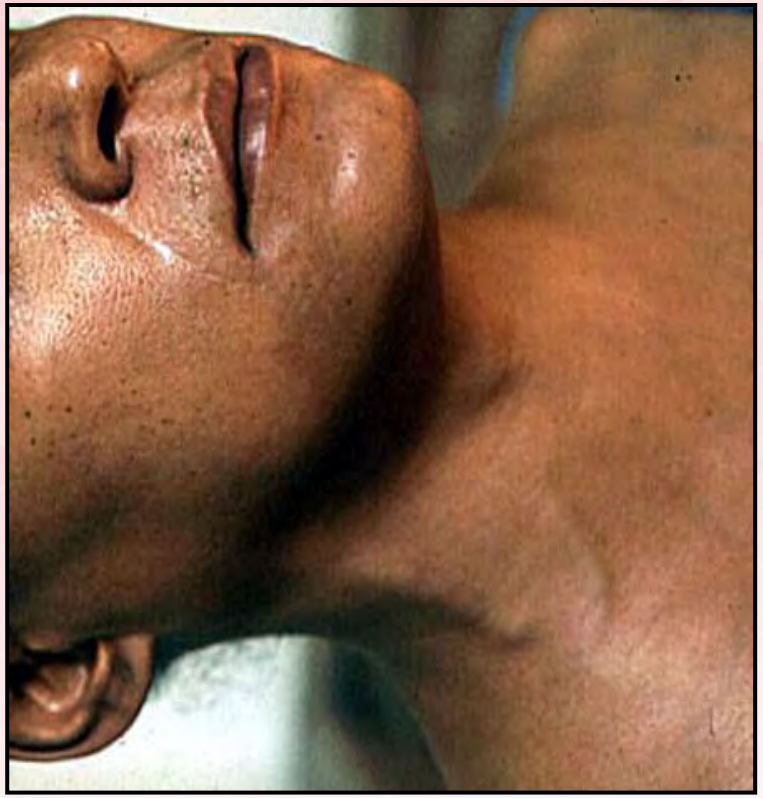
Pericardial Tamponade

- Commonly result of penetrating trauma

Symptoms:

  - Reluctant to lie flat
  - Feeling of “impending doom”
  - May have “Beck’s triad”
    - Distended neck veins
    - Hypotension
    - Muffled heart sounds

- \+ FAST



(Asensio, Mazzini, & Vu, 2013)

Pericardial Tamponade

Treatment

- Pericardiocentesis
  - Temporizing measure
- Pericardial window
  - Open pericardium
  - Relieve tamponade
  - Repair underlying injury

Potentially Life Threatening

- Pulmonary contusion
- Blunt cardiac injury
- Aorta rupture
- Diaphragm rupture

Pulmonary Contusion

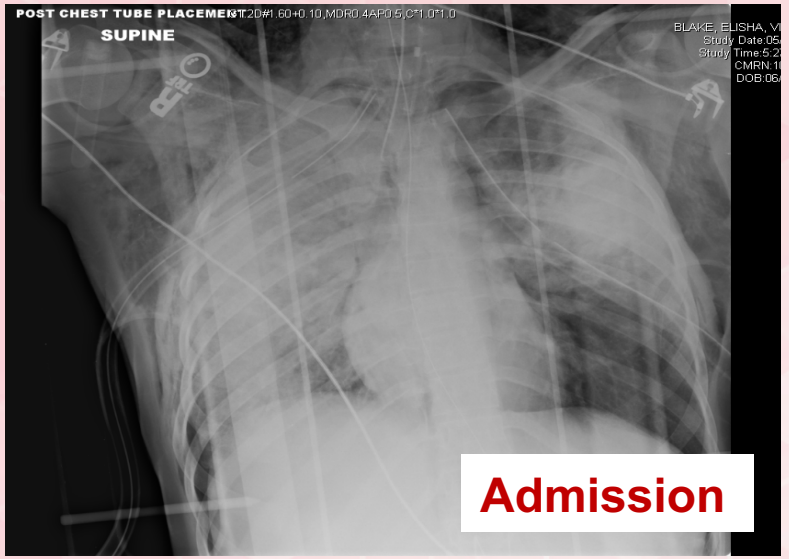
- Bruising of the lung tissue
- Occurs over time following thoracic trauma
- Blood and other fluids accumulate in lung tissue
  - This interferes with ventilation and may lead to hypoxia

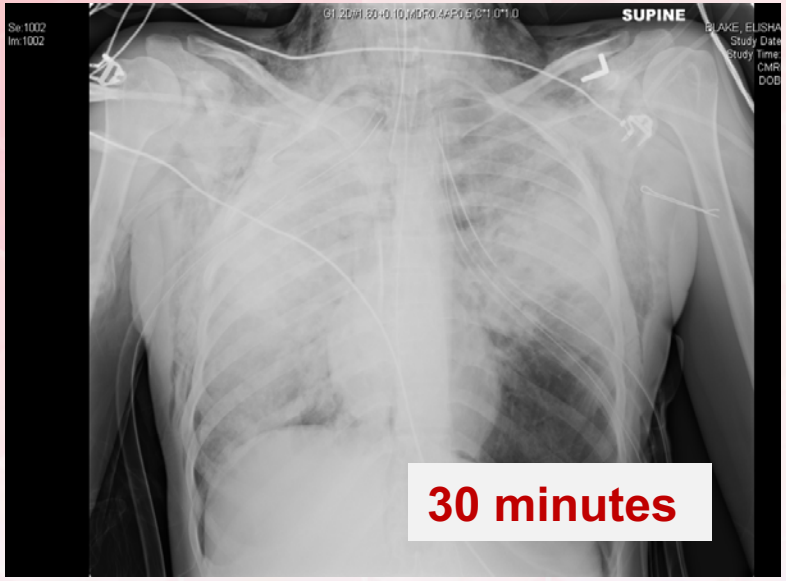
(American College of Surgeons, 2018)

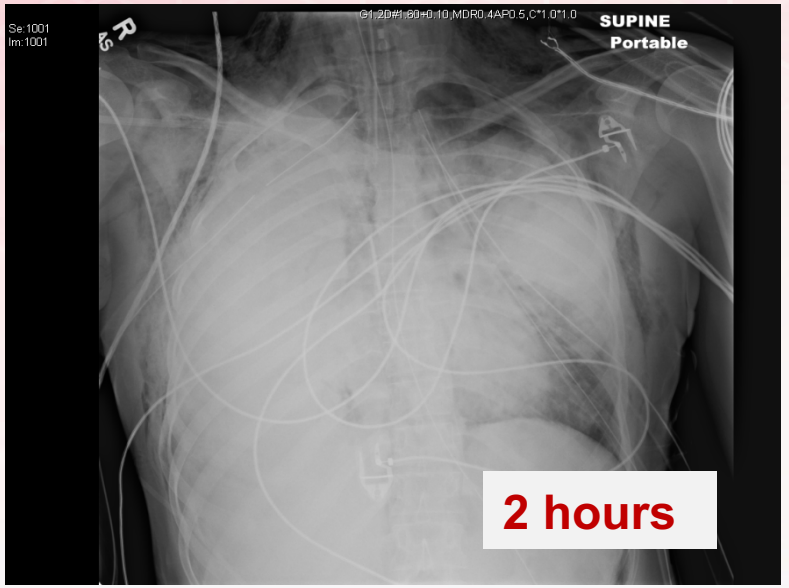
Pulmonary Contusion

Worsening progression

- On arrival
- 30 minutes
- 2 hours







SOCIETY OF TRAUMA NURSES

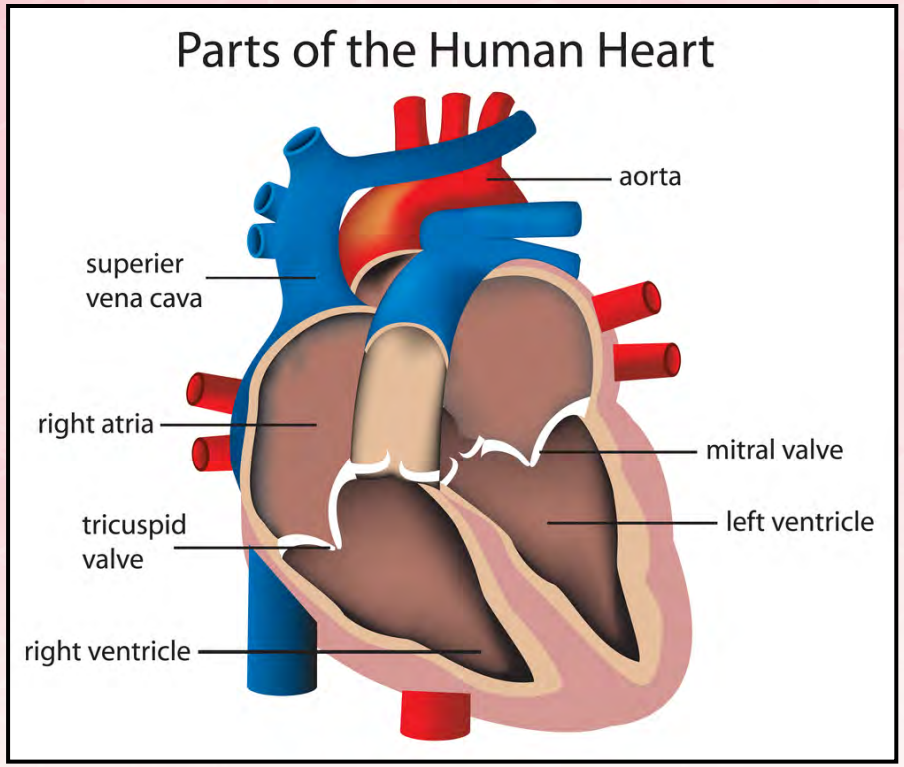
Assessment and Treatment

- Hypoxemia and respiratory compromise
- Bloody sputum, secretions
- Chest x-ray: patchy infiltrates or consolidation hours after injury
- Oxygen therapy and aggressive pulmonary toilet
- Judicious use of fluids in resuscitation
- Ventilator strategies

(Asensio, Mazzini, & Vu, 2013)

Blunt Cardiac Injury

- Mild tenderness to chamber rupture
- Types of injuries
  - Compression
  - Deceleration
  - Blast
  - Direct impact



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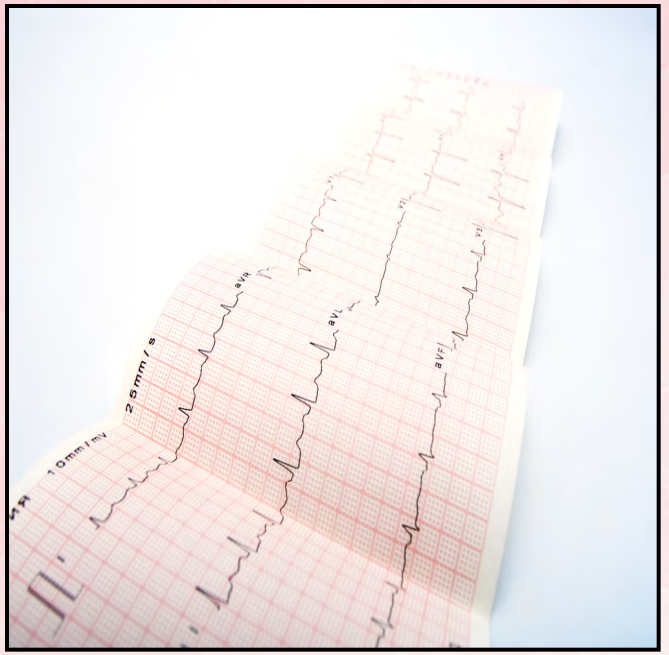
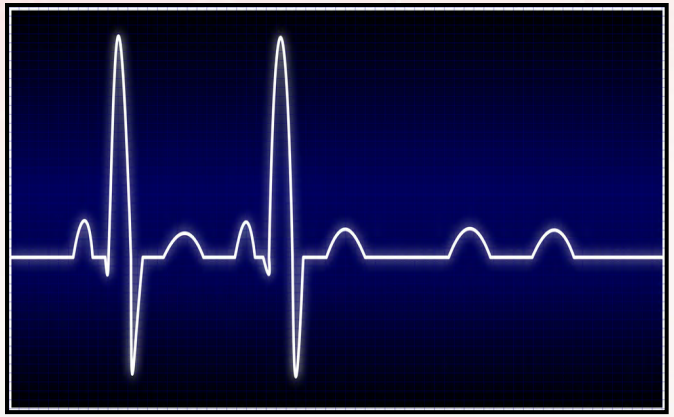
Assessment

- Chest pain
- Arrhythmias
- Electrocardiogram
- Echo
- Lab panel
  - Patients with changes/ abnormalities must be monitored for the first 24 hours





(American College of Surgeons, 2018)

SOCIETY OF TRAUMA NURSES

Traumatic Aortic Disruption

- Common cause of death at scene
- Survivors may have incomplete laceration or hematoma
- Most common site is distal to left subclavian artery
- Not always with specific symptoms
- Maintain high index of suspicion for deceleration type of injuries

(American College of Surgeons, 2018)

SOCIETY OF TRAUMA NURSES

Traumatic Aortic Disruption

Assessment

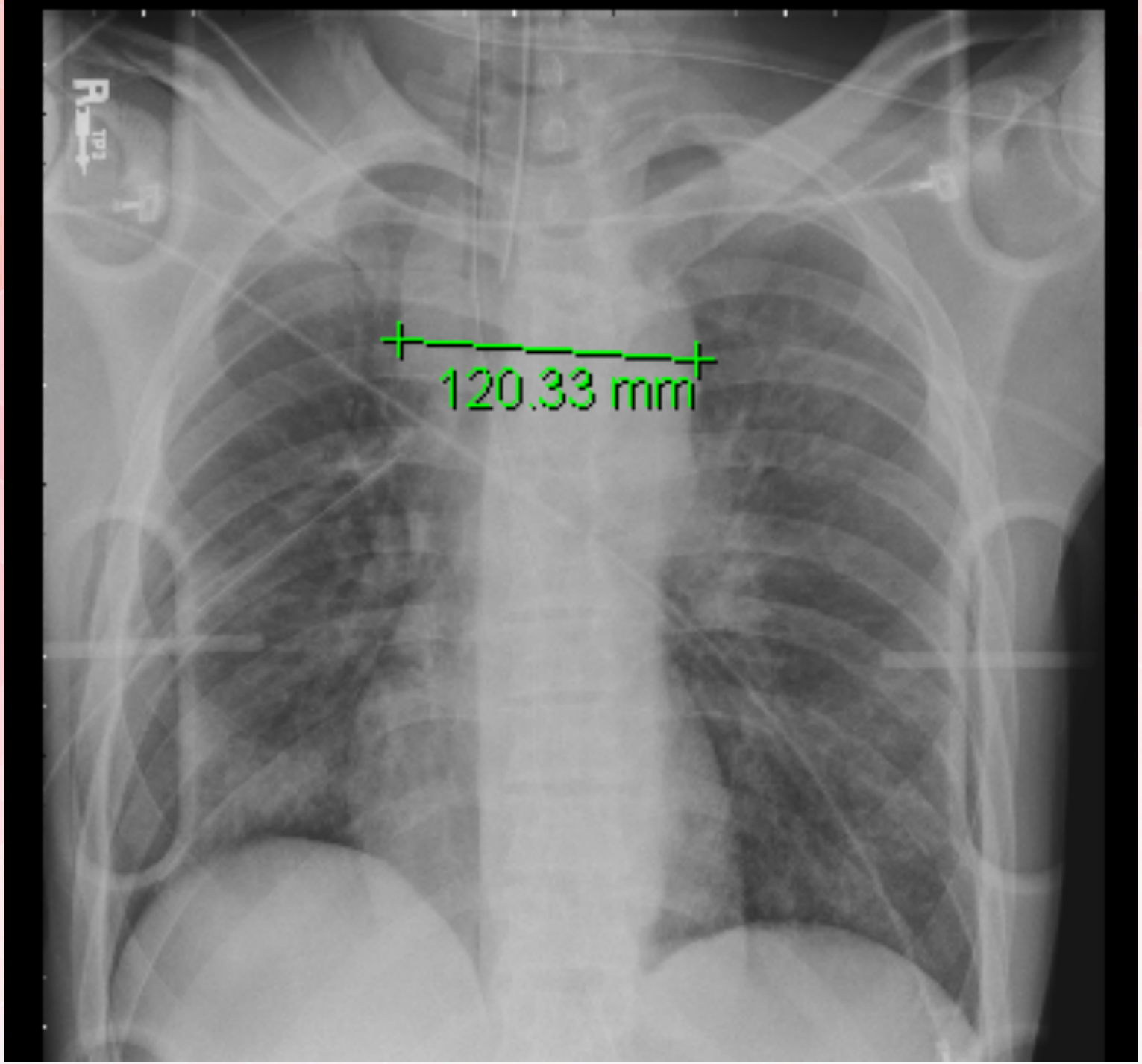
- Patient complaints
- Clinical signs

Diagnostics

- CXR – widened mediastinum
- CT scan
- CT angiography
  - Confirm location for intervention if necessary
- Transesophageal echocardiography

(American College of Surgeons, 2018)

SOCIETY OF TRAUMA NURSES



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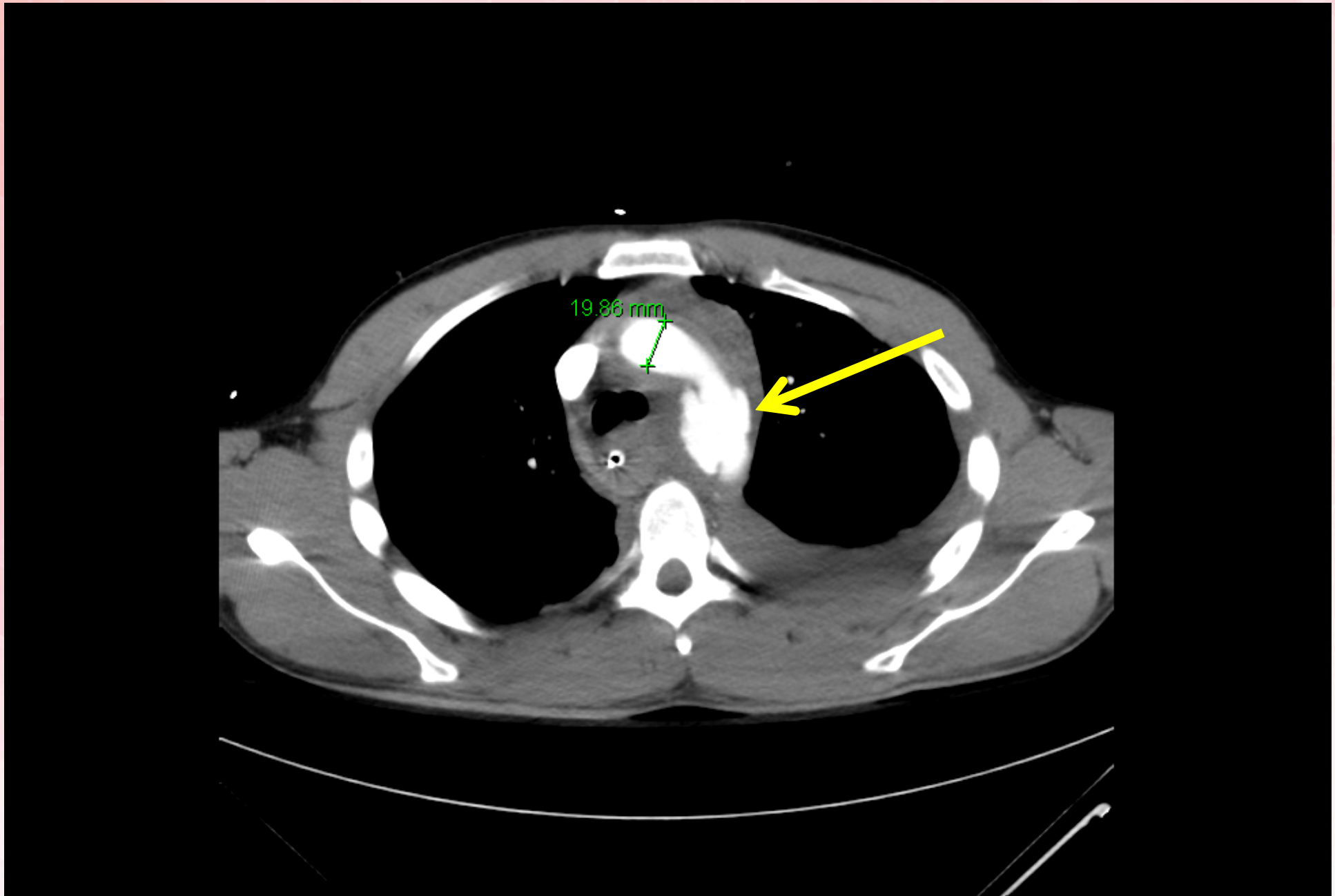


SOCIETY OF TRAUMA NURSES

Traumatic Aortic Disruption

Treatment

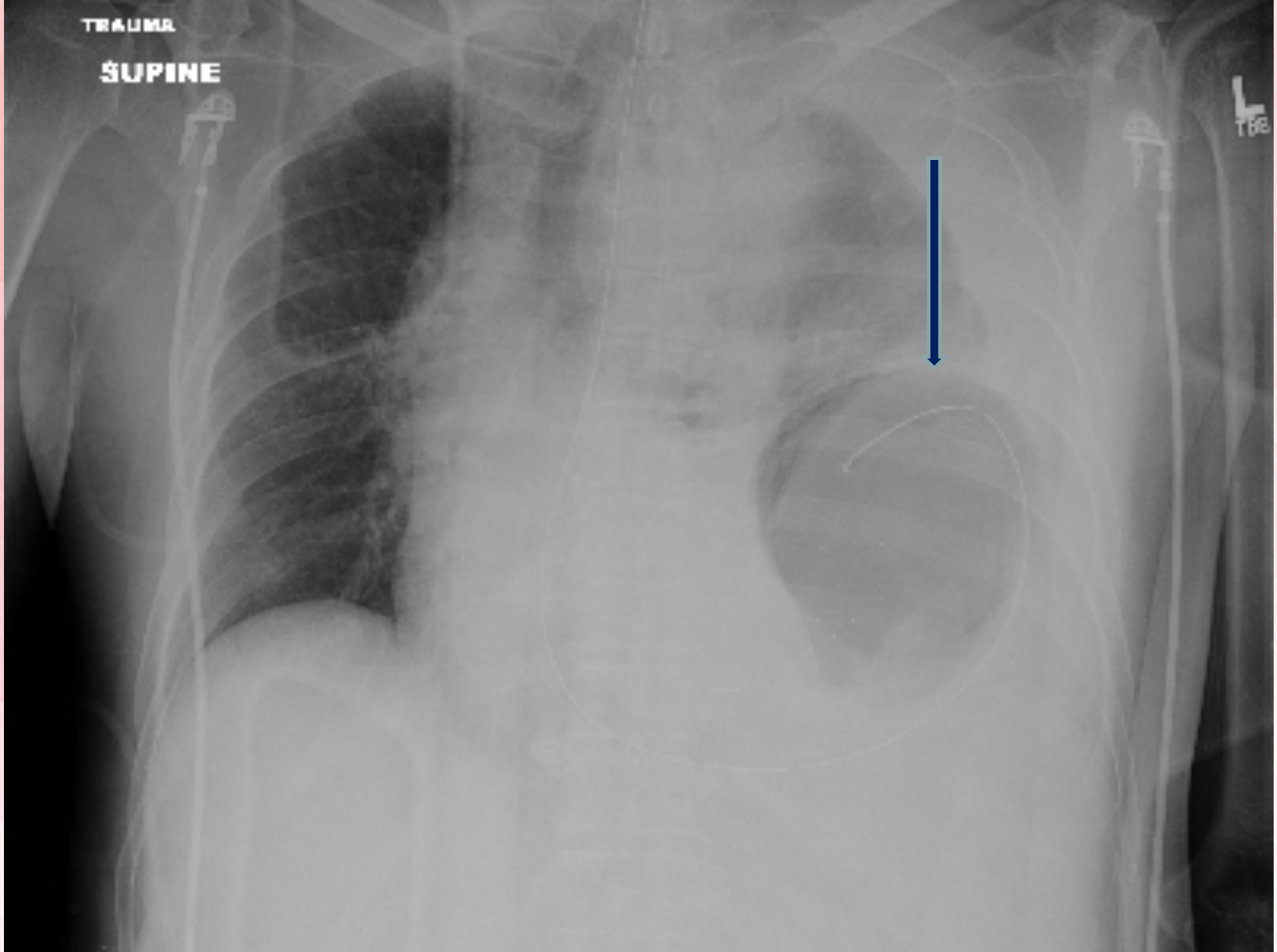
- Heart rate and blood pressure control
  - HR < 80, MAP goal 60-70 mmHg
- Open repair
- Endovascular repair
  - Most common
  - Excellent short-term outcomes

SOCIETY OF TRAUMA NURSES

Blunt Diaphragmatic Injury

- Usually result from high-speed MVC or severe blow to abdomen
- Initial chest x-ray may be normal
- Suggestive findings
  - Abnormal nasogastric tube placement
  - Ipsilateral hemidiaphragm elevation
  - Abdominal visceral herniation

(American College of Surgeons, 2018)

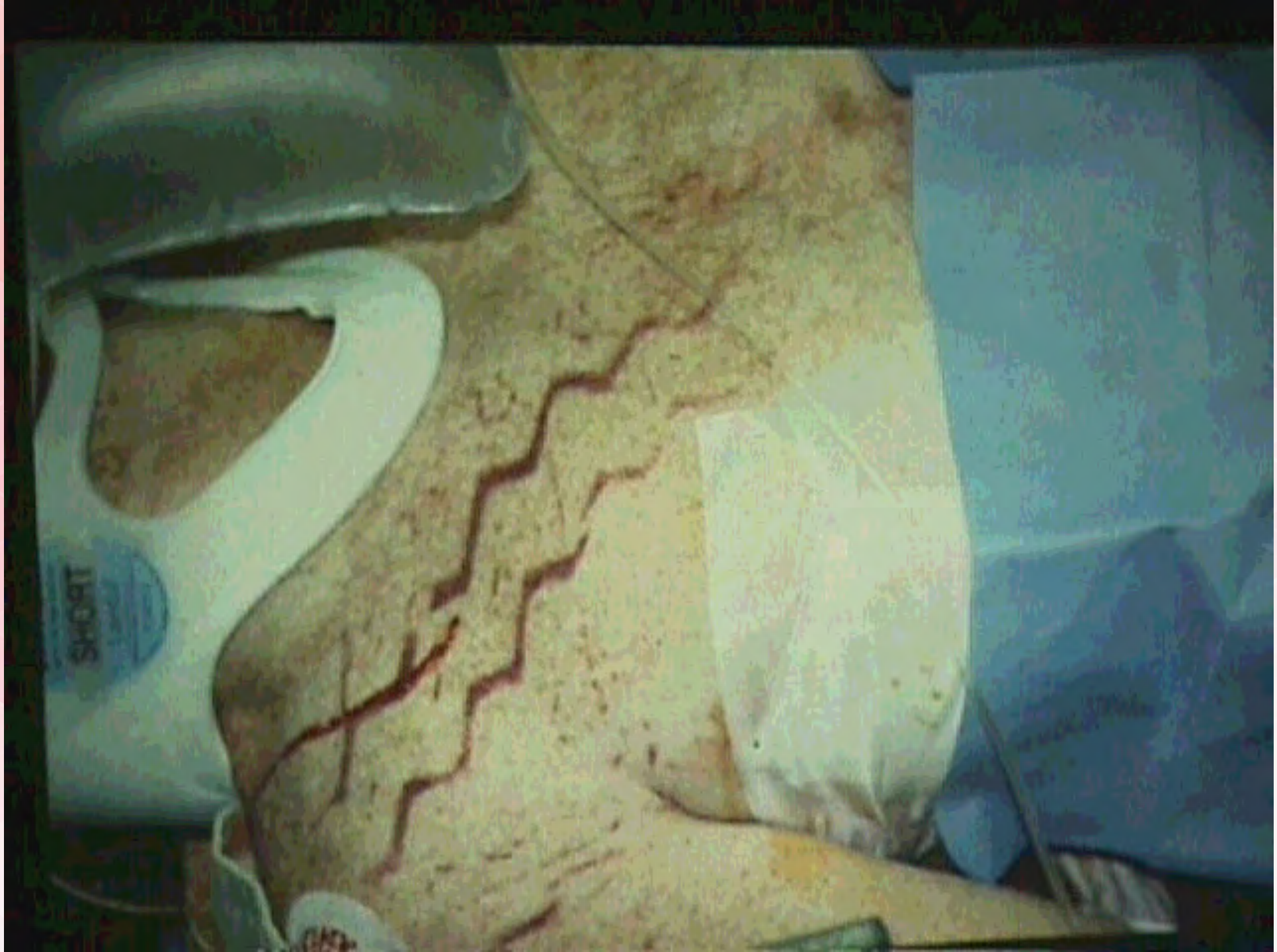

TRAUMA
SUPINE

Other Thoracic Injuries

- Rib fractures
- Simple pneumothorax
- Hemothorax
- Subcutaneous emphysema
- Traumatic asphyxia
- Tracheobronchial tree injury
- Esophageal injury
- Scapula, clavicle, sternal fractures
- Thoracic duct injury

Rib Fractures

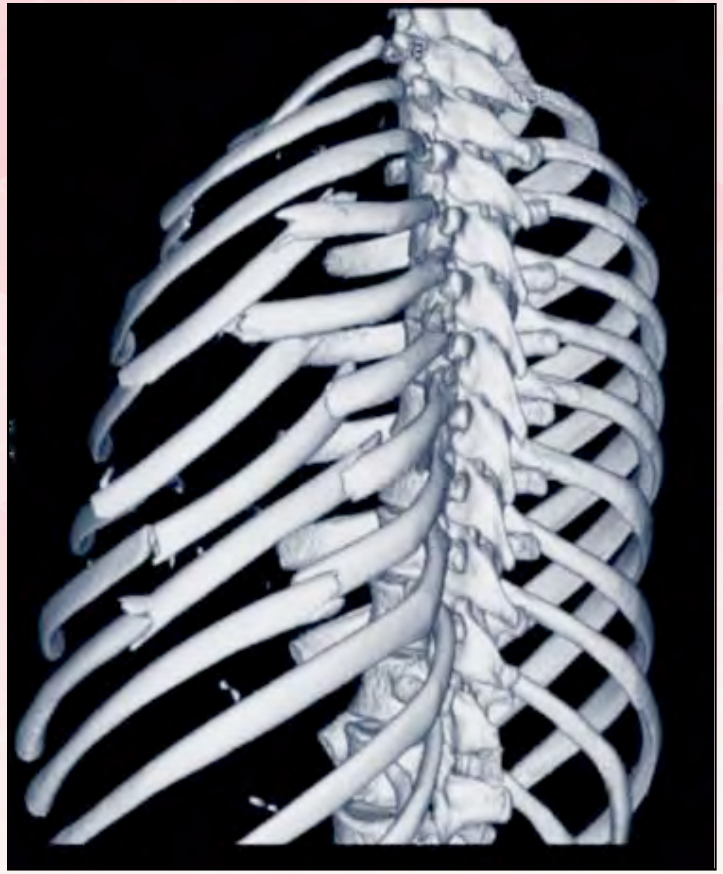
- 1st & 2nd rib fracture
  - High impact trauma
  - Suspect neck or great vessel injury
- 4th-9th rib fracture
  - Most common site of fractures
  - Suspect lung injury
- 9th-11th rib fracture
  - Suspect intra-abdominal injury



SOCIETY OF TRAUMA NURSES

Clinical Challenges

- Mechanical factors
- Rib fracture motion
- Prolonged pain
- Contracture of fractured segments
- Thoracic volume loss
- Persistent pain



Rib Fractures

Triad

- Inspiratory pain
- Shallow respirations
- Retained secretions

Goal of Therapy

- Pain control
- Adequate pulmonary function
- Avoid potential complications

(American College of Surgeons, 2018)

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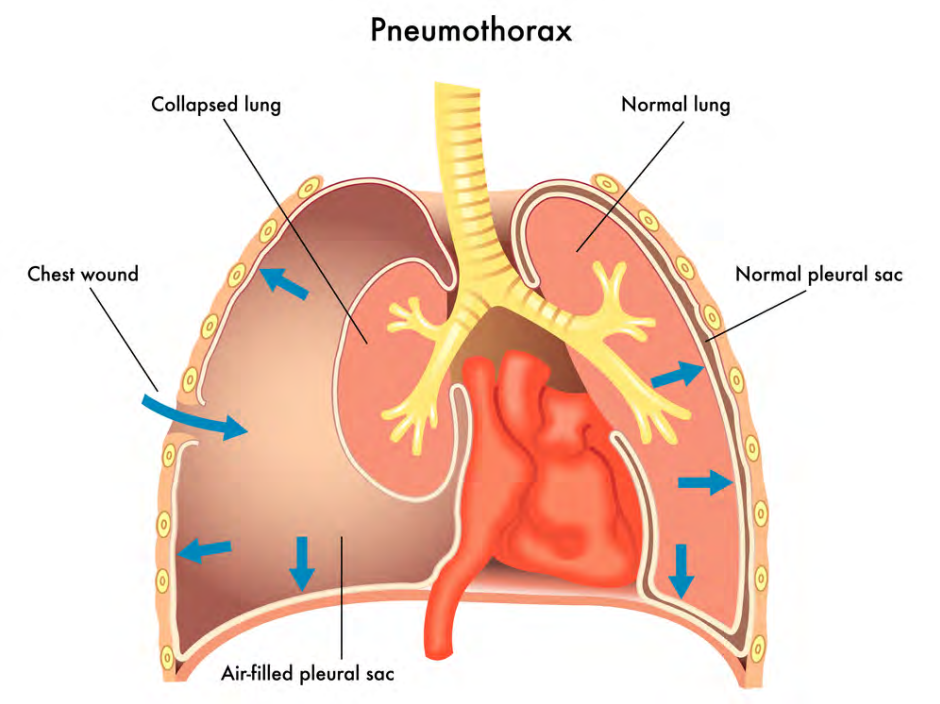
Pleural Space Injuries

- Dyspnea
- Decreased/absent breath sounds
- Hyperresonance/dullness to percussion
- Chest pain

Pneumothorax



Etiology:

- **Blunt**
- **Penetrating**

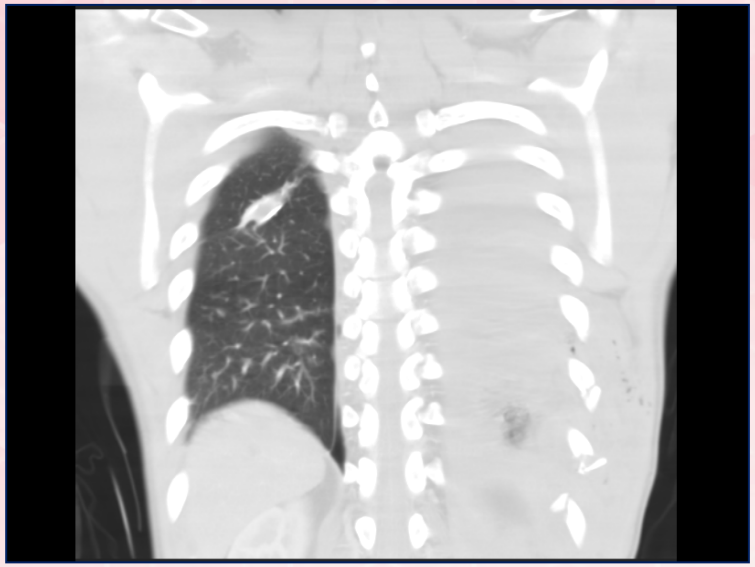
Collection of Air in:

- Pleural space
- Visceral pleura
- Parietal pleura

Hemothorax

Etiology:

- Lung laceration
- Intercostal vessel laceration
- Internal mammary artery laceration
- Thoracic spine fracture/dislocation



Collection of:

- Blood or other fluid in pleural cavity

(American College of Surgeons, 2018)

STN
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Pleural Space Management

- Small pneumo/hemothorax may be monitored with serial chest x-rays
  - Usually spontaneously reabsorbs
- Chest tube required for moderate to large pneumo/hemothorax
  - Monitor output for amount and color
  - Monitor air leaks
  - Assess insertion site and connections
- Apply supplemental oxygen

(Feliciano, Mattox, & Moore, 2017)

Chest Tube Insertion

Complications

- Laceration of intrathoracic &/or abdominal organs
- Pleural infection
- Damage to intercostal nerve, artery, vein
- Intercostal neuritis/neuralgia
- Incorrect tube position
- Persistent PTX

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Chest Tube Management

- Chest x-ray post insertion
- Monitor chest tube output
- Provide amount of suction per physician's order
- Chest tube dressing per hospital protocol
- Evaluate effectiveness of chest tube

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Troubleshooting Chest Tube

CT falls out:

- Apply dressing with pressure at end-expiration
- Ensure tight seal with tape
- Call physician immediately
- Monitor patient's condition

No drainage with continued presence of HTX

- Assess tubes for kinks, disconnection
  - Do not milk tubing
- Raise HOB and lower pleurovac
- Turn patient to affected side
- Consider patient's condition

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SOCIETY OF TRAUMA NURSES

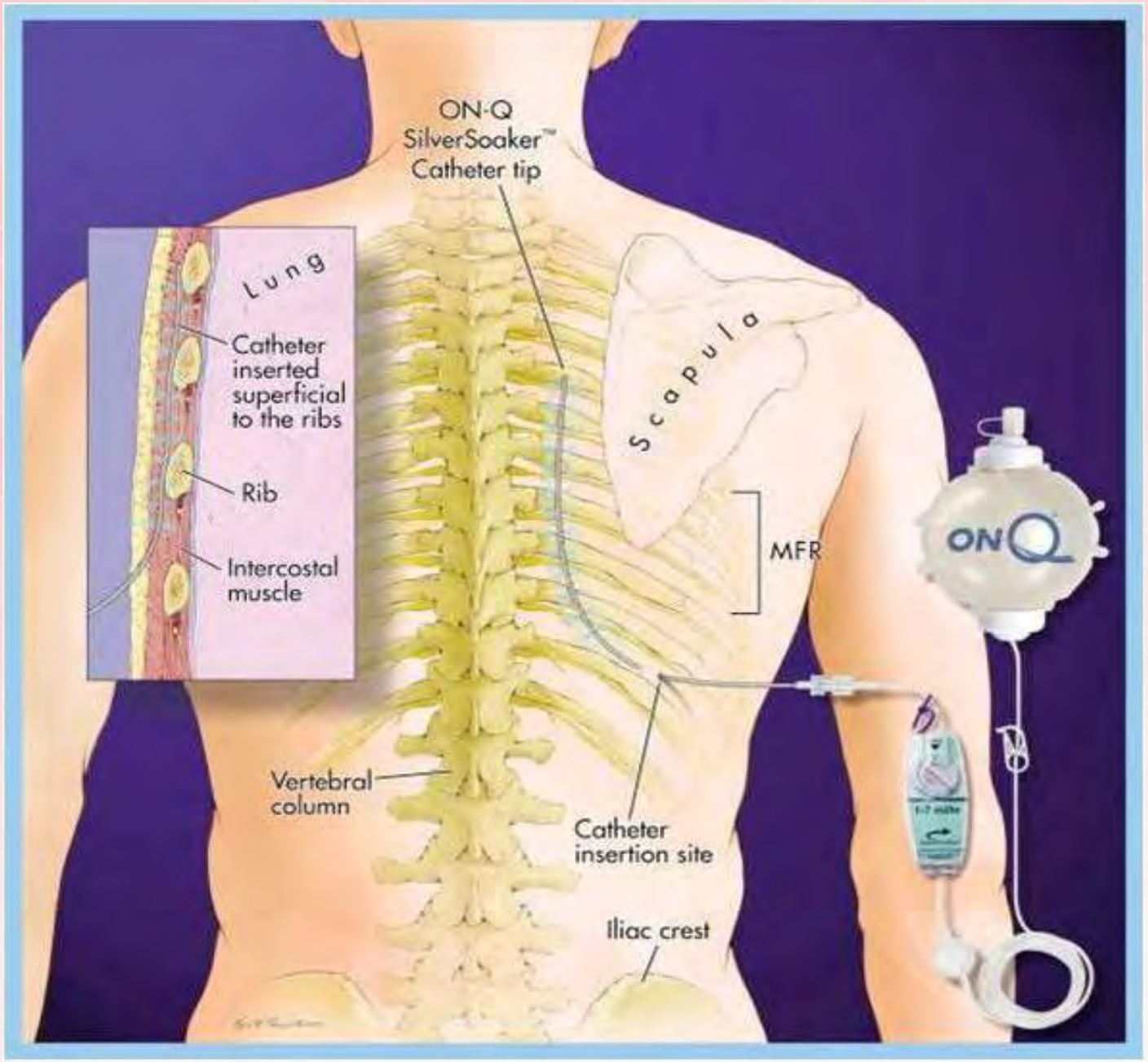
Pain Management

Various options

- Analgesic agents
- Intercostal nerve blocks
- Local anesthetic
- Epidural analgesia
- Internal rib fixation

ON-Q® PainBuster® Redefining Recovery™

Photo courtesy of on Q pump; I Flow, LLC



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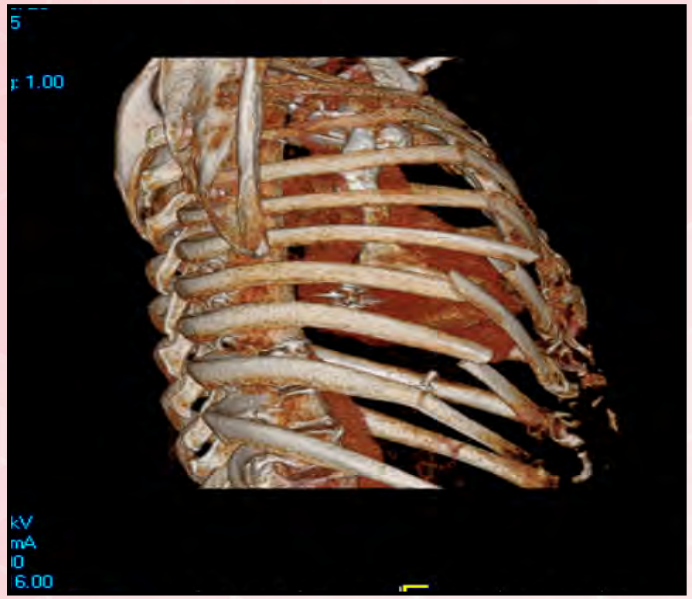
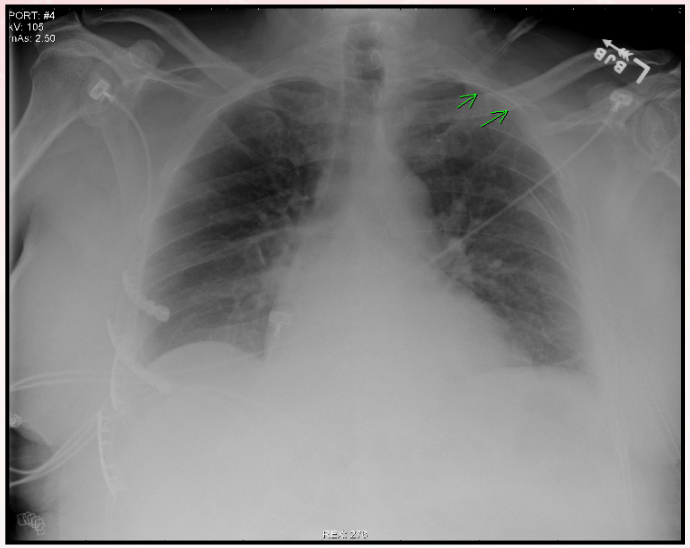
Pain Management Goals

- Decrease opioid use
- Improved gas exchange
- Earlier extubation
- Ideally the above leads to improved length of stay

Operative Fixation

- Reduction in pain
- Ability to reconstruct chest wall
- Restore thoracic volume
- Decreased ventilator days
- Decreased hospital LOS
- Decreased neuralgia





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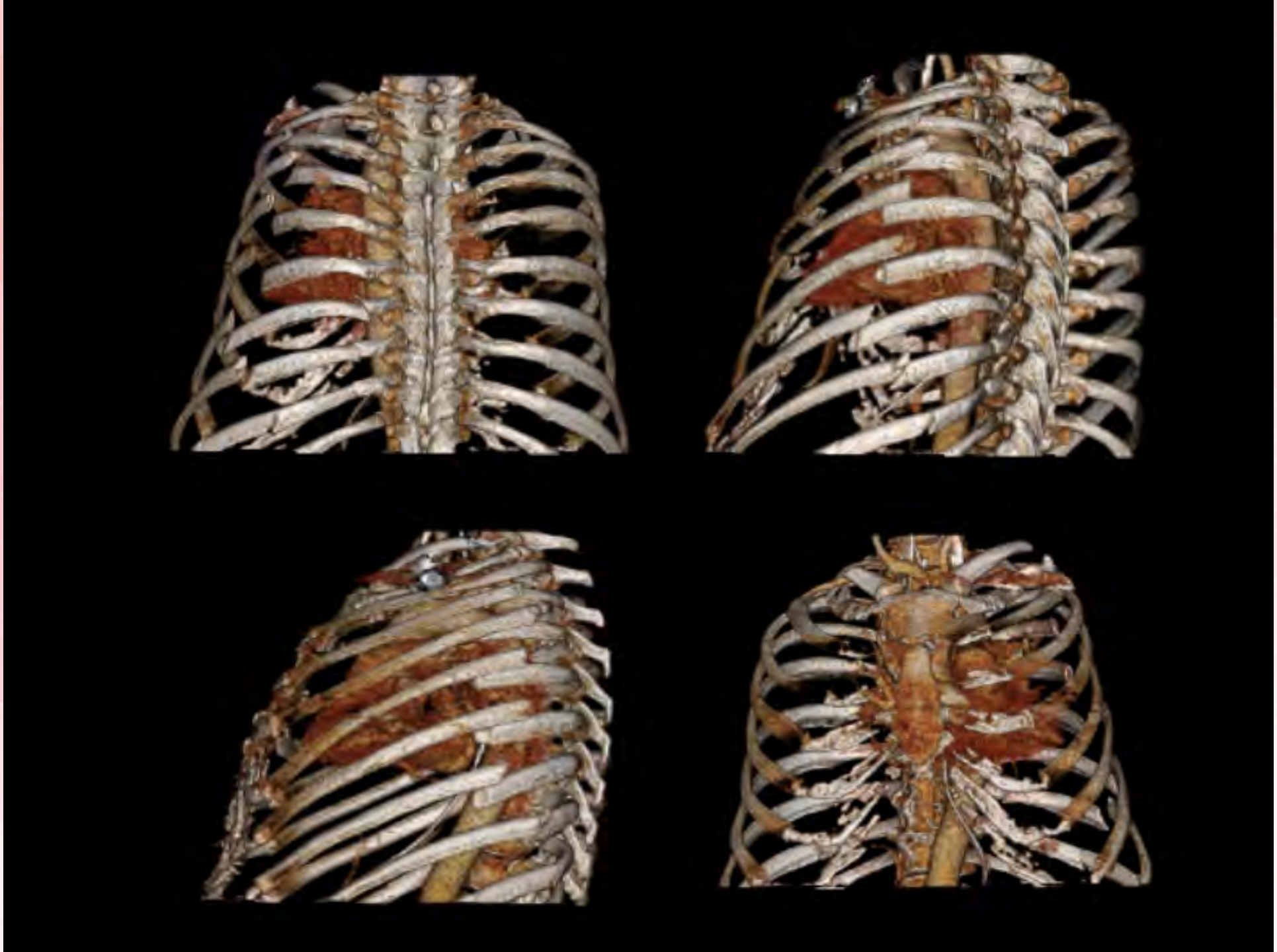

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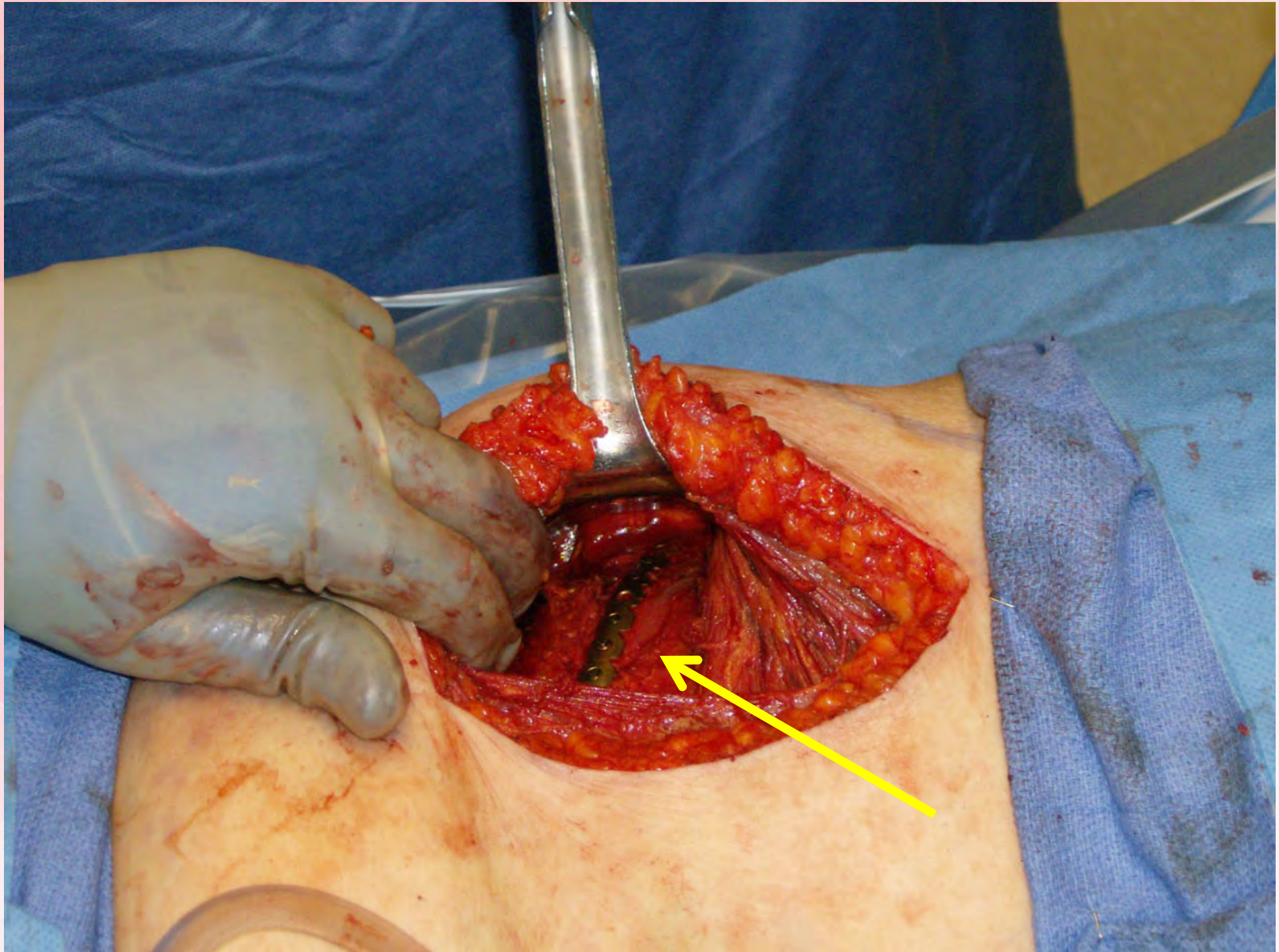
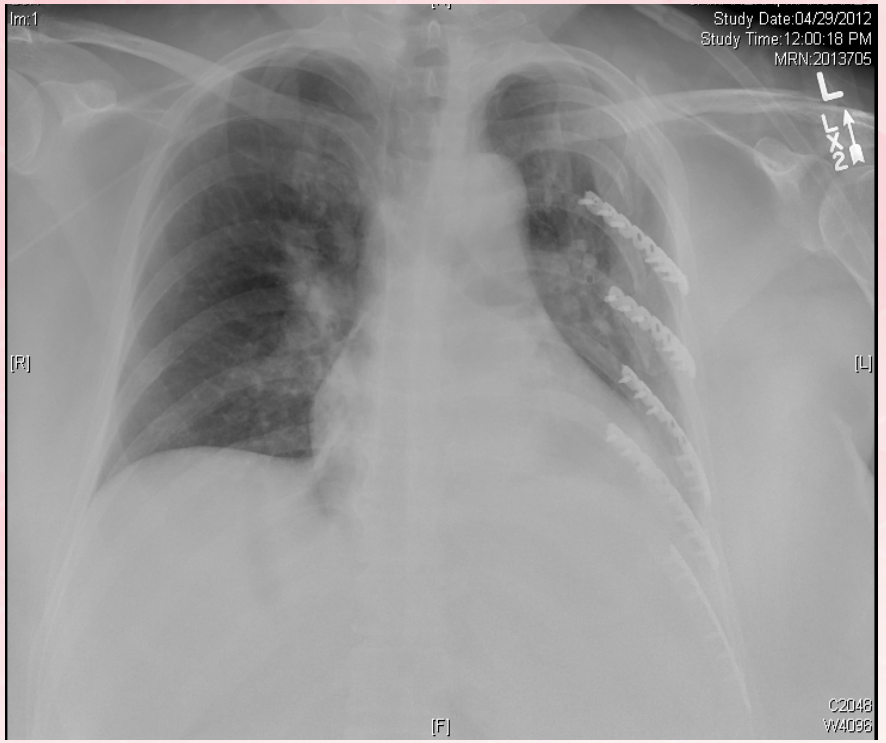


Rib Fixation Results

Rib fixation may improve:

- Pain control
- Bone healing
- Pulmonary function
- Early vent weaning
- Decreased LOS



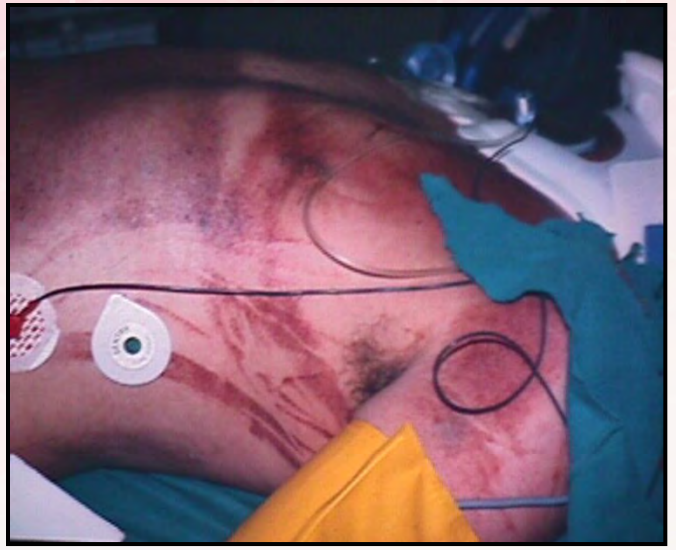
SOCIETY OF TRAUMA NURSES

Subcutaneous Emphysema

- Airway injury
- Facial swelling
- Pneumothorax
- Blast injury

Traumatic Asphyxia

- Crushing force to chest
- Cyanosis of head and neck
- Subconjuctival hemorrhage
- Hemotypanum
- Associated injuries



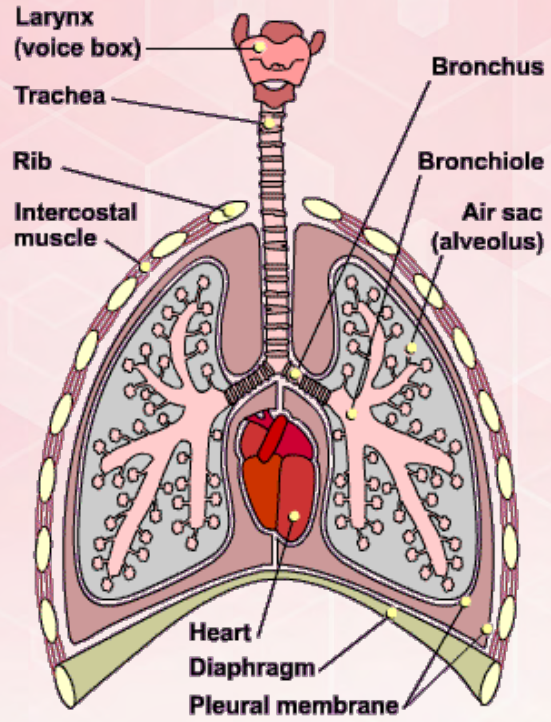
Tracheobronchial Tree Injury

- Blunt or penetrating trauma
- Frequently missed
- Persistent PTX
- Persistent chest tube air leak
- Bronchoscopy for diagnosis

Tracheobronchial Tree Injury

Treatment

- Airway and ventilation
- Tube thoracostomy
- Operative repair



http://www.daviddarling.info/encyclopedia/B/bronchus.html

Esophageal Injuries

Incidence

- Rare
- More common in penetrating injury
- Blunt: Severe blow to abdomen
- Suspect if left PTX or left HTX without a related rib fracture
- Can occur anywhere along esophagus
- Often associated with severe concomitant injuries that mask findings and delay diagnosis

Esophageal Injuries

Symptoms

- Varies depending on location and amount of contamination
- Pain at the sight of injury
- Radiation of pain to neck, chest, shoulders or throughout abdomen
- Peritoneal irritation
- Dyspnea
- Mediastinitis
- Empyema development
- High risk for tension PTX

Esophageal Injury

Diagnosis

- X-ray and/or CT scan may reveal a suspicious finding
- Endoscopy or esophagography

Treatment

- Surgical emergency
- Minimize bacterial contamination and enzyme erosion

Potential complications after repair

- Peritonitis
- Mediastinitis
- Intra-abdominal abscess
- Respiratory compromise
- High risk for developing tension PTX
- Esophageal stricture
- Esophageal fistula

Scapula and Clavicle Fractures

Scapula

- Uncommon
- Clinical signs
  - Pain
  - Edema
  - Crepitus
- Management
  - Analgesia
  - Immobilization followed by PT

Clavicle

- Common
- Clinical signs
  - Tenderness
  - Crepitus
  - Deformity
- Management
  - Shoulder immobilizer
  - ORIF

(American College of Surgeons, 2018)

Sternal Fracture

Clinical Manifestations

- Anterior chest pain
- Tenderness
- Palpable deformity
- Unstable fracture may result in flail chest
- ECG changes

Management

- Cardiac monitoring
- Serial ECG to rule out myocardial insult
- Echocardiogram
- Pain Control

Thoracic Duct Injury

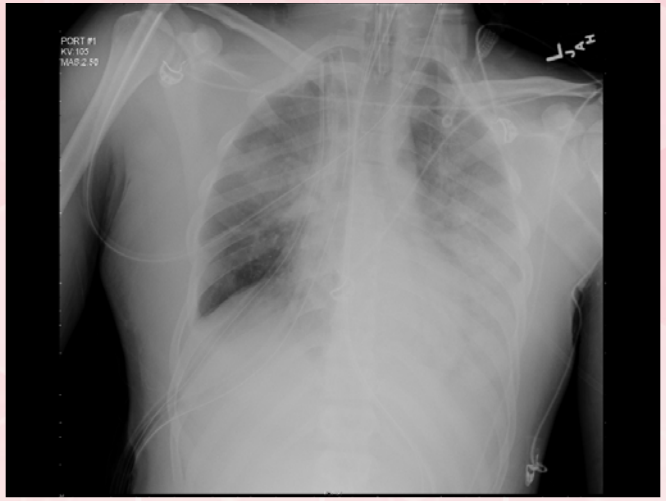
- Uncommon
- Milky white fluid (Chyle)
  - May be clear if patient NPO
- Chylothorax
  - Chyle in pleural cavity
  - May not occur for several days after trauma
  - Nutritional support needed
    - No long chain fatty acids
- Continued chest tube drainage coupled with nutritional support usually results in spontaneous closure in <1 month

(Feliciano, Mattox, & Moore, 2017; Lee, Cho, Hoseok, & Kim, 2017)

Secondary Thoracic Trauma Complications

- Respiratory Failure
  - ALI
  - ARDS
- Pneumonia
- Empyema
- Persistent Air Leak
- Pneumatocele
- Air Embolism

Acute Lung Injury (ALI)
Acute Respiratory Distress Syndrome (ARDS)



ALI/ARDS

- Severe Hypoxemia
- Acute onset of diffuse bilateral pulmonary infiltrates
- Vasculature and alveolar endothelium injured
- No evidence of hydrostatic pulmonary edema
  - **ALI:**
    - PaO_2:FiO_2 200-300
  - **ARDS**
    - PaO_2:$FiO_2 \leq 200$
    - PAOP < 18 mm Hg
- Treatment includes ventilatory strategies

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Pneumonia

- Trauma patient susceptible particularly if they are intubated
- VAP partially iatrogenic
- Especially common in patients with ARDS
- Multiple pathogens associated with VAP
- Indiscriminate use of antibiotics
- Optimal treatment is prevention to include:
  - Hand hygiene, gowning, gloving
  - Endotracheal hygiene per protocol
  - Minimizing duration time of intubation
  - Consideration of NIPPV vs intubation

(Feliciano, Mattox, & Moore, 2017)

Empyema

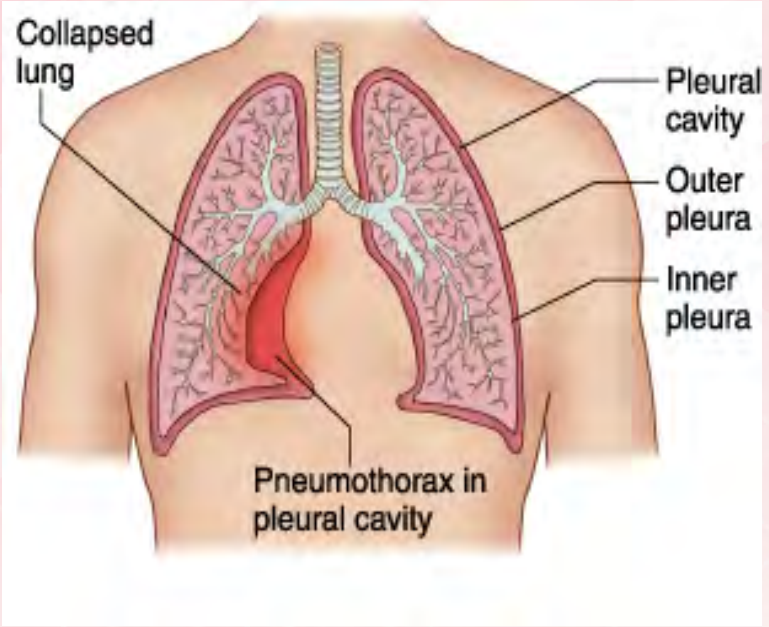
- Risk of development remains high
- Etiology includes inadequately drained pleural space, direct contamination from the penetrating injury or secondary infection such as a clotted HTX or diaphragm disruption
- Suspect in chest trauma with an unexplained fever, leukocytosis or respiratory failure
- Early CT Scan if suspected
- Pathogen identification

Empyema Treatment Options

- Antibiotics once pathogen identified
- Chest Tube
- CT guided drainage
- VATS
- Thoracotomy and decortication

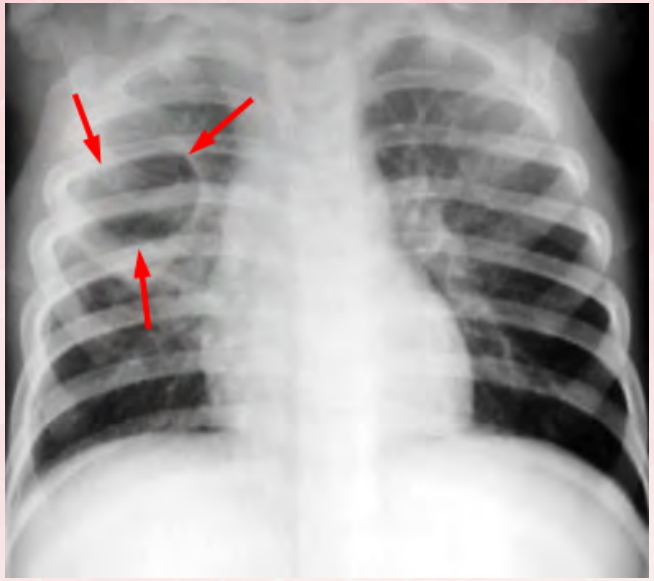
Persistent Air Leak

- Air escaping lung parenchyma into the pleural space
- Common initially after the chest trauma
- Chest tube insertion often treats the leak
- Persistent and larger air leaks requires an urgent bronchoscopy to rule out tracheobronchial injury



Pneumatocele

- Air collection in lung parenchyma
- Usually develops during mechanical ventilation
- Usually resolves following weaning from ventilator
- May need CT guided drainage

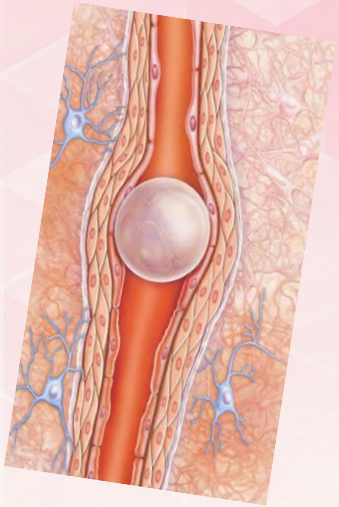


Air Embolism

(Bronchovenous/Systemic/Right & Left Heart)

Etiology

- Patient with large HTX requiring intubation with positive pressure
- Iatrogenic from central venous access procedures
- Fistula between pulmonary vein & bronchiole due to a penetrating lung injury results in systemic air embolism



Symptoms

- Sudden cardiac or cerebral dysfunction
- Air in retinal vessels and arterial aspirations
- Hemoptysis
- Seizures

(Bastos, et al, 2008; Feliciano, Mattox, & Moore, 2017)

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Air Embolism

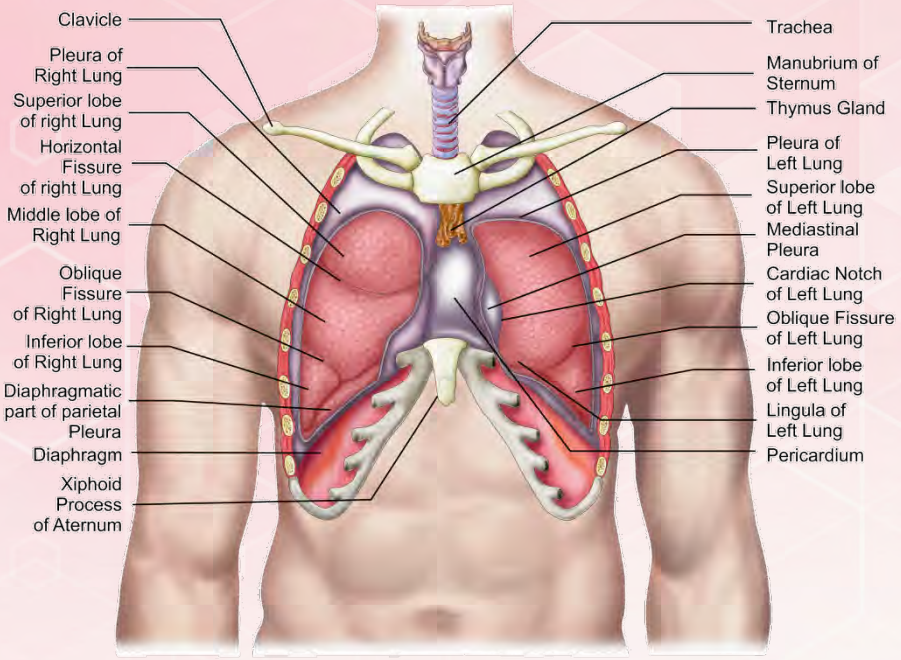
Treatment

- Immediately place patient in Trendelenburg position
- Rotate patient to left lateral decubitus position
- Airway management:
  - Possibility of selective lung ventilation
  - Use of various modalities to reduce incidence and severity
- Immediate thoracotomy and clamping of hilum to avoid propagation of air embolus before repair of injury
  - Aspiration of air from cardiac chambers, aortic root and/or right coronary artery
  - Cardiac massage

(Bastos, et al, 2008; Feliciano, Mattox, & Moore, 2017)

Thoracic Trauma Considerations

- ED/Resuscitative Thoracotomy
- Nursing Considerations/ Summary in Thoracic Trauma



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ED/Resuscitative Thoracotomy

Criteria

- Patients with penetrating thoracic injury presenting with recent loss of life
- Consider “down time”
- Signs of life in field and/or on arrival
- Has not been pulseless > 15 minutes
- Appropriate surgical specialists available

Futile

- No signs of life in field or on arrival
- > 15 minutes without pulse at any time
- Massive, nonsurvivable injuries are obvious

(Asensio, Mazzini, & Vu, 2013; Feliciano, Mattox, & Moore, 2017)

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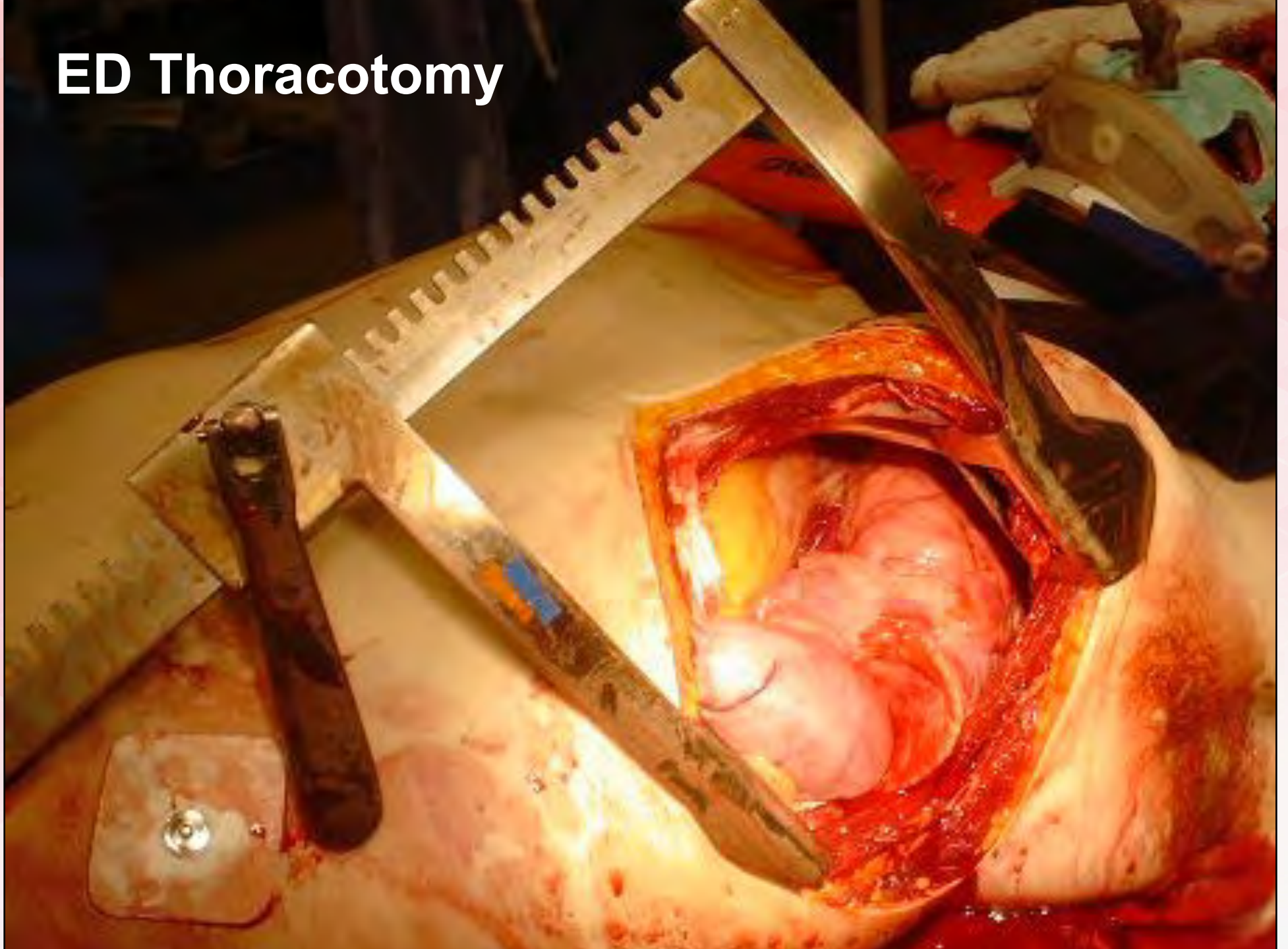
ED Thoracotomy



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Nursing Considerations /Summary

- Monitor the ABCs continuously
- Identify and treat life-threatening injuries during primary survey
- Consider whether the injury is blunt or penetrating
- Maintain high rate of suspicion
- Know the chest anatomy
- Understand potential complications and be vigilant in observing for their occurrences

Nursing Considerations /Summary

- Chest x-ray identifies majority of blunt thoracic trauma
- Majority of thoracic injuries are managed non-operatively or with a well-placed chest tube
- Provide aggressive pulmonary toilet
- Oxygenate
- Ventilate
- Pain Management

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Abdominal Injuries

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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

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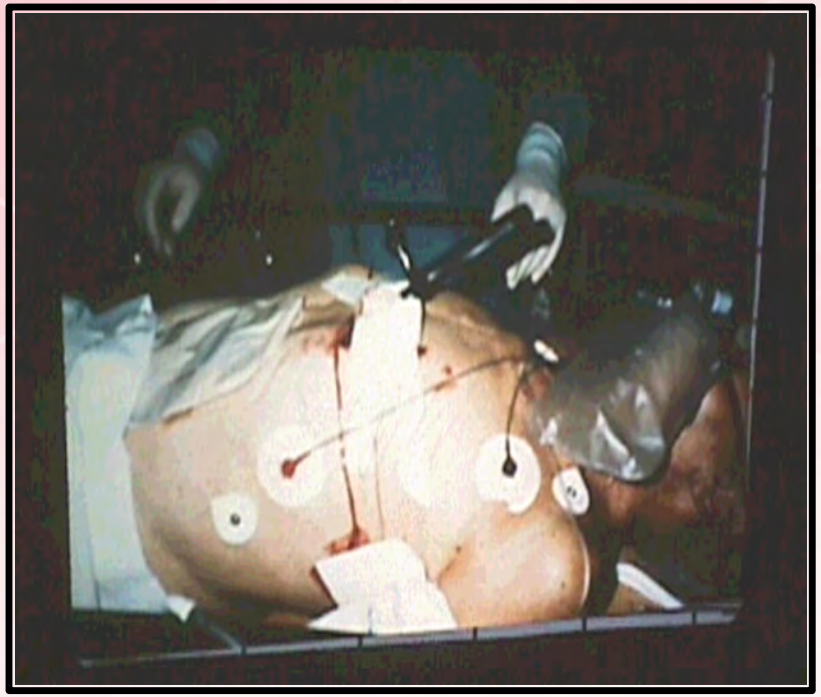
Epidemiology

- Incidence
  - Abdominal injuries rank among the top 5 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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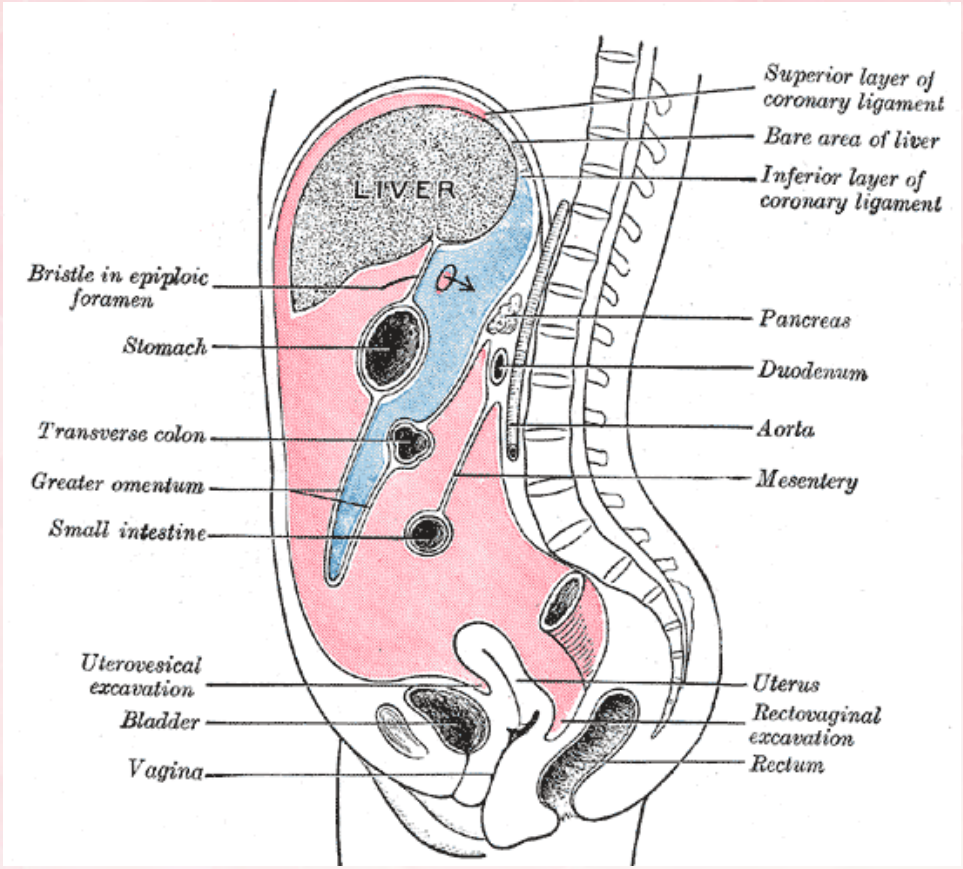
Mechanism of Injury

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

Anatomy and Physiology

Diaphragm

Abdominal and Iliac Muscles



Vertebral Column

Pelvis

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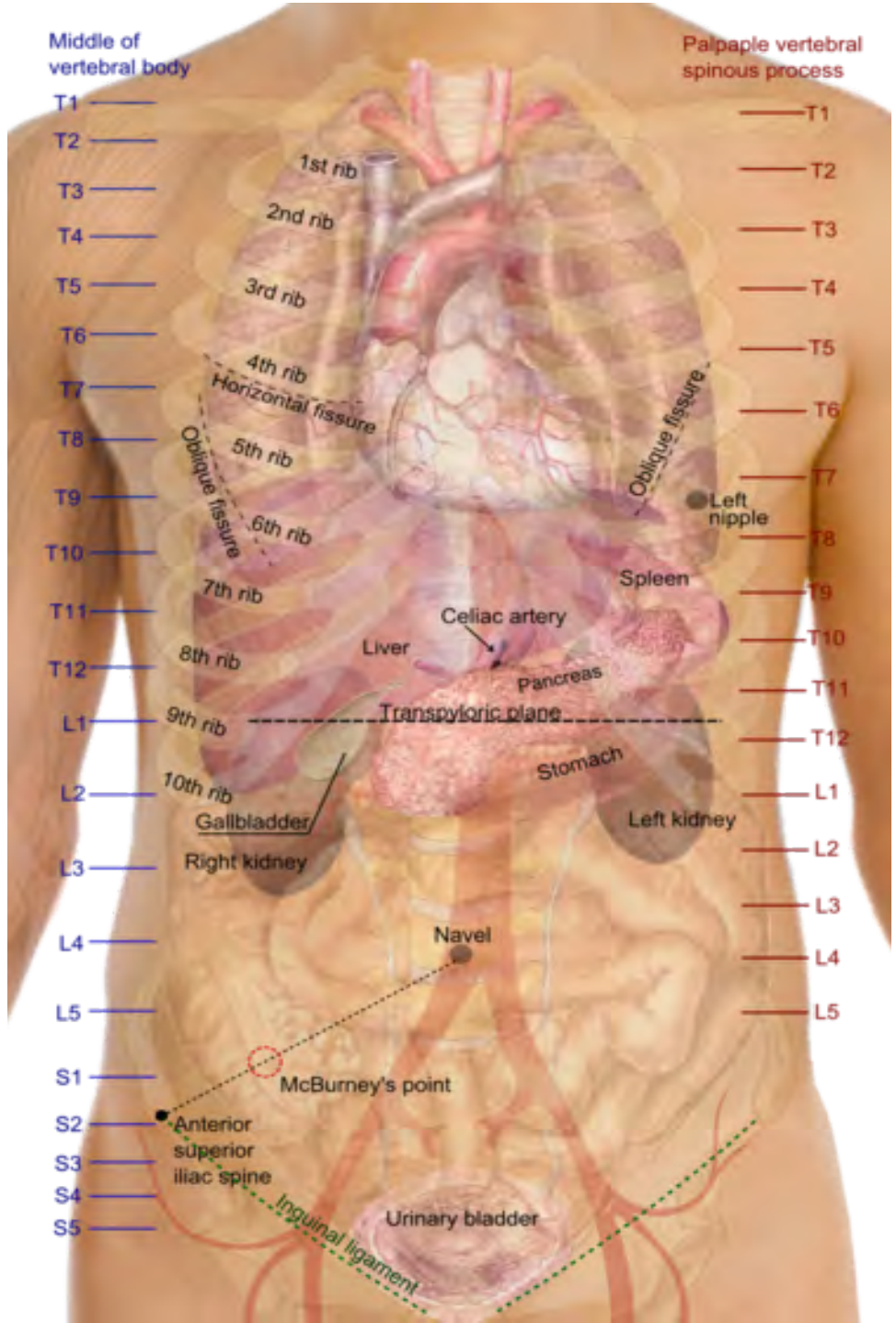

Middle of vertebral body
Palpaple vertebral spinous process
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
1st rib
2nd rib
3rd rib
4th rib
5th rib
6th rib
7th rib
8th rib
9th rib
10th rib
Horizontal fissure
Oblique fissure
Oblique fissure
Left nipple
Spleen
Celiac artery
Liver
Pancreas
Transpyloric plane
Stomach
Gallbladder
Right kidney
Left kidney
Navel
McBurney's point
Anterior superior iliac spine
Inguinal ligament
Urinary bladder

Abdominal Assessment

- Inspection
- Auscultation
- Percussion
- Palpation

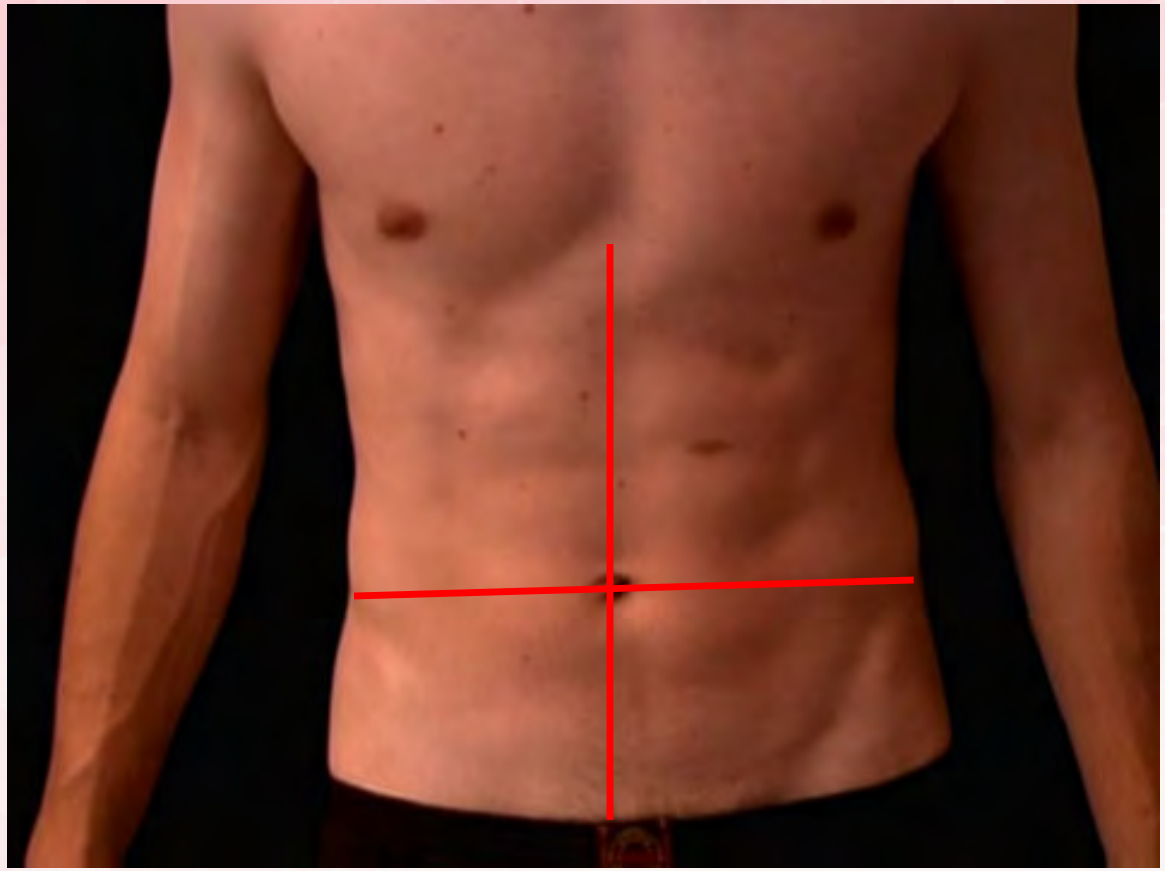
Four Quadrants

Right upper quadrant (RUQ)

Left upper quadrant (LUQ)

Right lower quadrant (RLQ)

Left lower quadrant (LLQ)

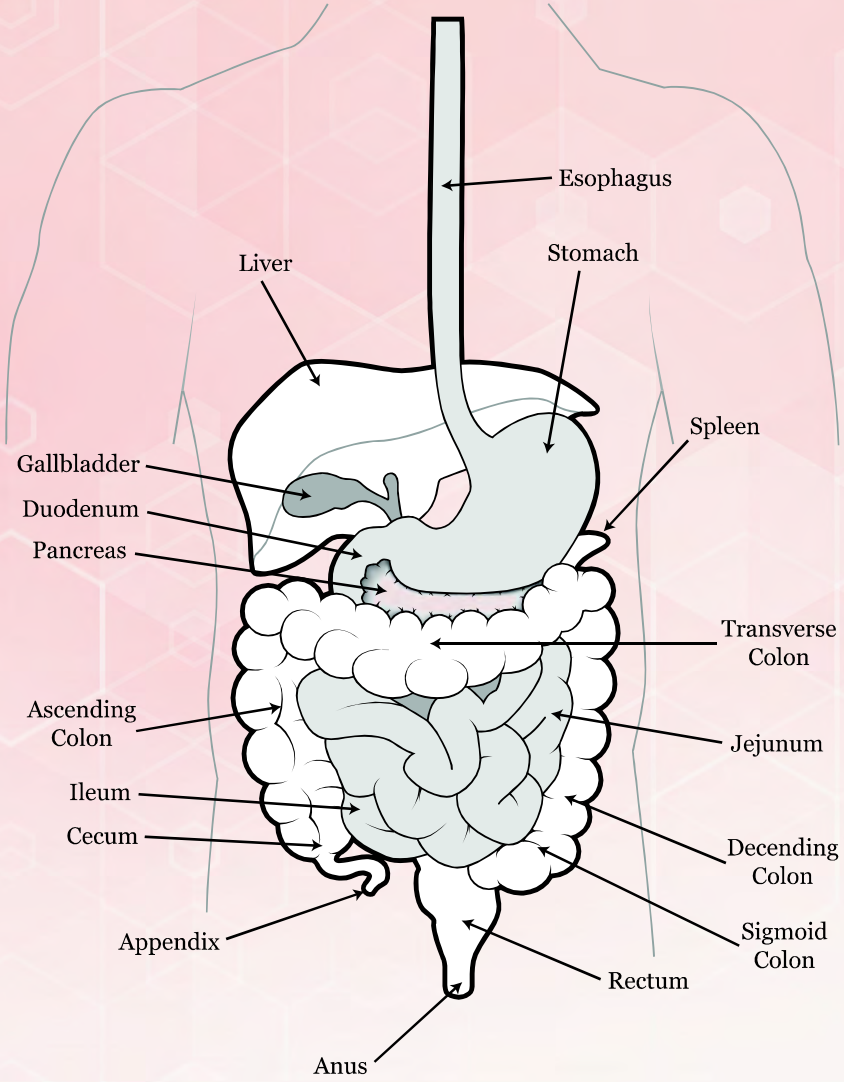


RUQ

- 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



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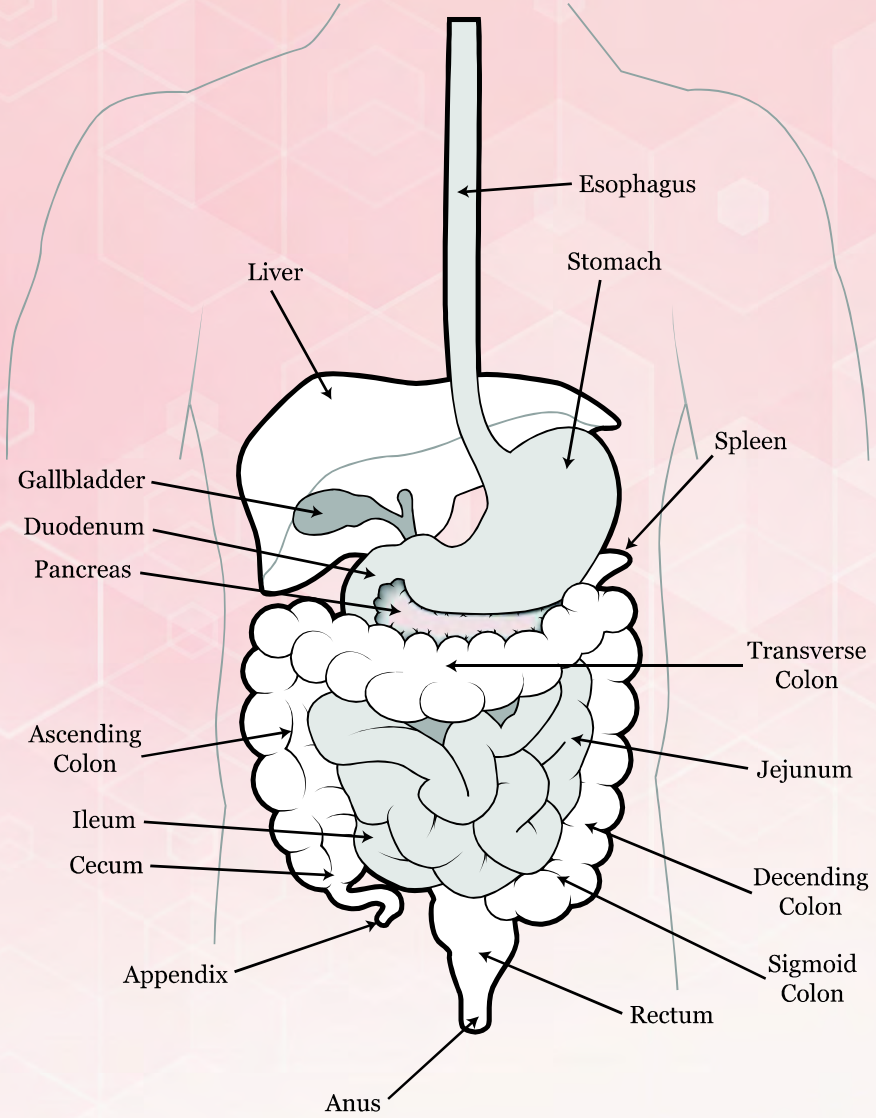
RLQ

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

LLQ

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



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Ongoing Assessment

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

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Diagnostic Labs

Are they necessary? Reliable?

- Hematocrit
- WBC
- Electrolytes
- Pancreatic enzymes
- Liver function tests

Diagnostic Labs

- Coagulation studies
- Urinalysis
- ABGs

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

M-Turbo Courtesy of Sonosite

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Ultrasound

Advantages

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

Disadvantages

- Clinician expertise variable
- Lacks specificity
- Not intended to replace DPL or CT scan
- Reliability is questionable
- May not reveal free fluid if performed too early

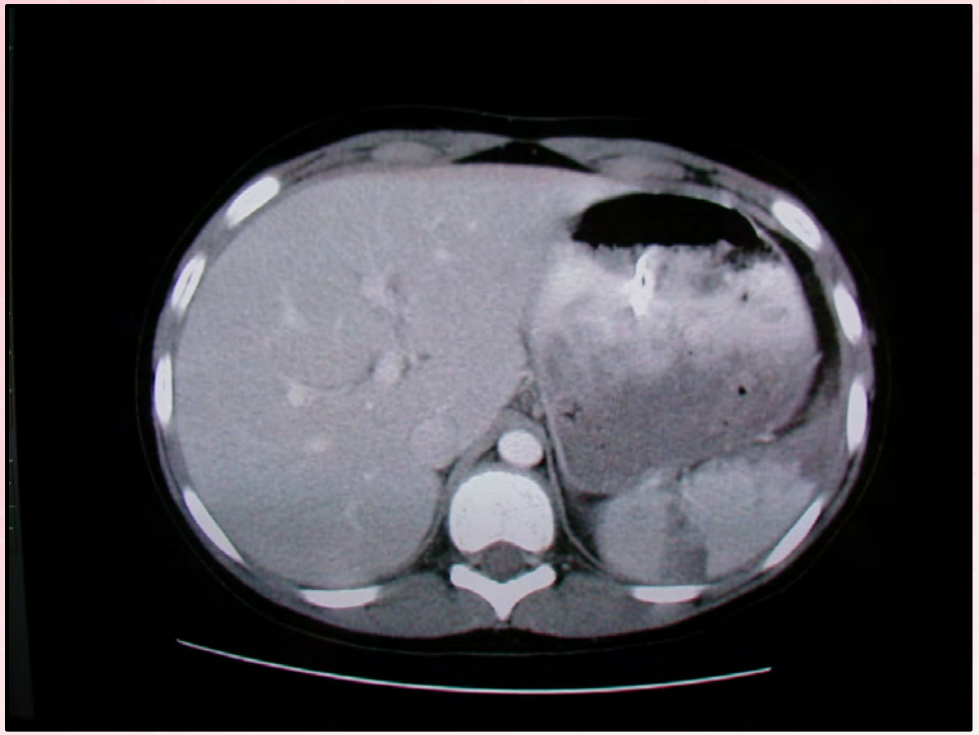
(Jang, 2017)

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



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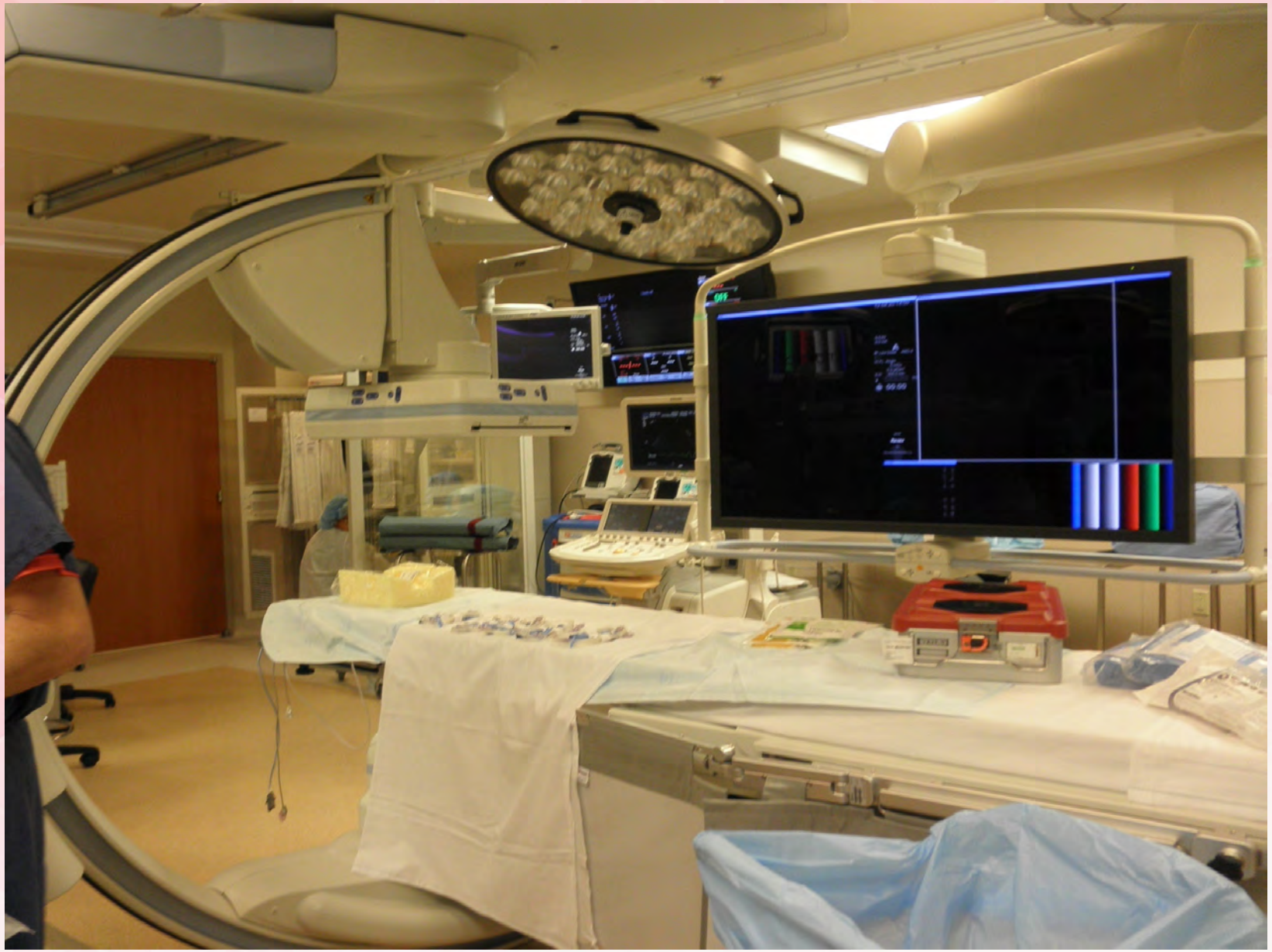
CT Scan Disadvantages

- 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



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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

(Hoff et al, 2002)

Other Diagnostic Procedures

ERCP

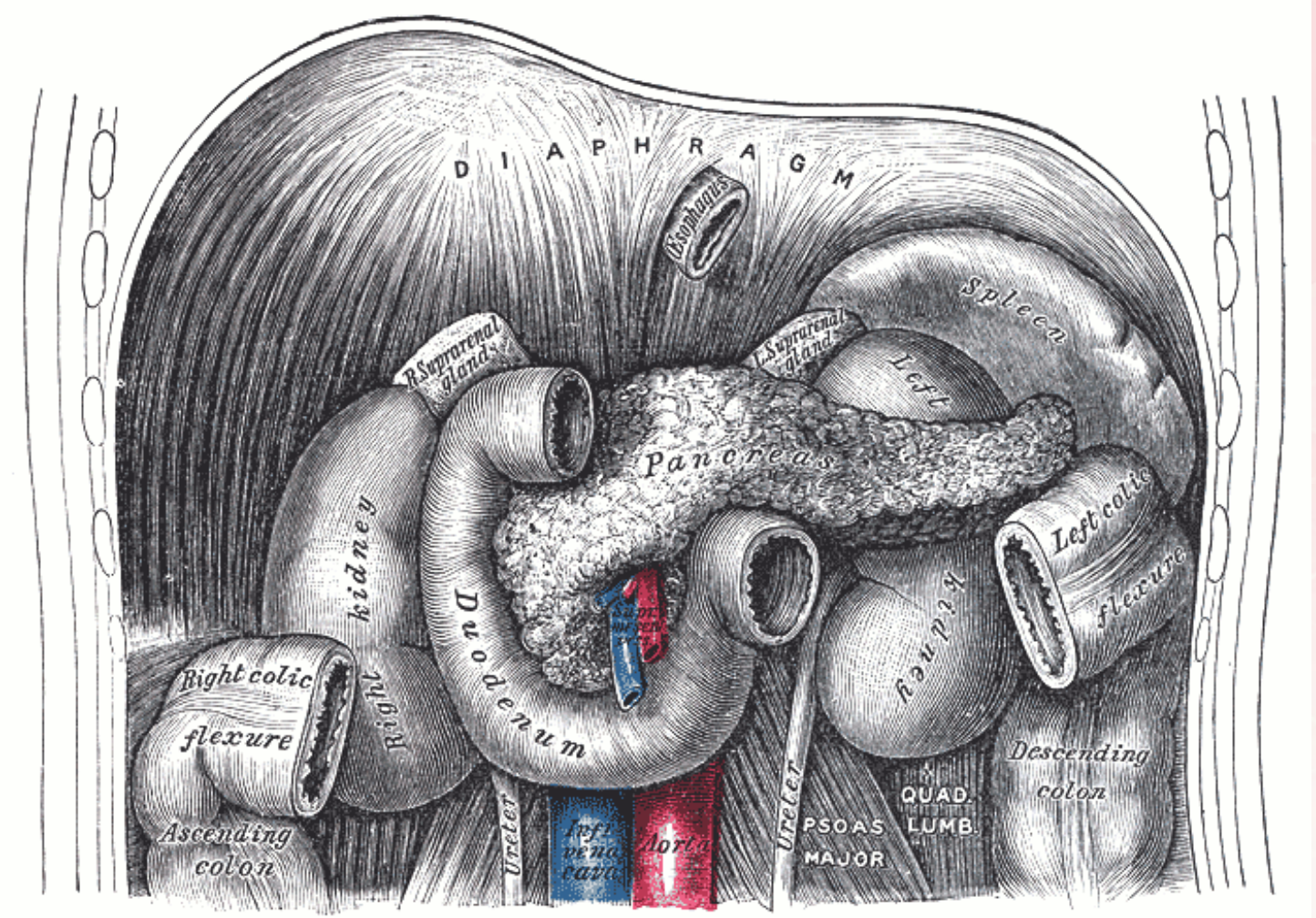
- May be indicated in the stable trauma patient suspected of having biliary tract or pancreatic duct injury
- Most accurate test in the patient with hyperamylasemia and in those following pancreatic surgery

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

Specific Injuries



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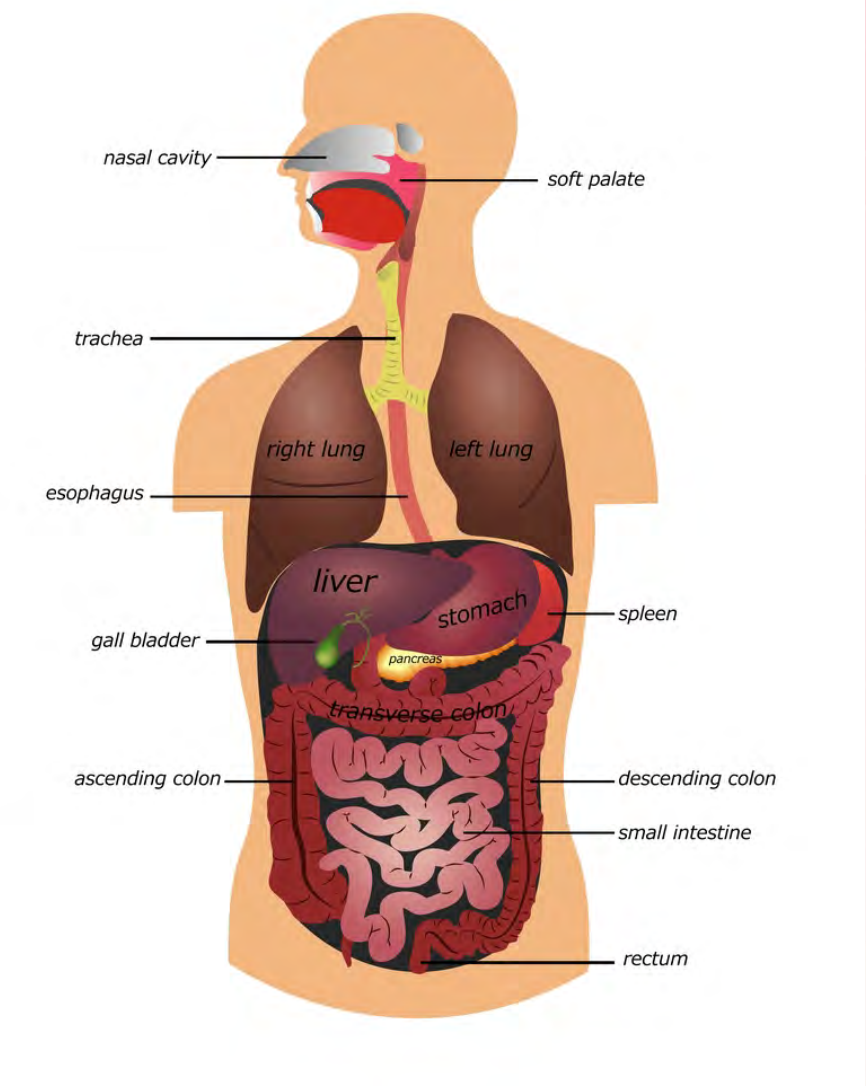
Esophageal Injuries



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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

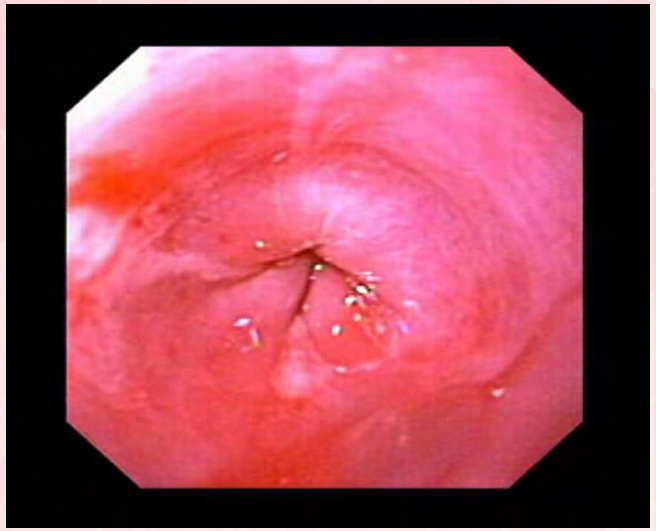
Esophageal Injury

Management

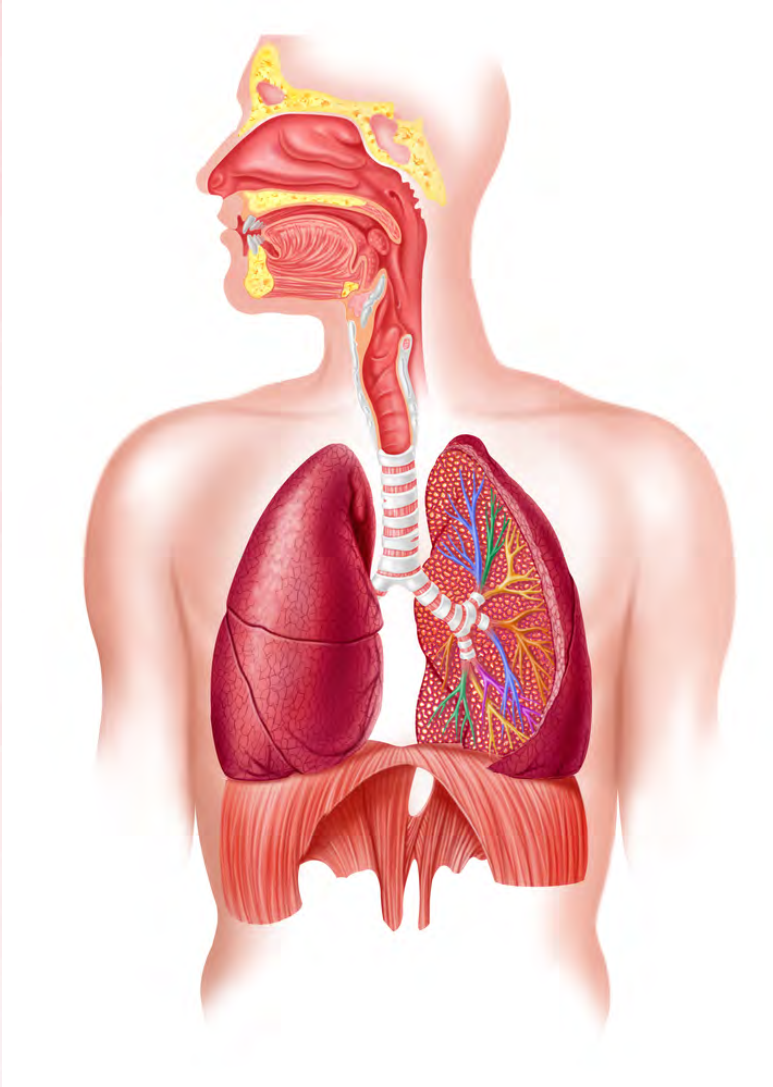
- Initial assessment complex
- Goal is to minimize the bacterial contamination and enzyme erosion
- Gastric decompression
- Antibiotic coverage
- Drainage of wound
- Surgical repair

Esophageal Injury Management

- Continuous monitoring for injury
- Complications after repair



Diaphragm



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Diaphragmatic Injury

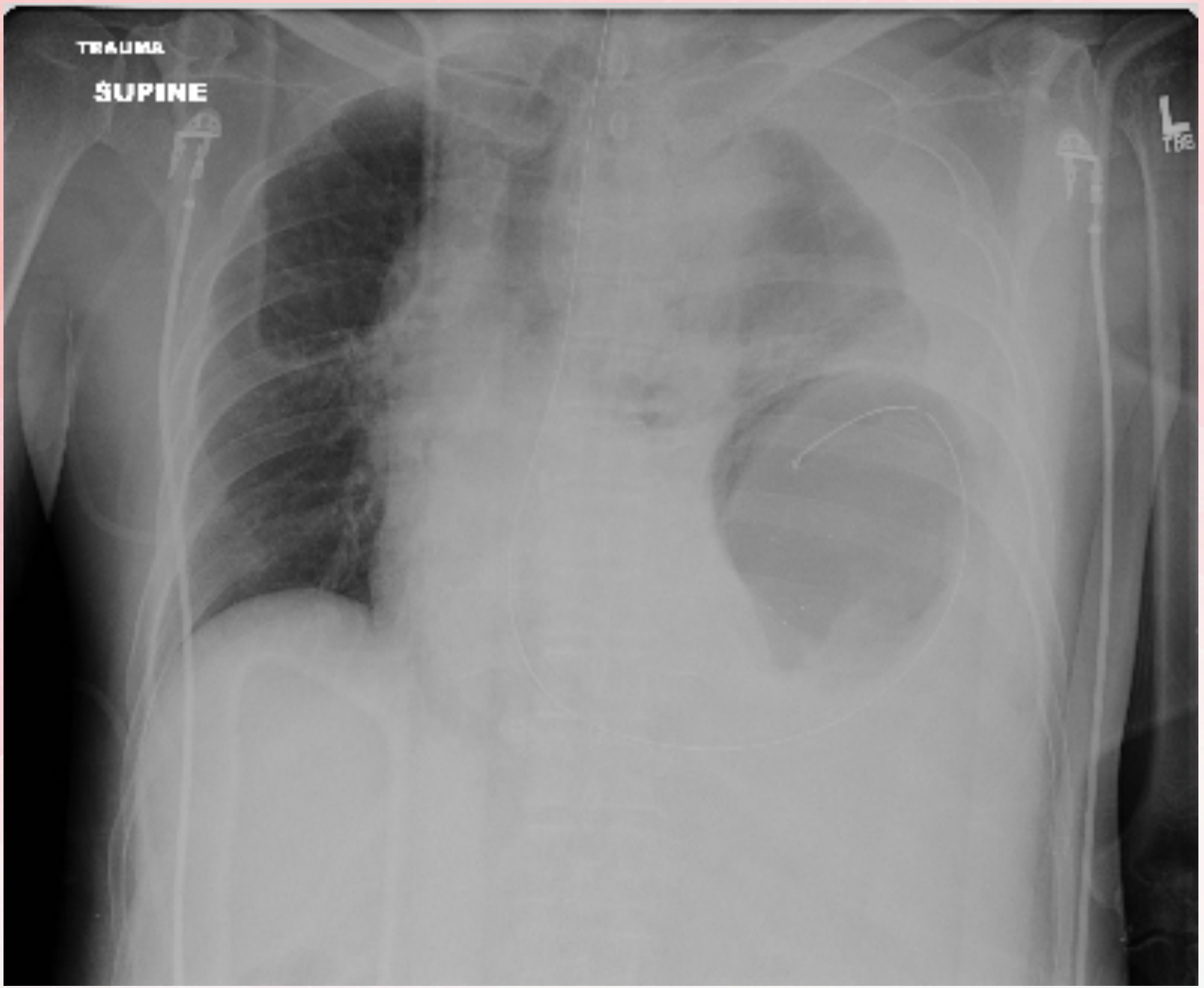
Incidence

- 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



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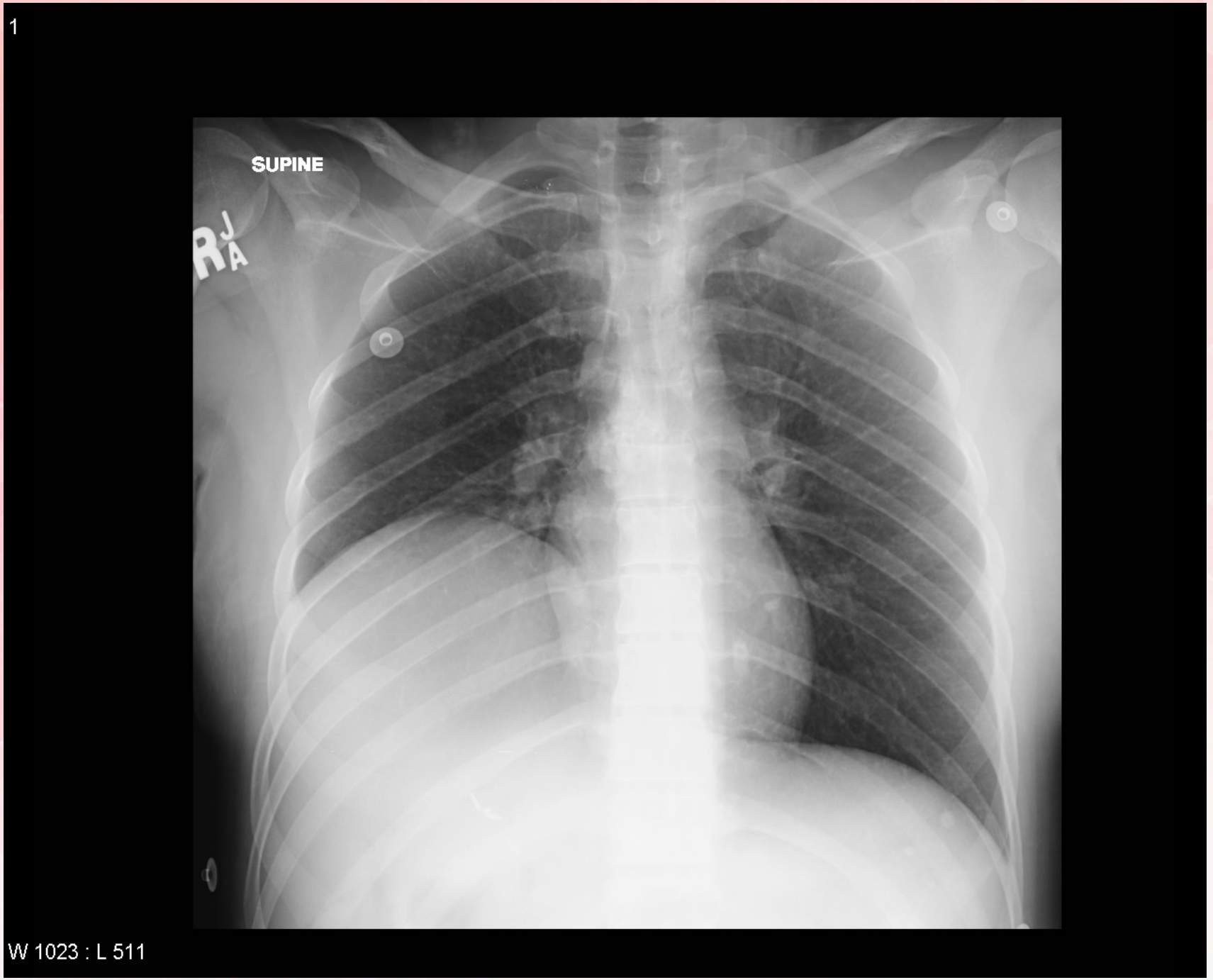
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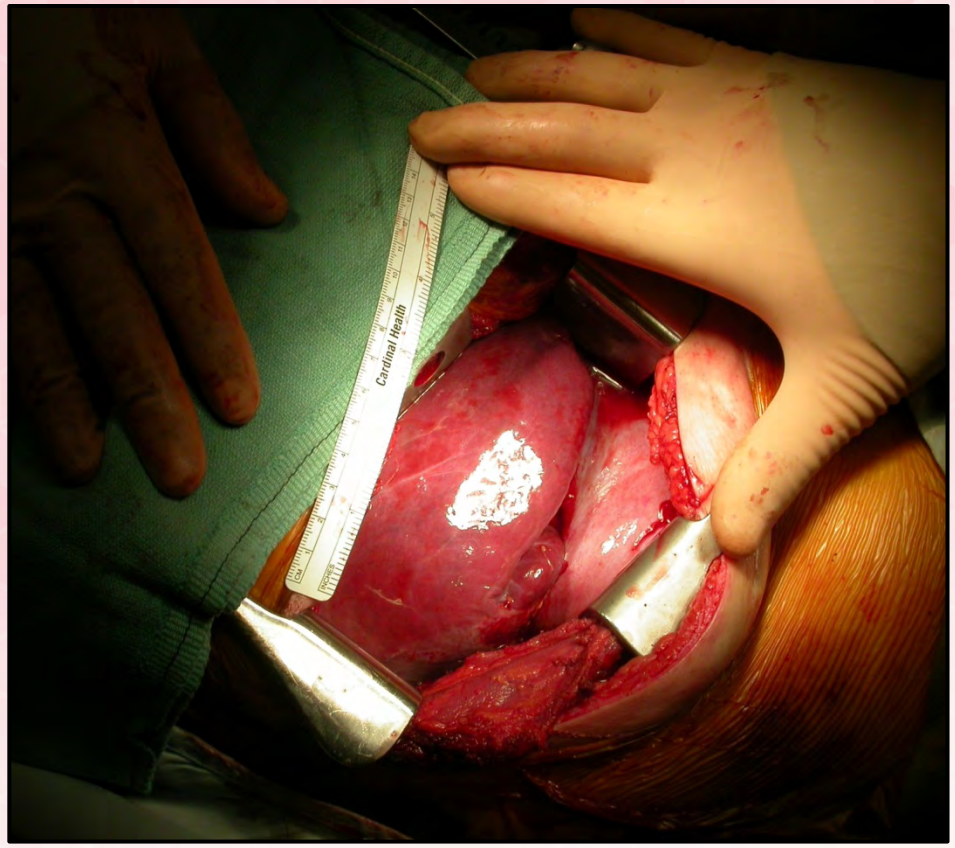
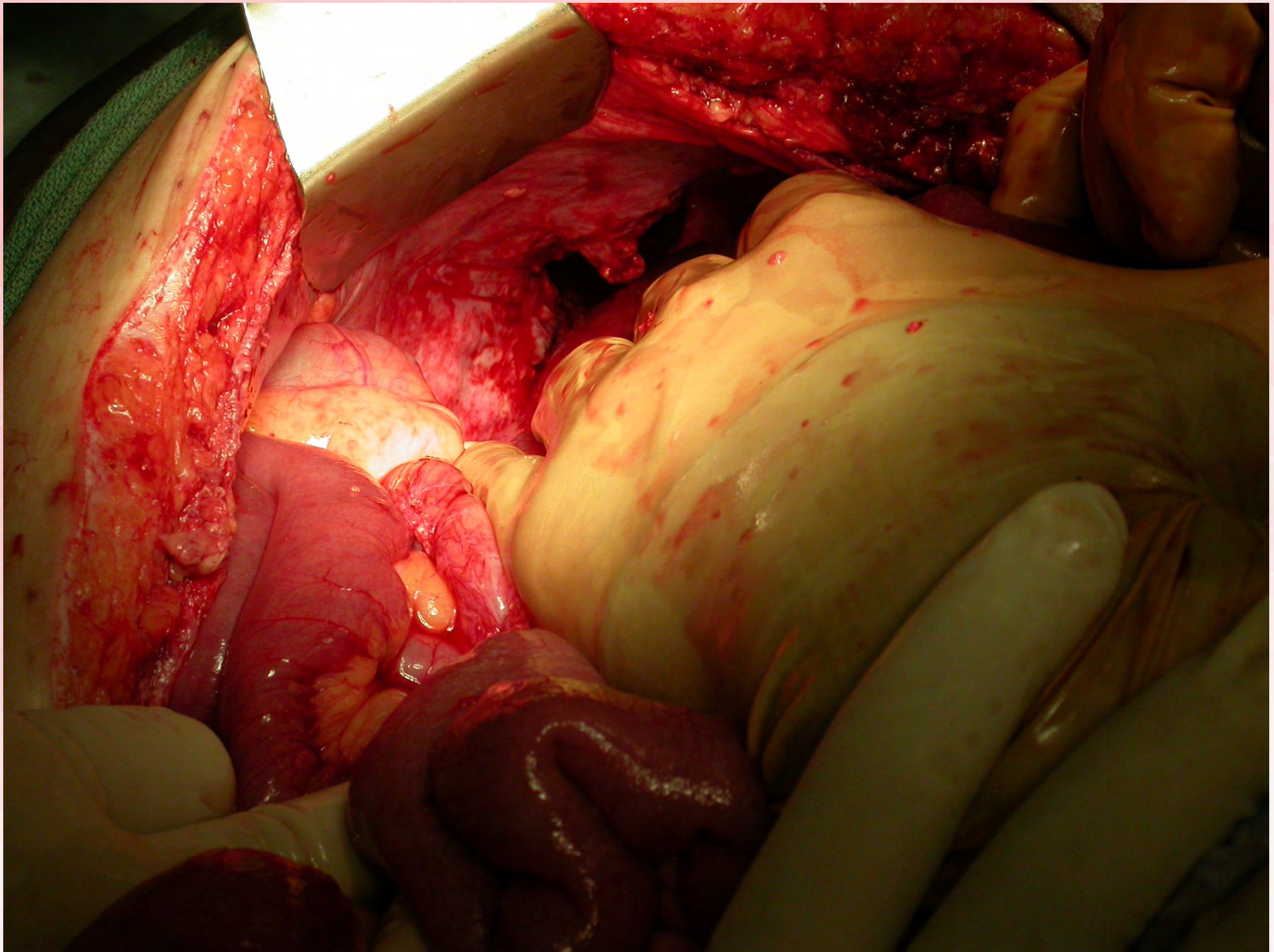
Diaphragmatic Injury

Management

- Exploratory laparotomy
- Diagnostic laparoscopy in penetrating trauma





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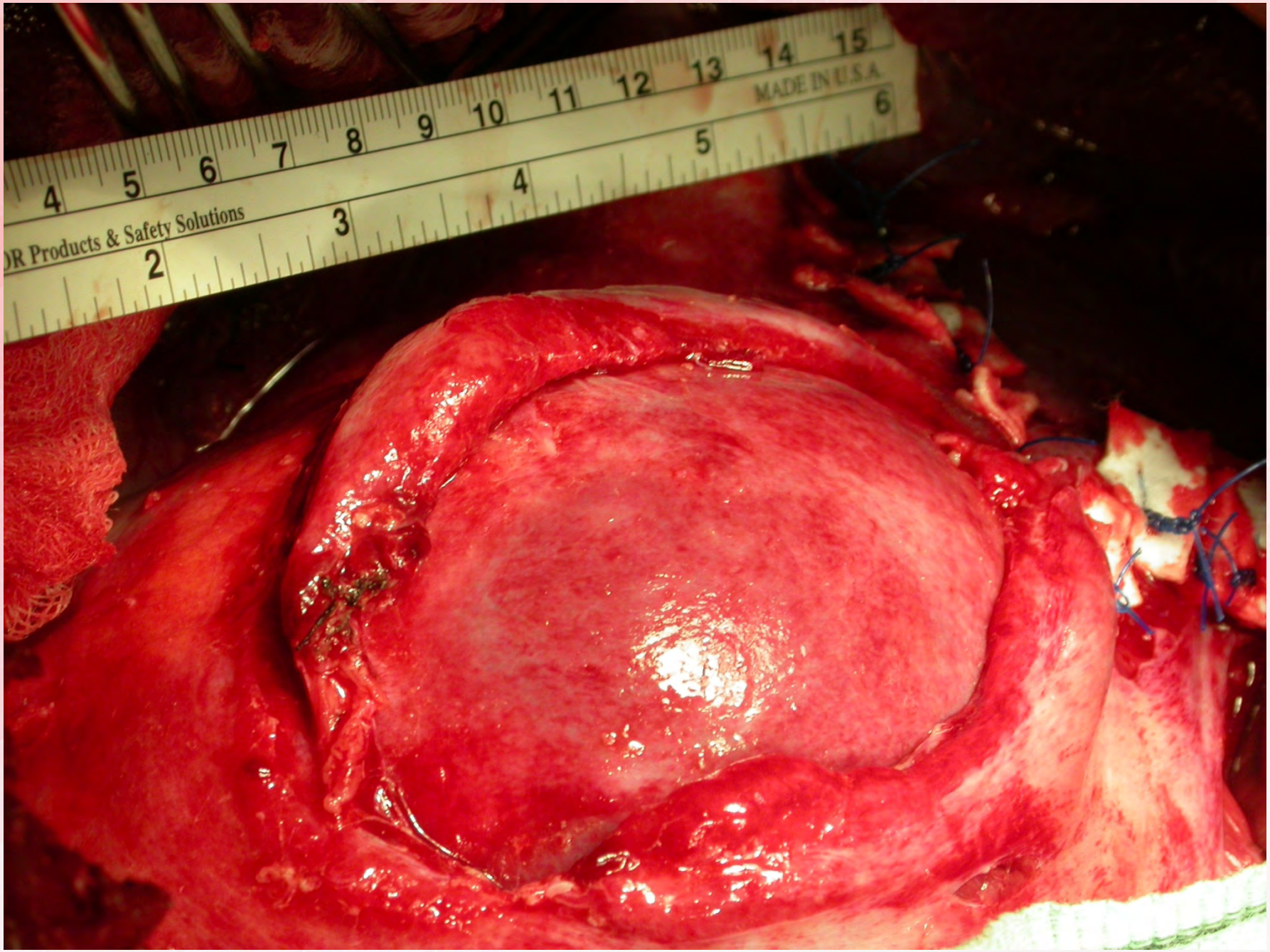

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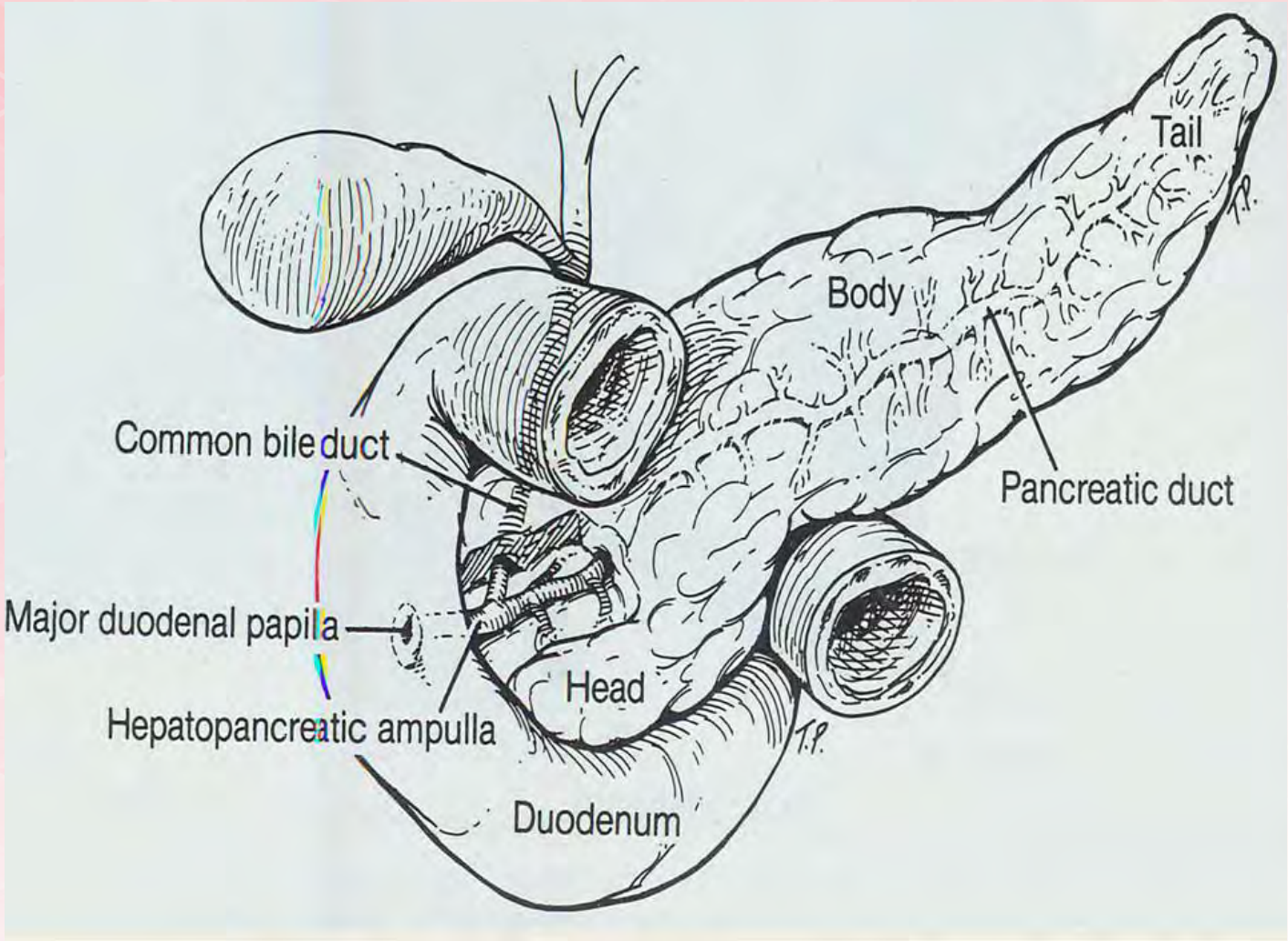
Pancreatic Injuries



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Pancreatic Injuries

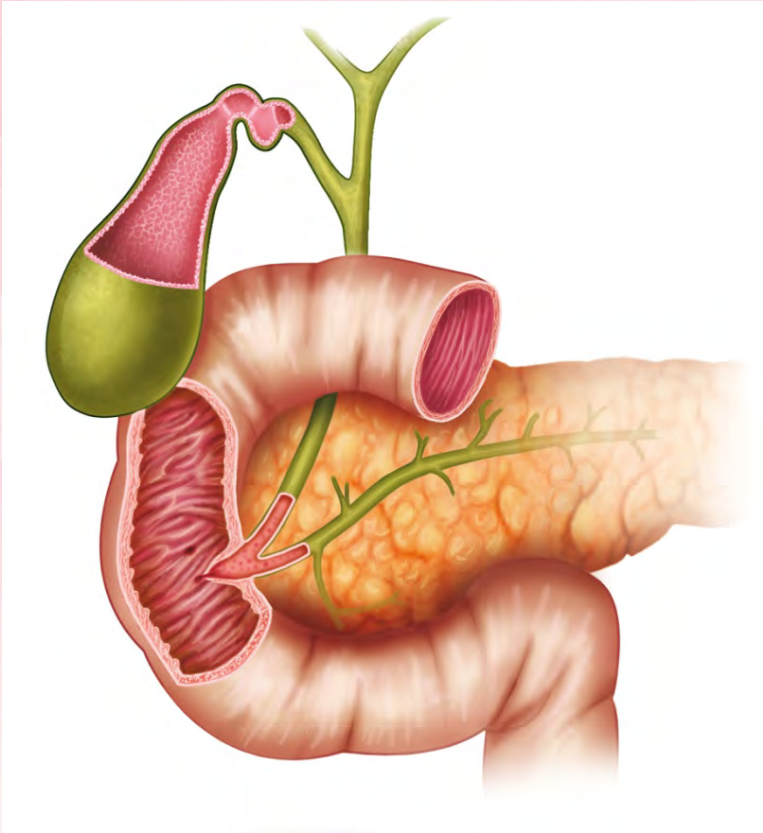
Incidence

- 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

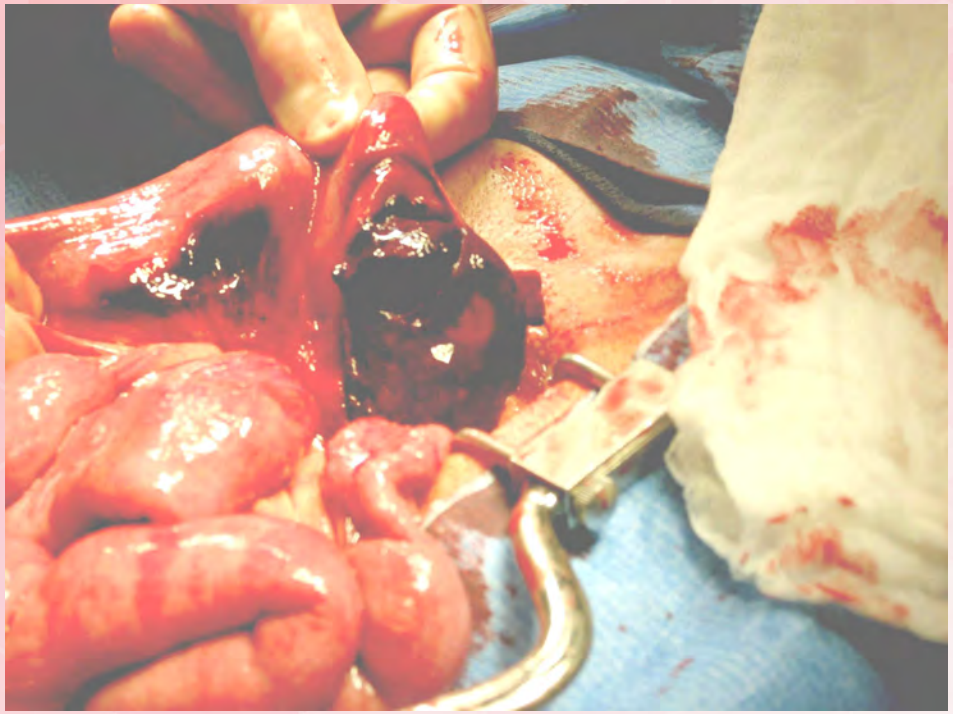
(Ho et al, 2017)

Duodenum

- First part of small intestine
- Location of most digestion and absorption
- Divided into four sections with only the superior portion residing in the peritoneal cavity
- Rapid deceleration may lead to rupture
- Vulnerable to compression injuries



Duodenal Injuries



Incidence

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

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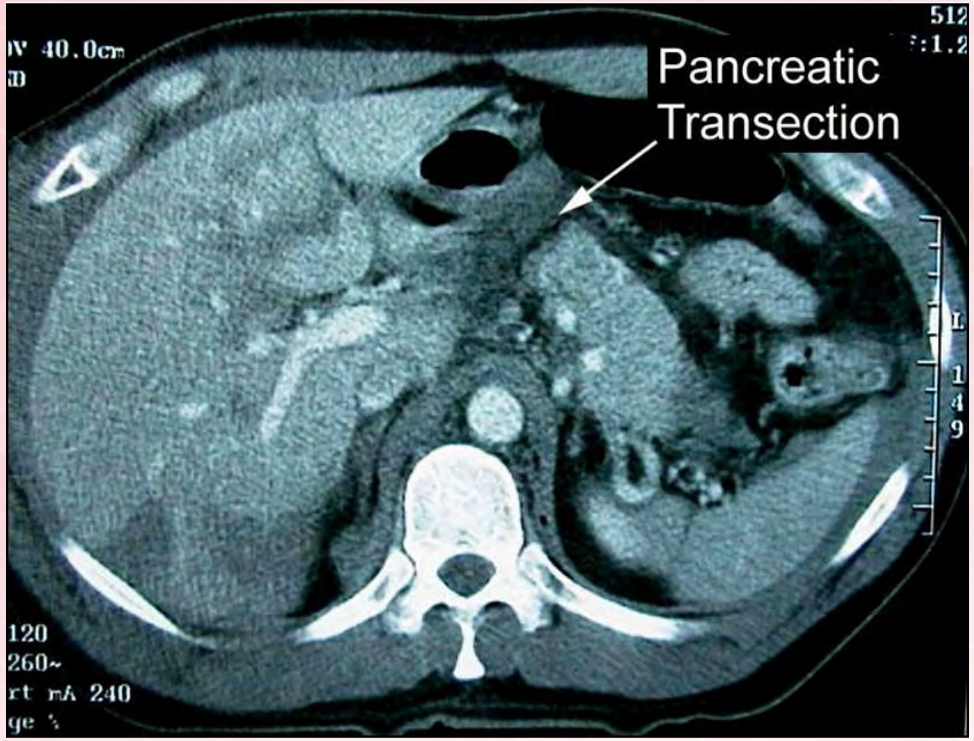
Pancreatic and Duodenal Injuries

Assessment

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



Pancreatic and Duodenal Injuries

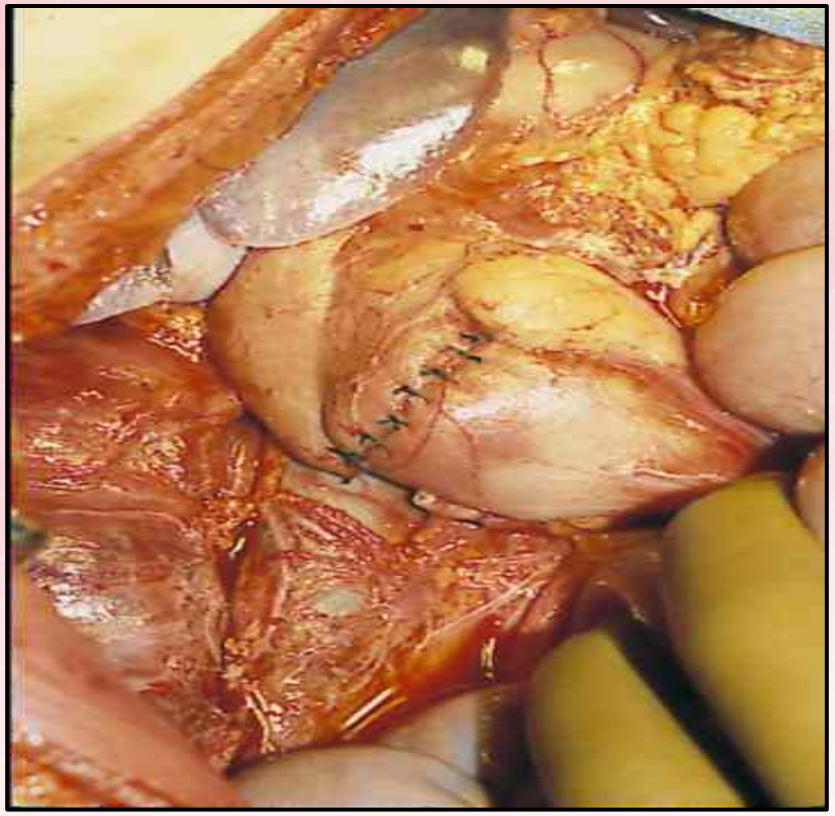
Assessment

- 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

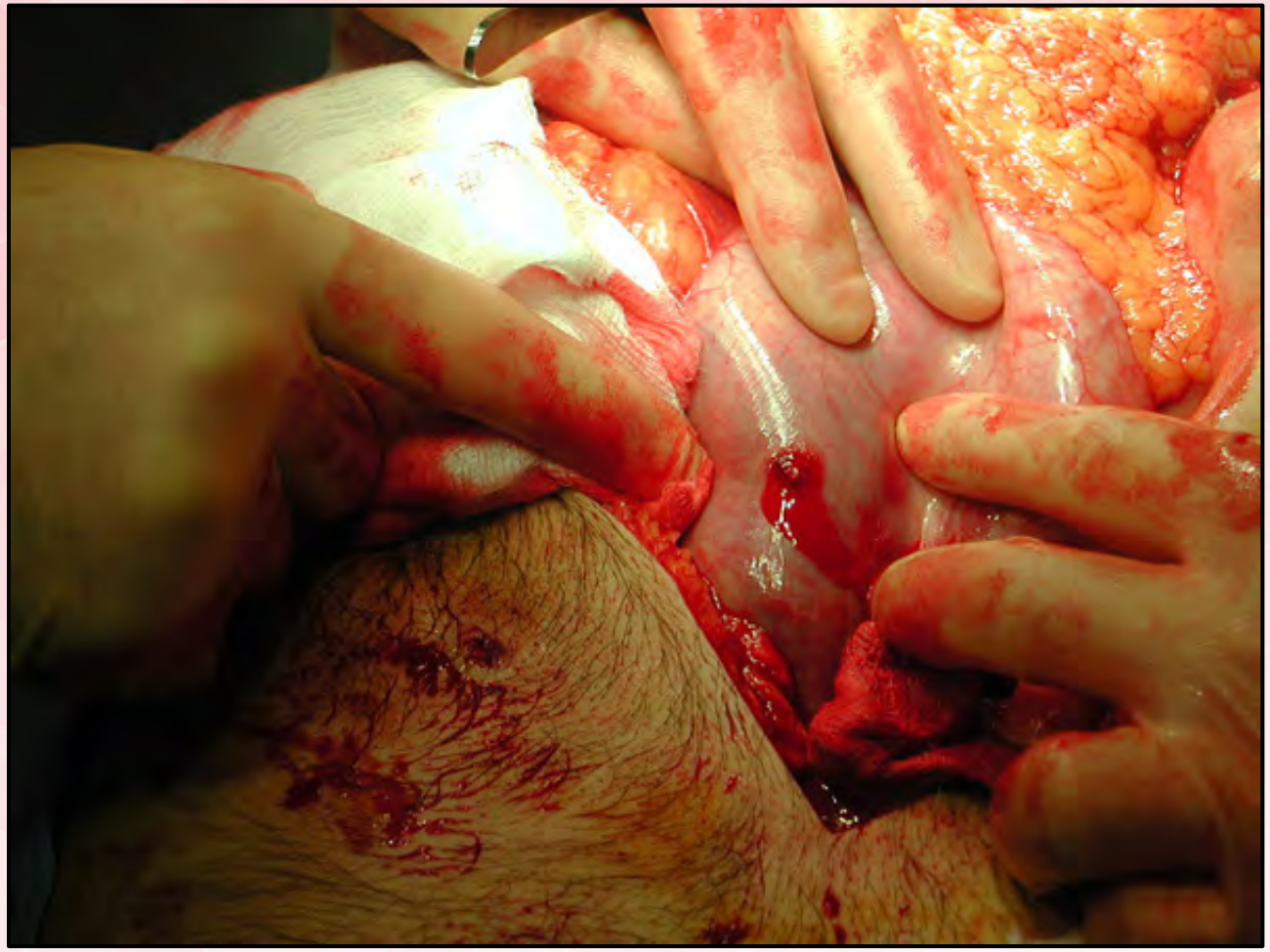
Duodenal Management

- 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



Trauma.org

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 gastric tube
- Free air on radiograph
- Findings on CT or DPL

Stomach Injury

Management

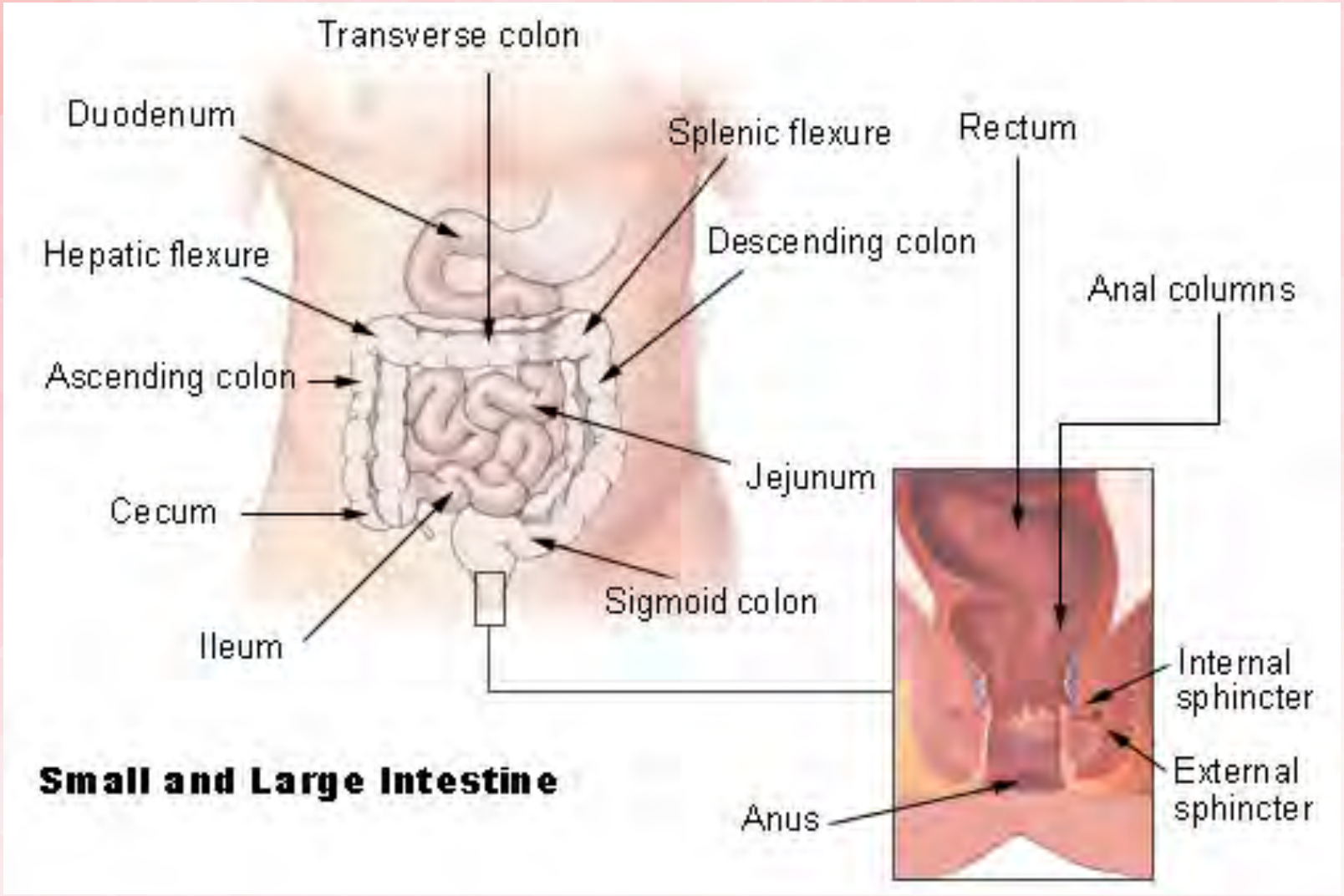
- Gastric decompression
- Surgical intervention
- If contamination exists, copious peritoneal irrigation and delayed primary closure
- Monitor for postoperative complications

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

Hollow Viscus Injuries



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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

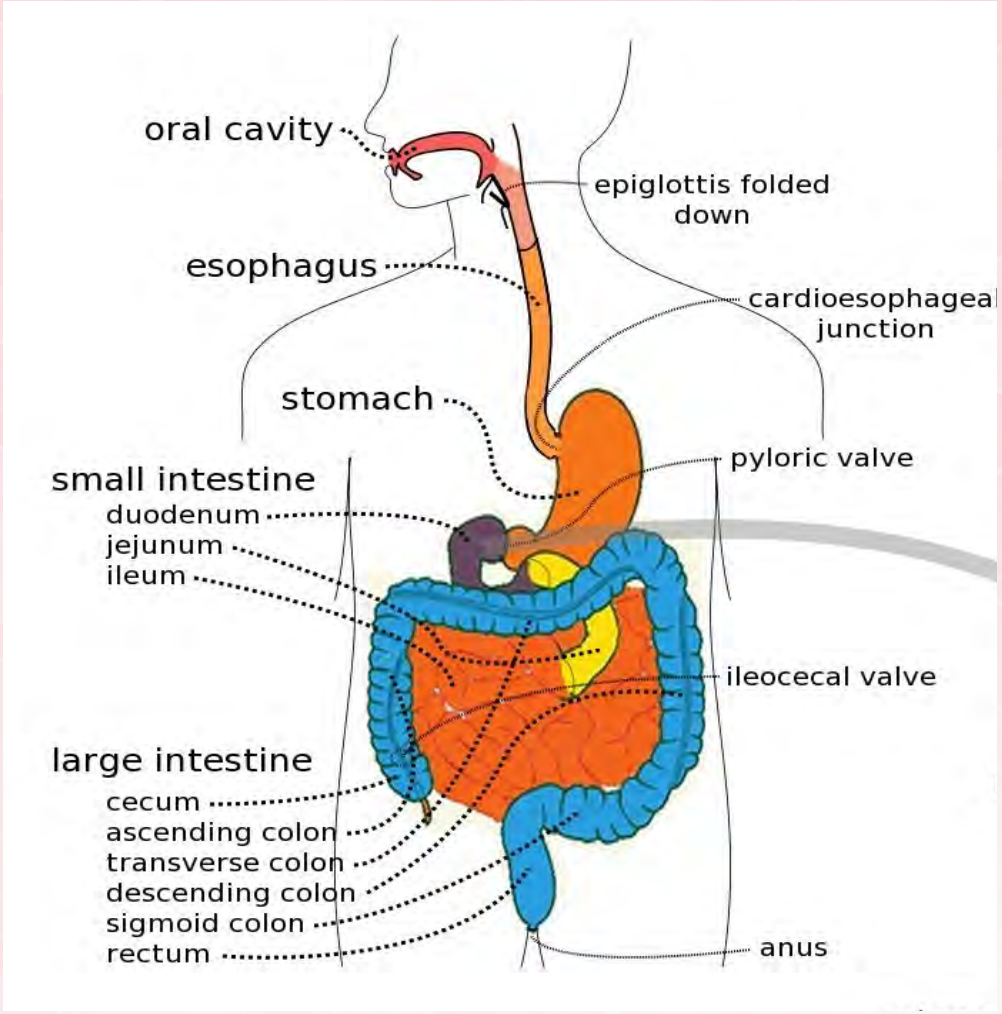
- Clinical signs may not be apparent initially
- Signs of peritonitis develop
- Any blow to the abdomen or penetrating injury to the lower chest or abdomen should increase suspicion of injury

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



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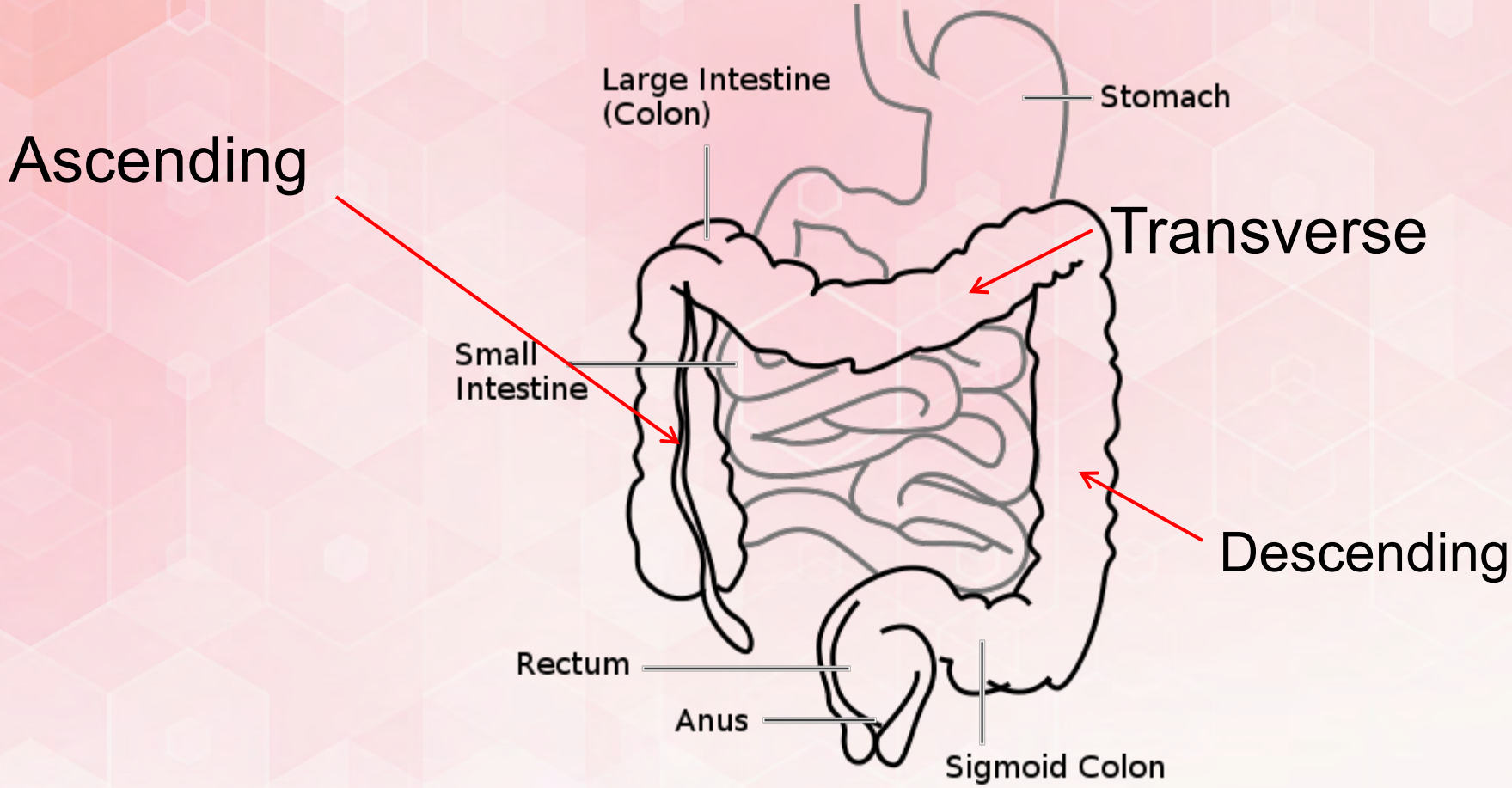
Colon


Ascending
Large Intestine
(Colon)
Stomach
Transverse
Small
Intestine
Descending
Rectum
Anus
Sigmoid Colon

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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

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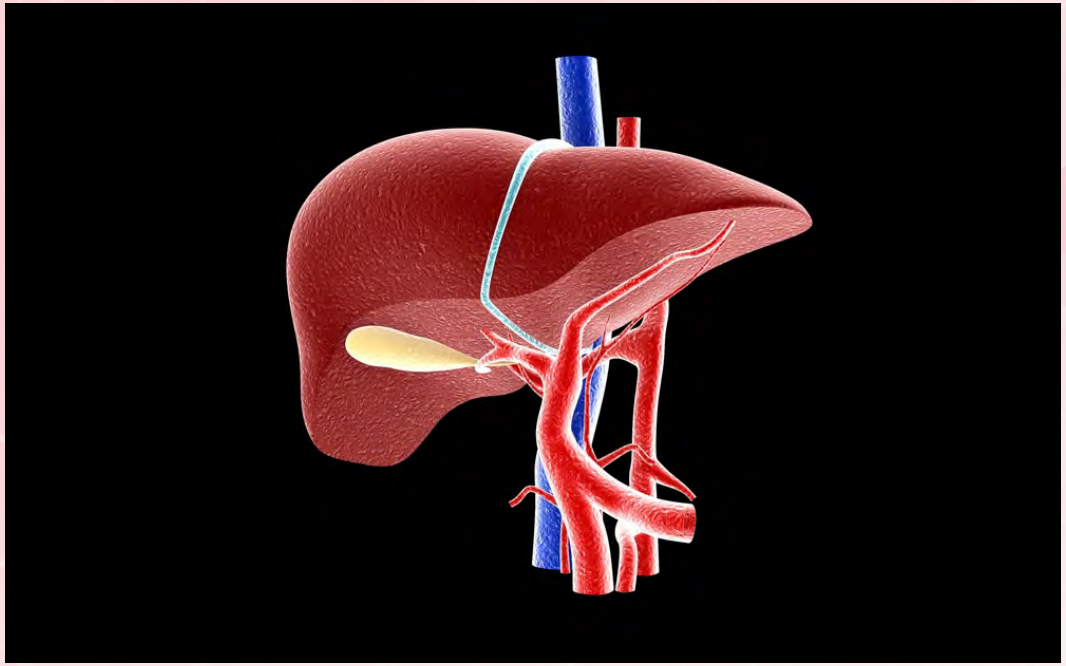
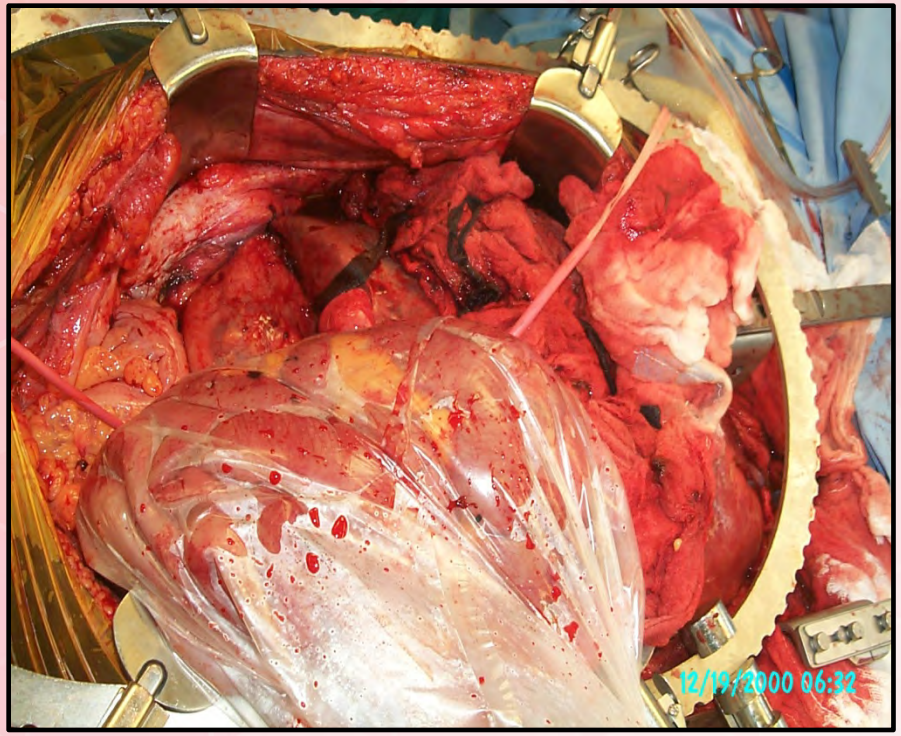
Liver Functions

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



Liver Injury



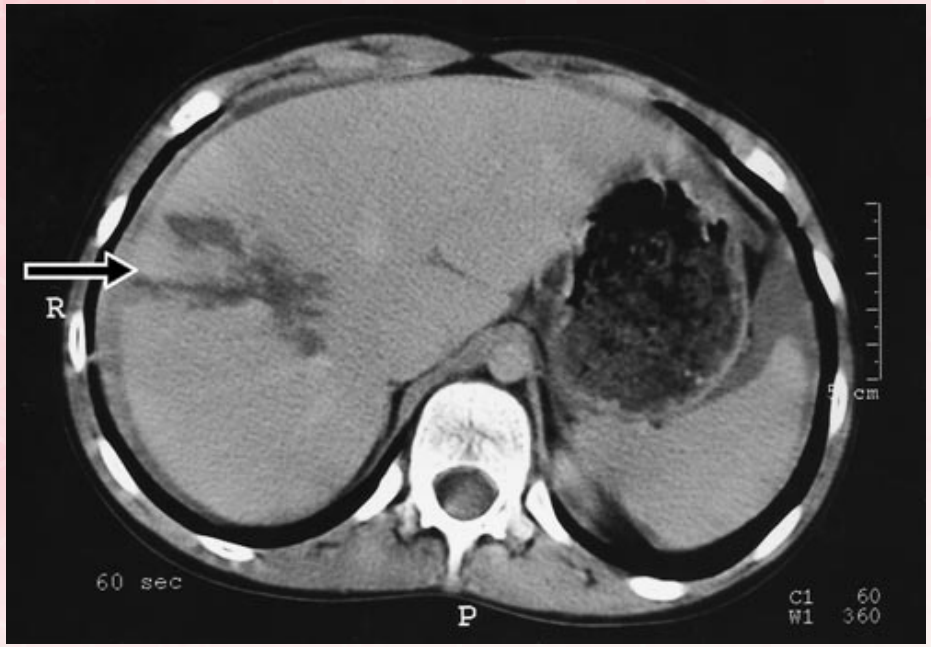
Incidence

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

Liver Injury

Assessment

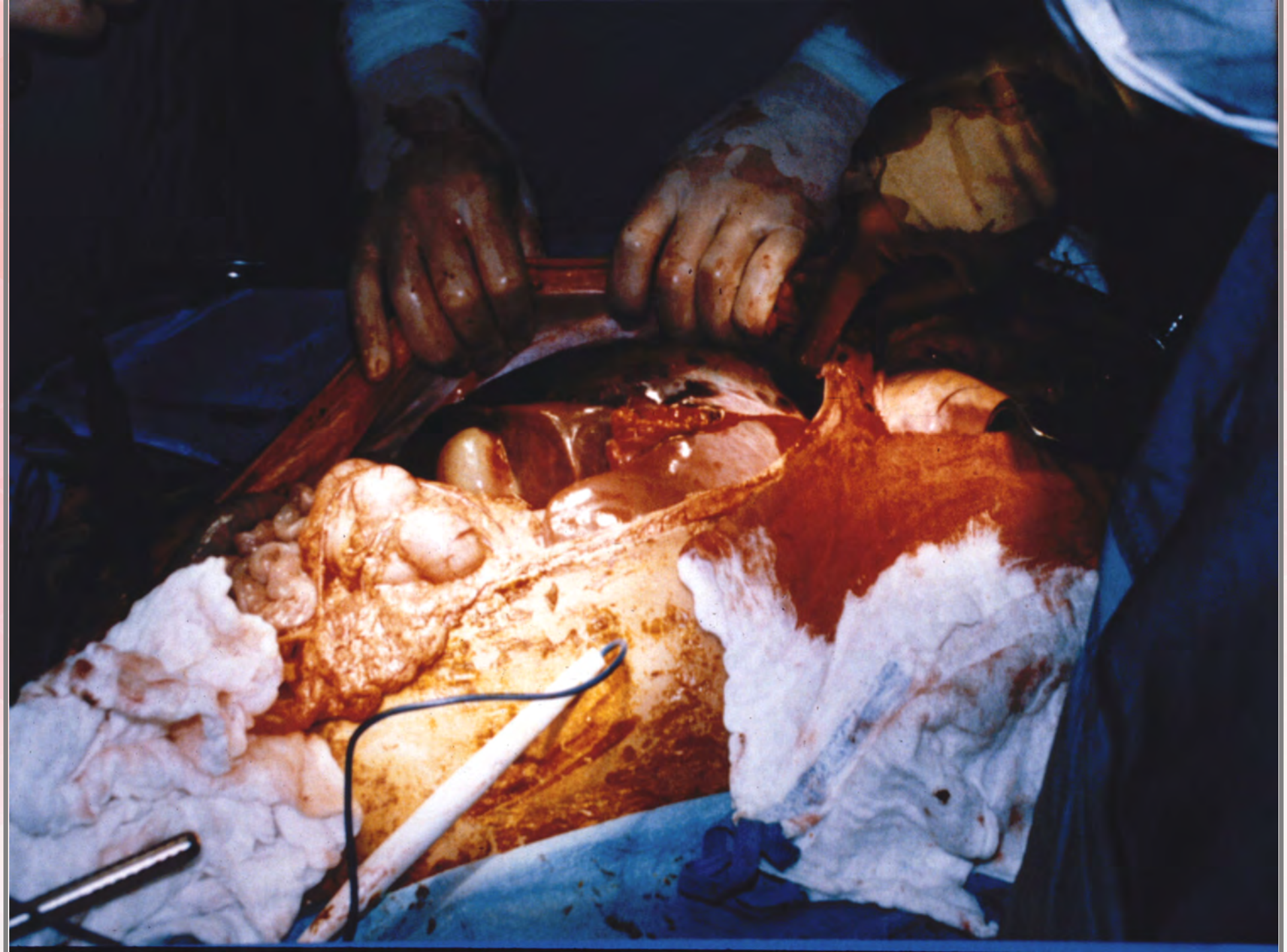
- Suspect in any patient with blunt injury to right side
- Penetrating trauma produces a range of injuries
- FAST, CT scan
- Grading system



Liver Injury

Management

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



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Liver Injury

Observe for complications

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

Injuries to the Spleen

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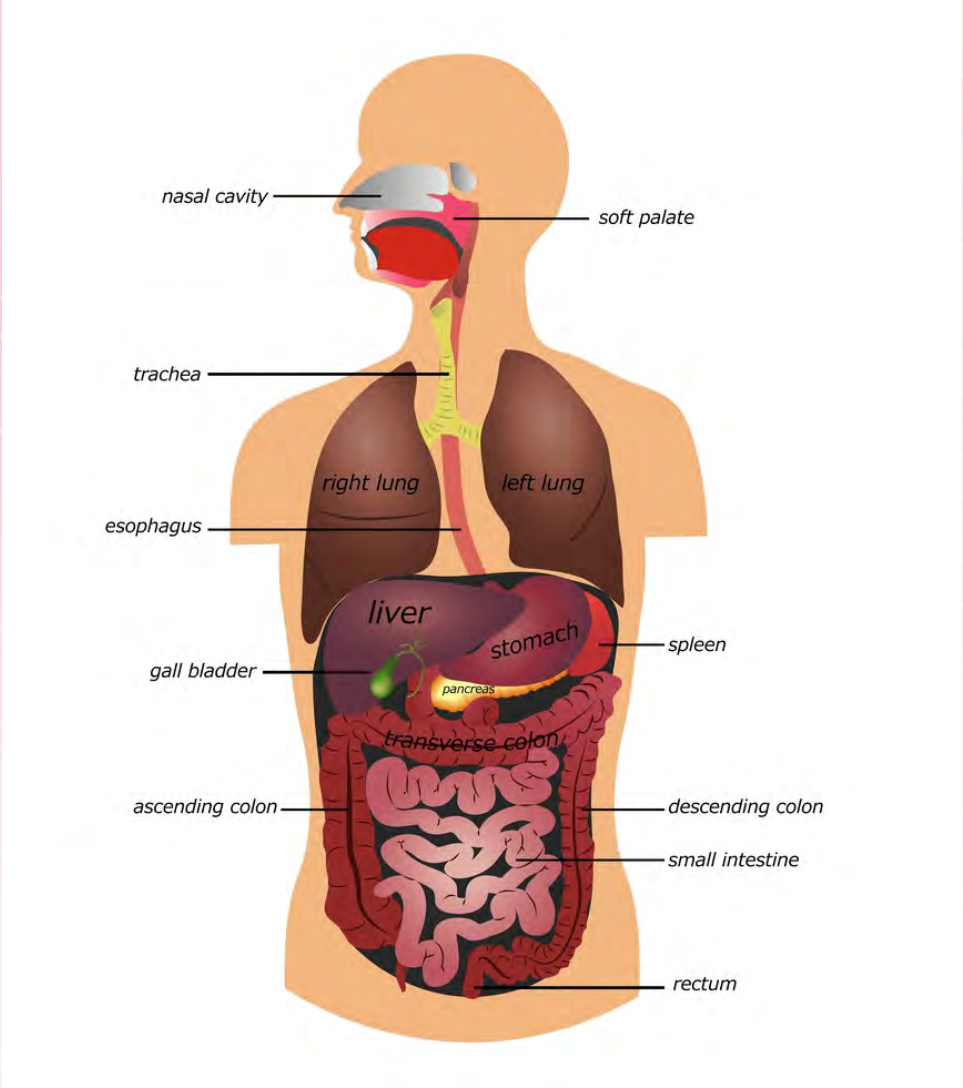
Spleen

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



Splenic Injury

- Incidence
  - 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

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Splenic Injury

Management

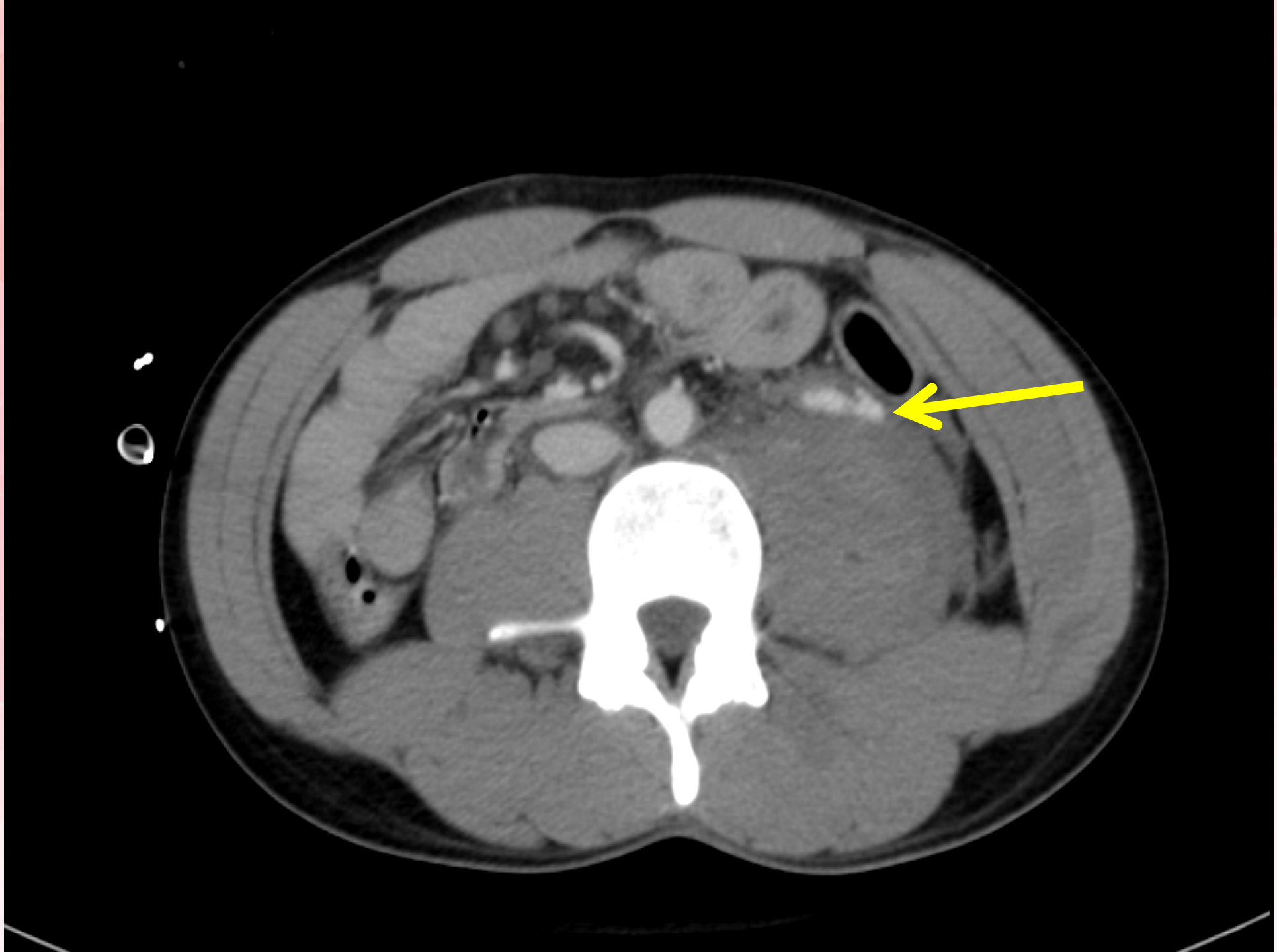
- Monitor for failed observation
- Observe for postoperative complications
  - Bleeding
  - Thrombocytosis
  - Gastric distention
  - Pancreatitis
  - Infection
- Ensure vaccines are given prior to discharge

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 and education

Retroperitoneal Hemorrhage

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



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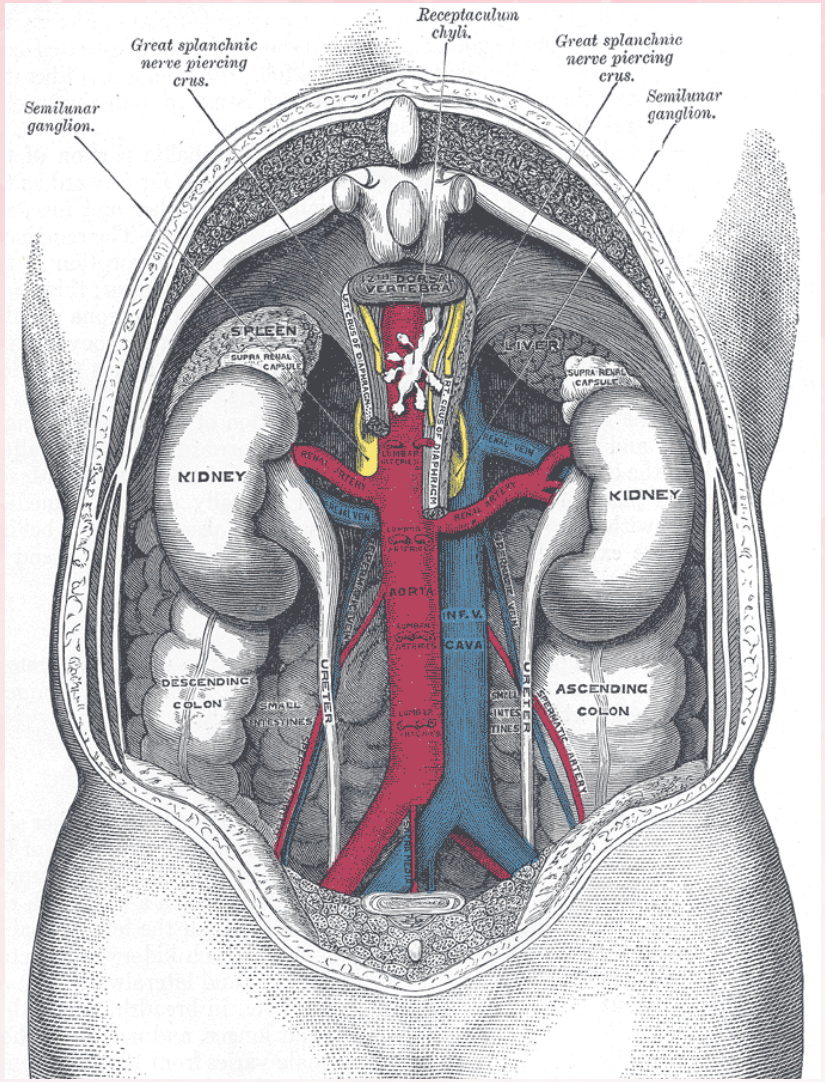
Abdominal Vascular Injuries



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Abdominal Vascular Injury

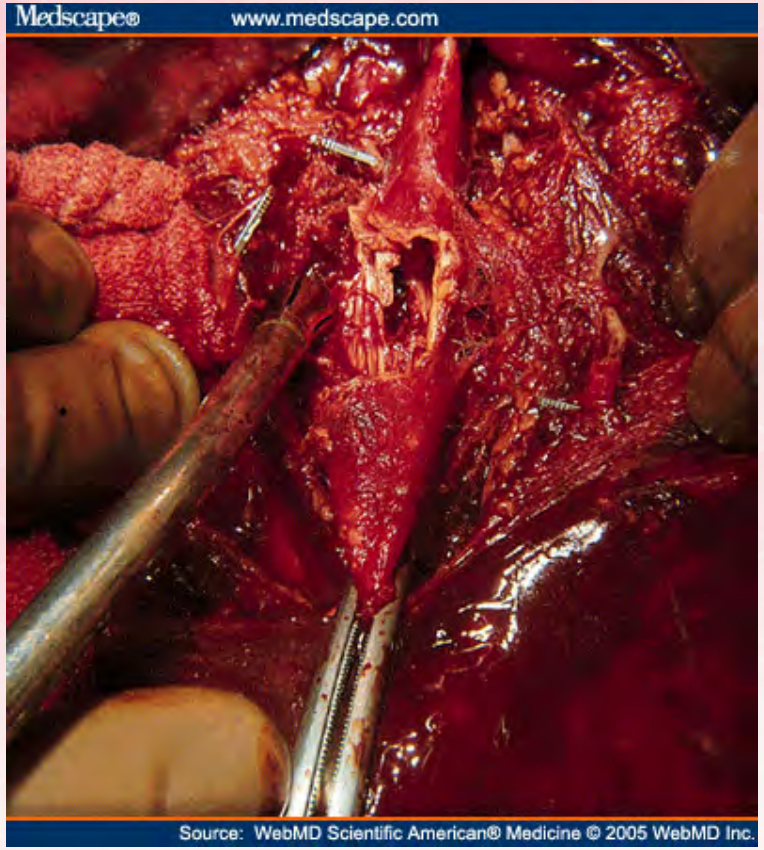
Arterial injury

- 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

Abdominal Vascular Injury

Arterial Injury Management

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



GSW to Infrarenal Aorta

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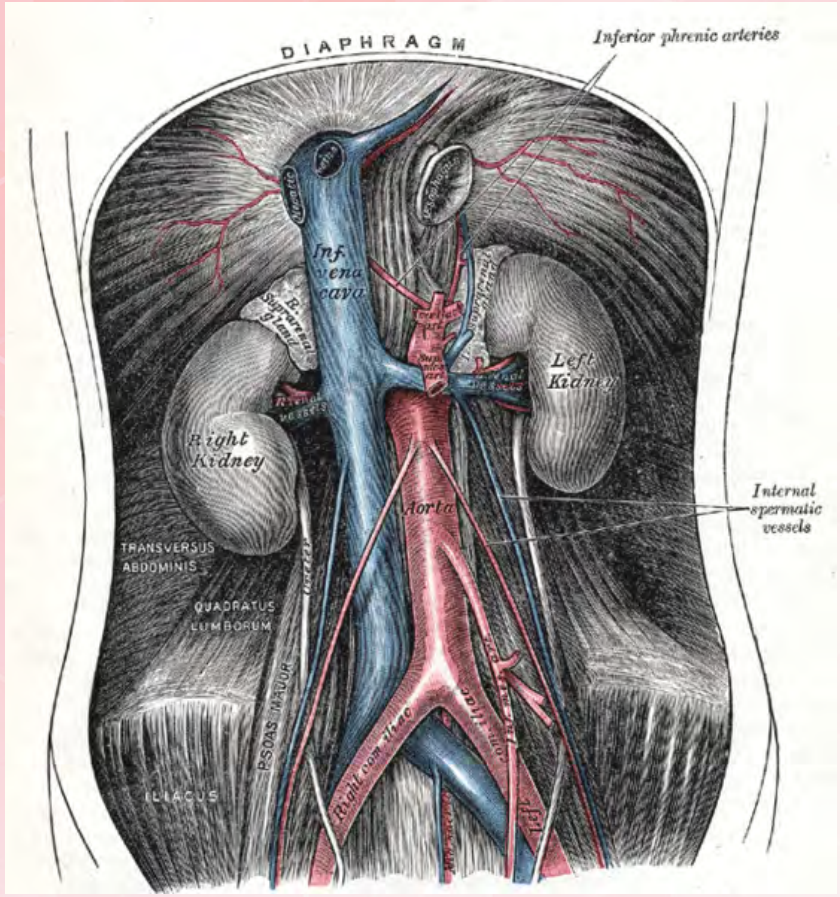
Abdominal Vascular Injury



Venous Injury

- Low pressure system capable of tamponade effect
- Emergent operative repair for instability
- Diagnostic tests for stable patients to determine extent of injury

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Abdominal Vascular Injury

Venous Injury Management

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

Damage Control

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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

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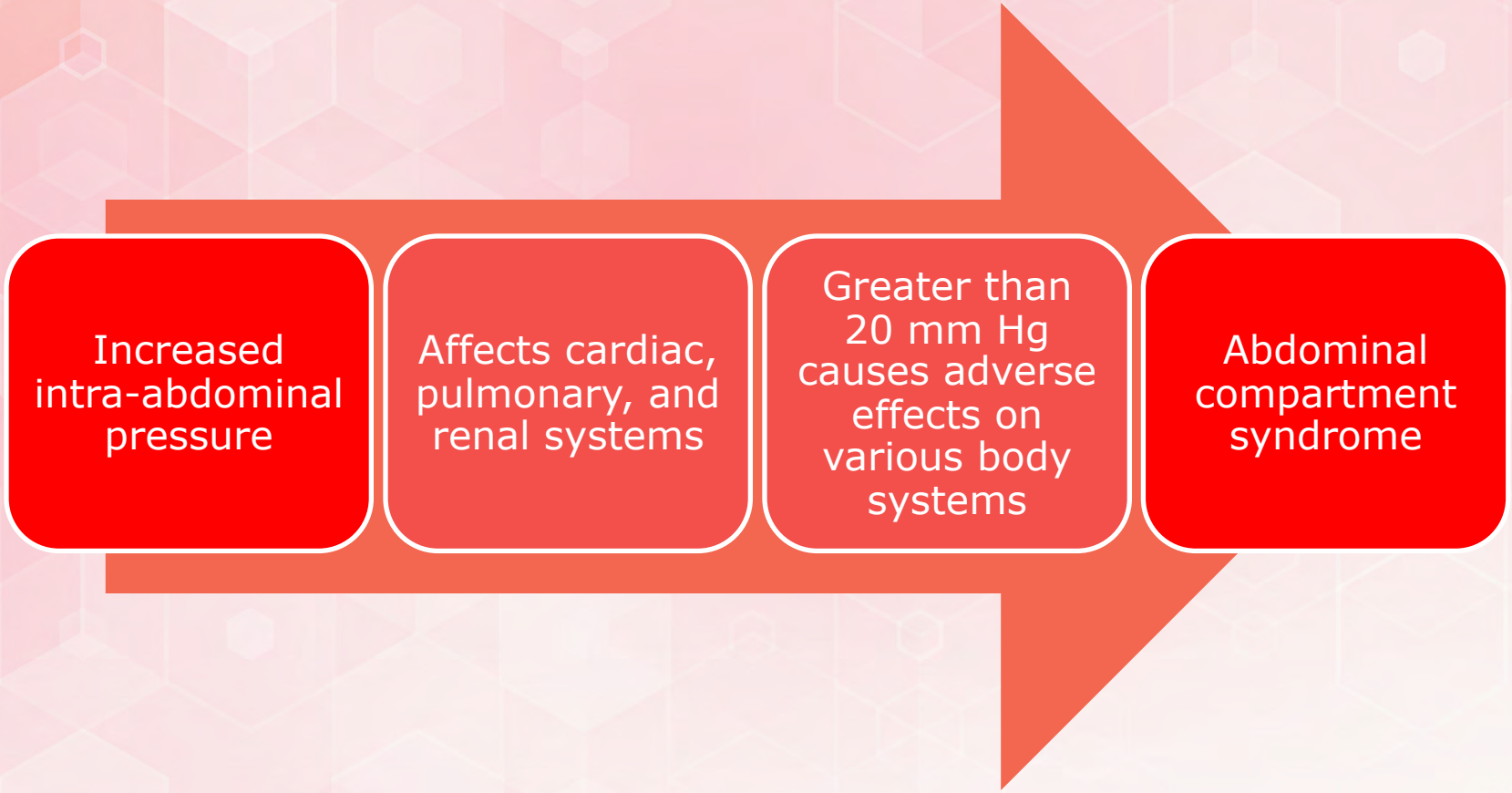
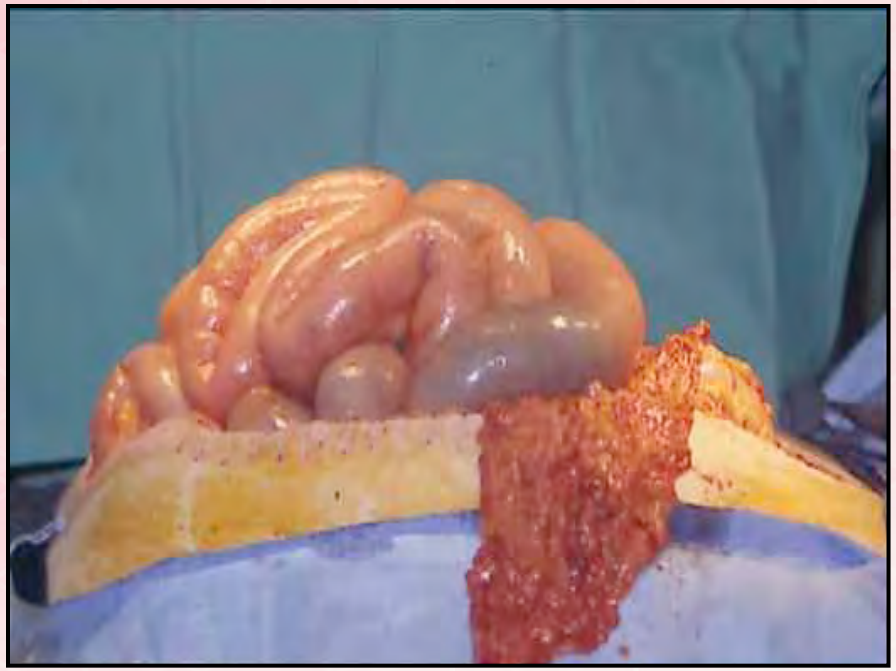
Complications of Abdominal Trauma



Abdominal Compartment Syndrome

Primary Causes

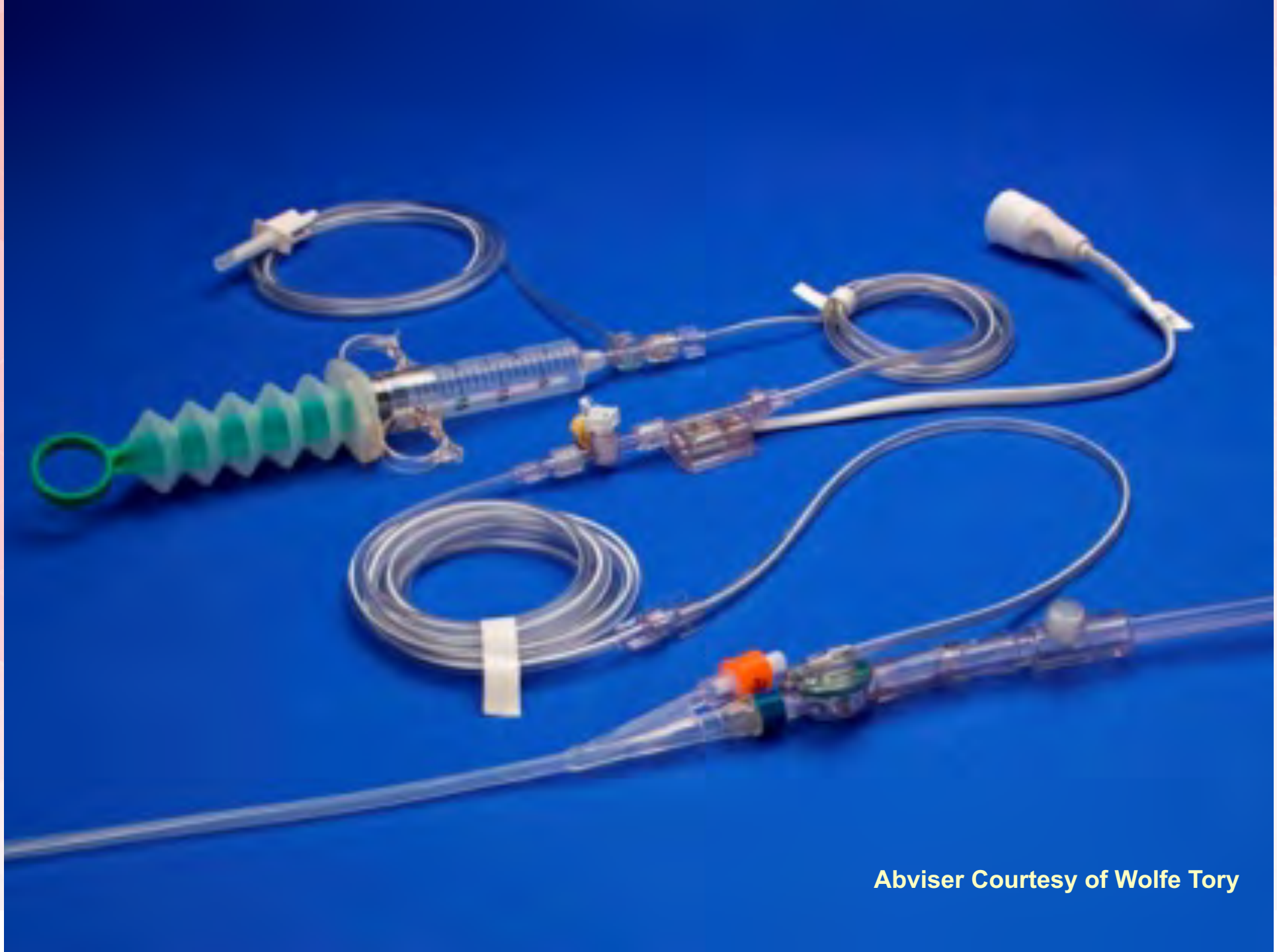
- Resuscitation edema
- Bowel edema
- Postoperative hemorrhage
- Bowel obstruction
- Closure of abdomen under tension
- Abdominal packing



Abdominal Compartment Syndrome

Secondary Causes

- Intra-abdominal
- Infection
- Ascites
- Ileus
- Pancreatitis
- Sepsis
- Major burns



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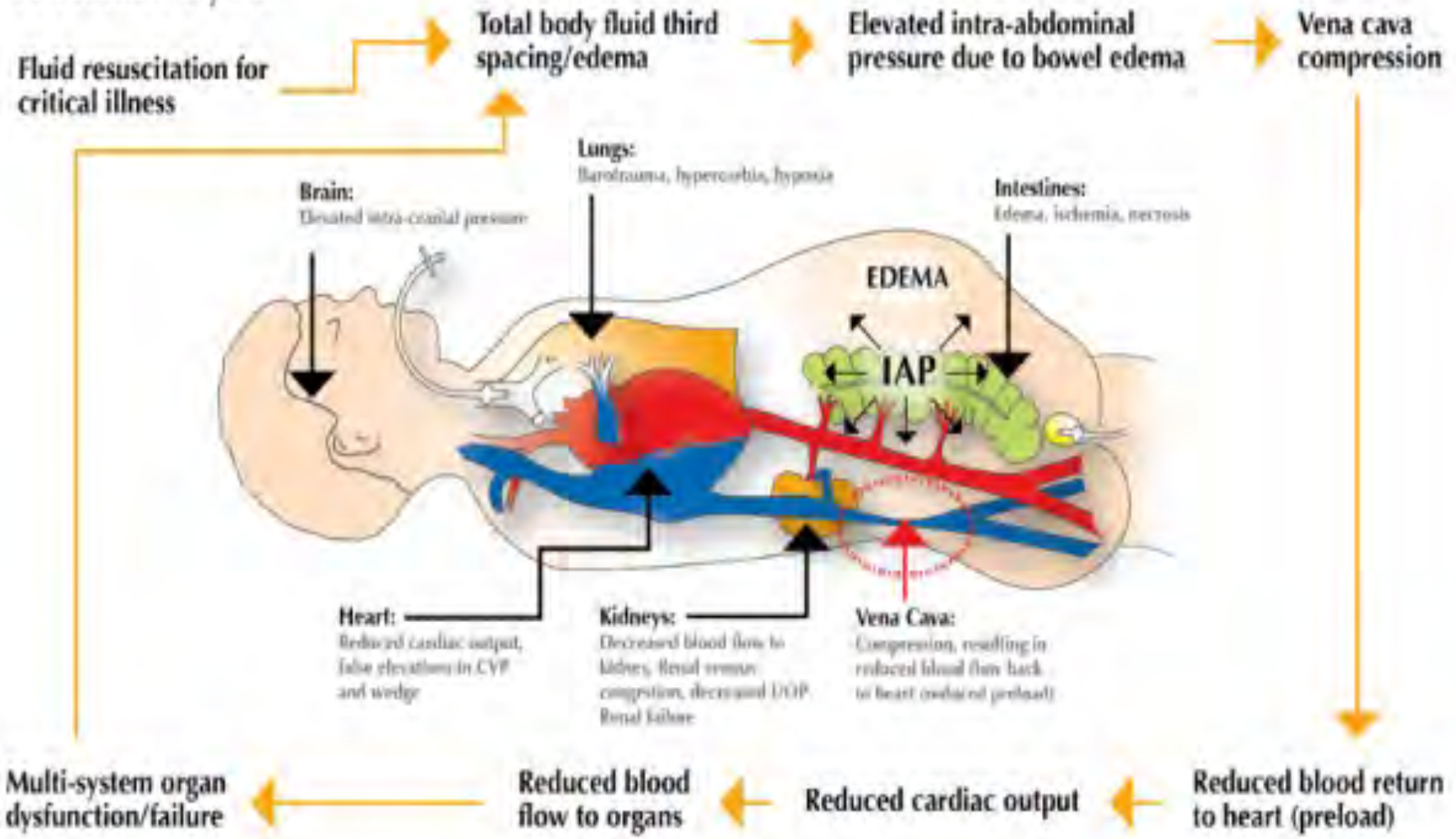
What Happens to the Body's Organs?

A Vicious Cycle



Abviser Courtesy of Wolfe Tory

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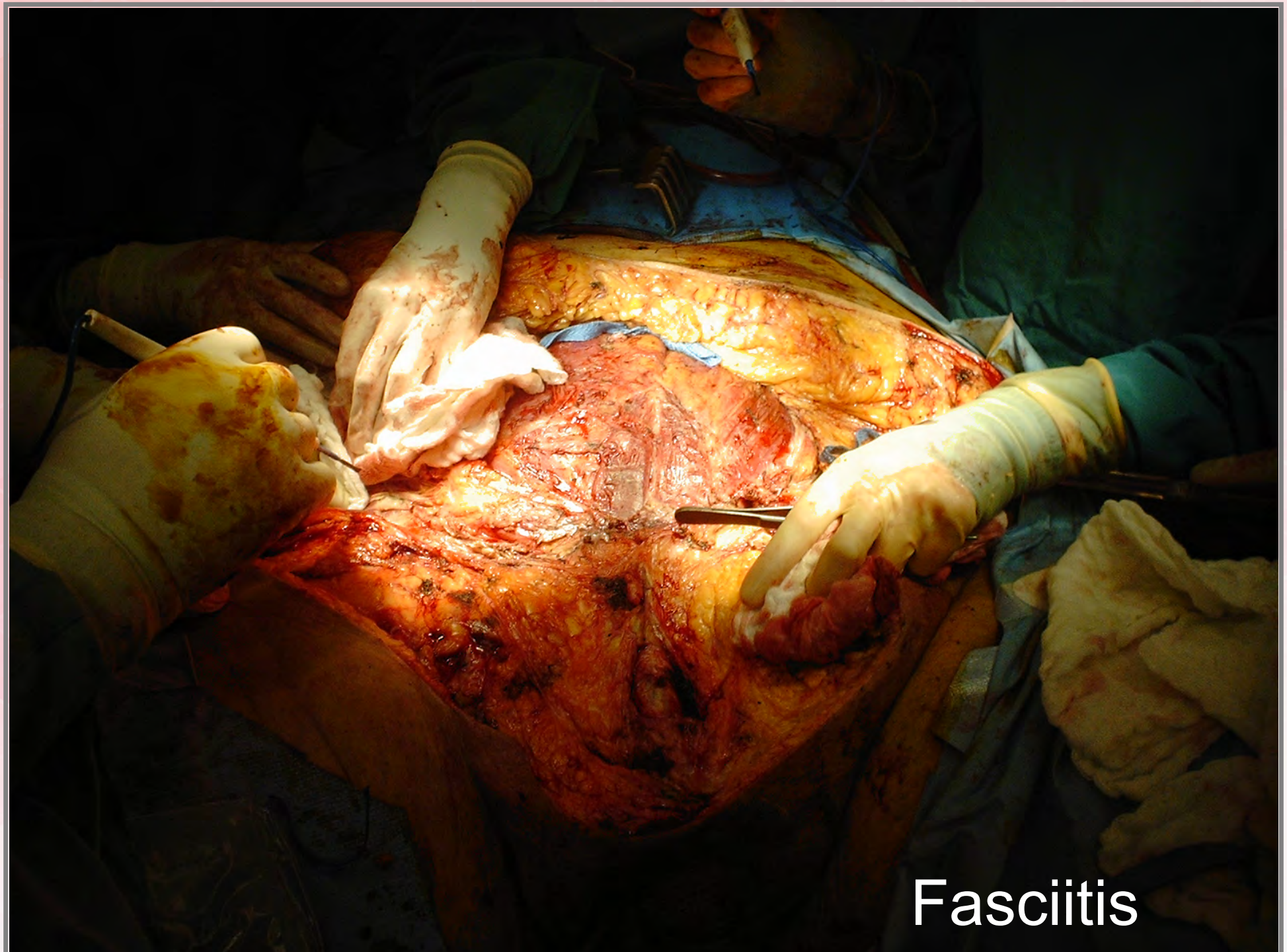

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Reperfusion Phenomenon

- 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

Complications of Abdominal Trauma

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

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

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TRAUMA LECTURES

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Genitourinary Injuries

Objectives

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

- Describe the mechanisms of injury for genitourinary (GU) trauma
- Identify the appropriate physical assessment and diagnostic studies for the initial and ongoing assessment of the GU injured patient
- Identify three complications that can occur during the hospitalization of a patient who has sustained a GU injury

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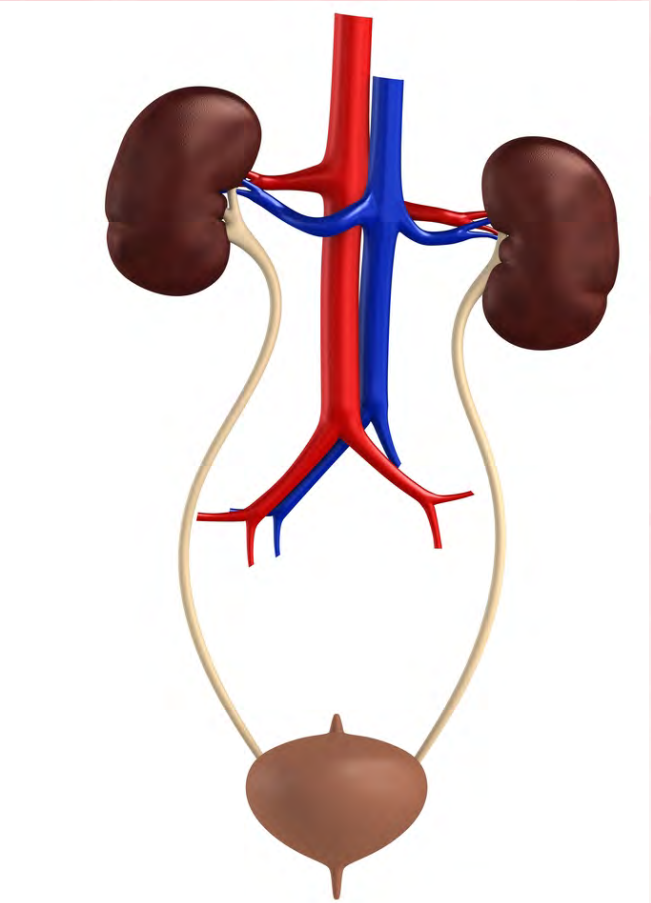
GU Epidemiology

- Incidence
  - Accounts for ~10% of abdominal injuries
- Organs affected
  - Kidney (>80%)
  - Bladder, urethra (~10% each)
  - Ureters and other organs – rare



GU Epidemiology

Associated Injuries

Morbidity and Mortality

Mechanisms of Injury-Blunt

Most common mechanism

- Forces
  - Compression forces
  - Shearing forces
  - Deceleration forces
- Sources
  - MVCs
  - Falls
  - Assaults
  - Blast

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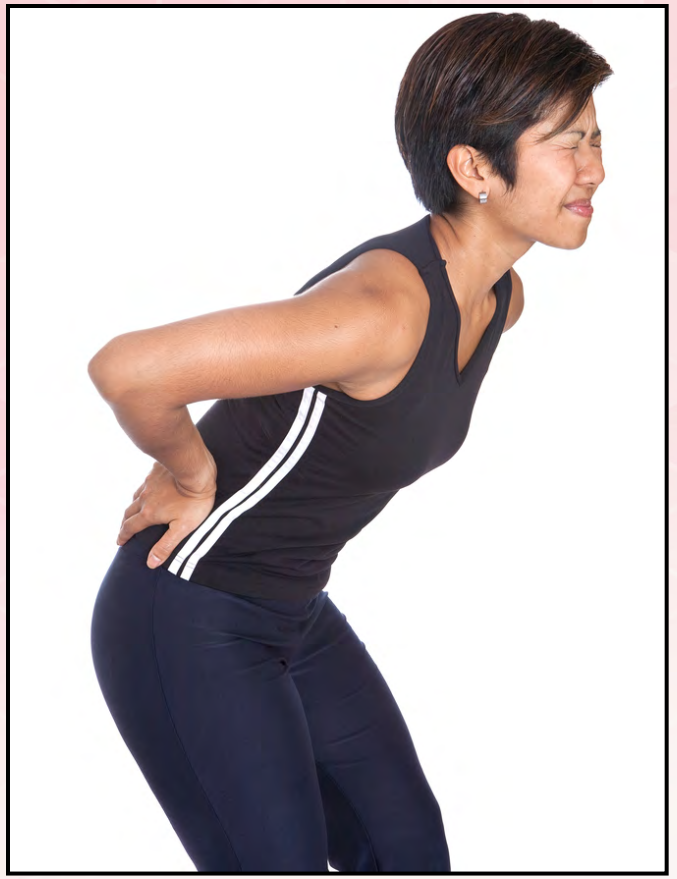
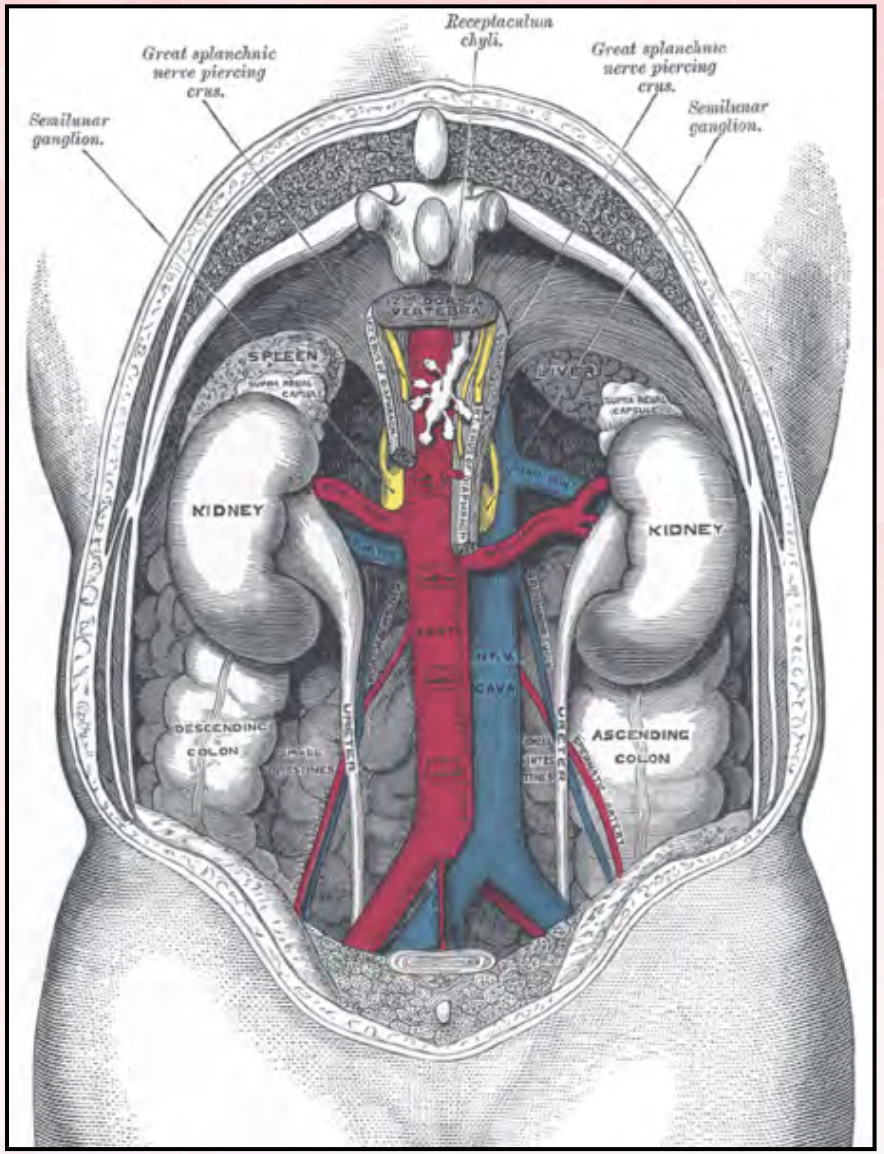
Mechanism of Injury - Blunt

- Suspect some type of renal injury if fractures of the posterior ribs or lumbar vertebrae are present
- Acceleration - Deceleration forces may cause damage to the renal vasculature



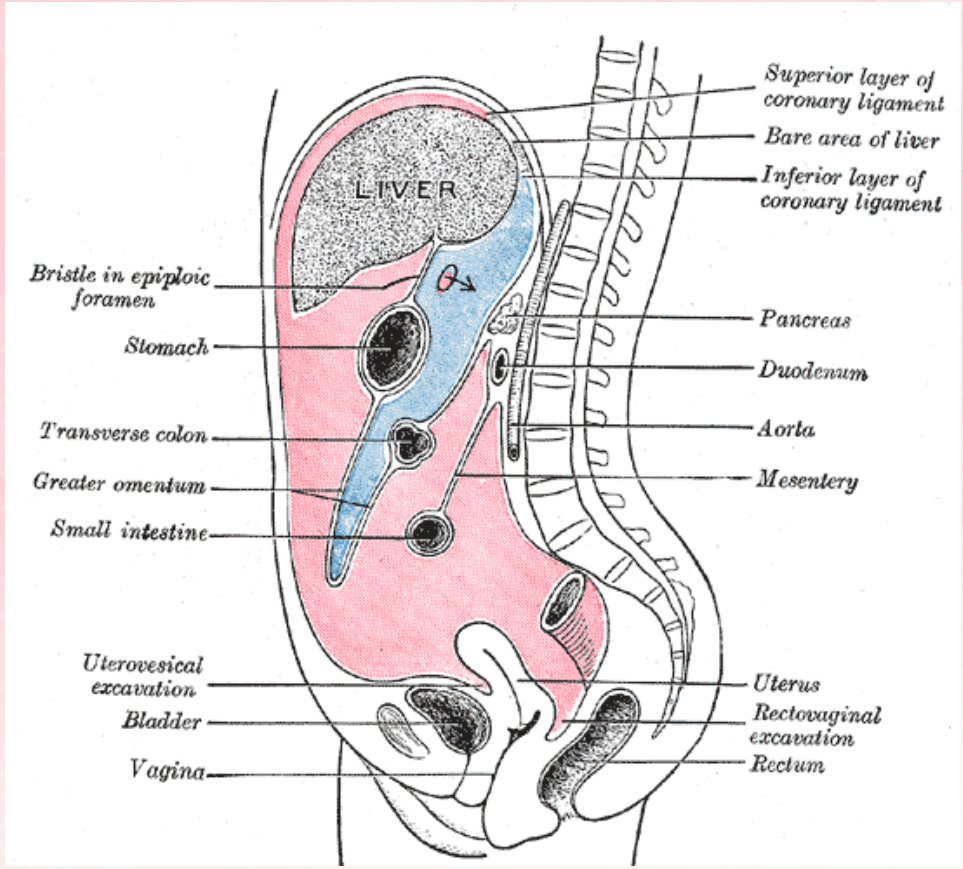
Mechanisms of Injury - Penetrating

Retroperitoneal Space



Abdominal Organs

- **Hollow**
  - Stomach, gall bladder, large and small intestines, ureters, urinary bladder
  - Hollow organs can rupture which causes content spillage, inflammation of peritoneum
- **Solid**
  - Liver, spleen, kidney, pancreas
  - When solid organs are injured, they tend to bleed heavily and can eventually cause shock



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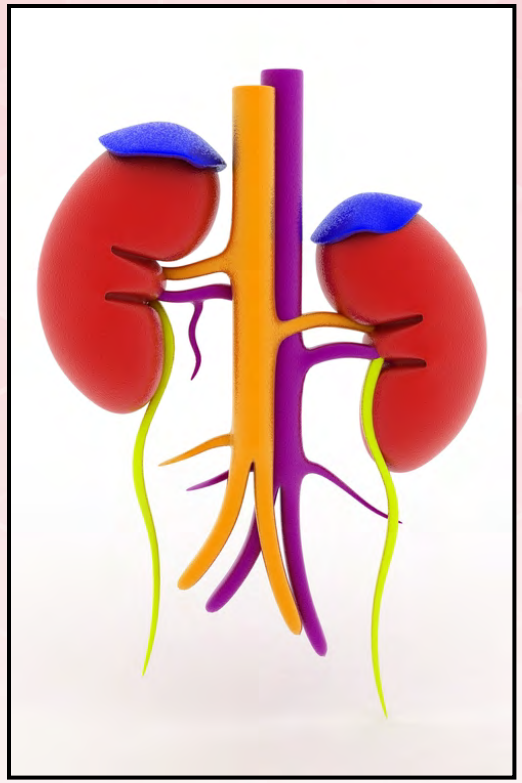
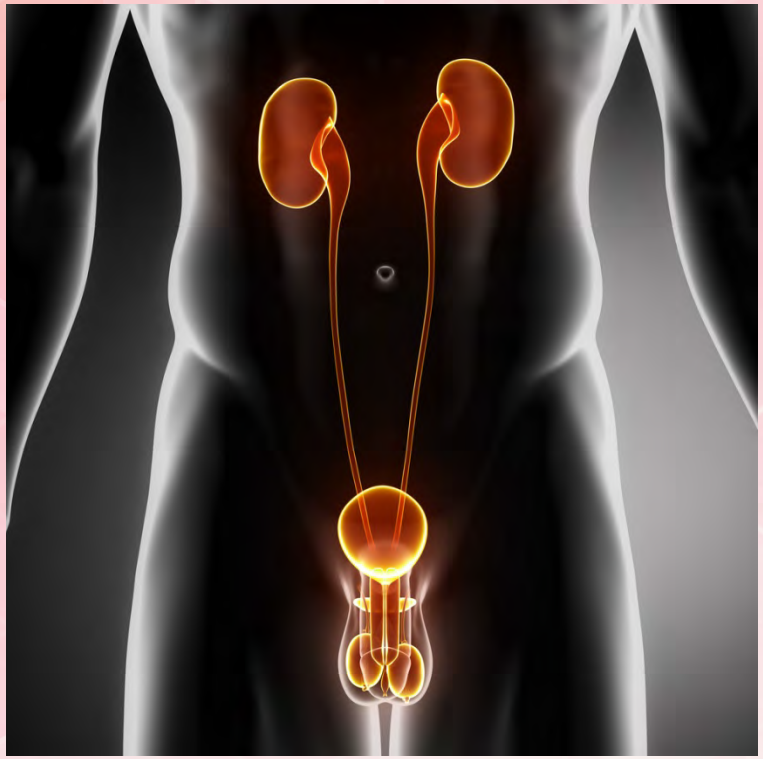
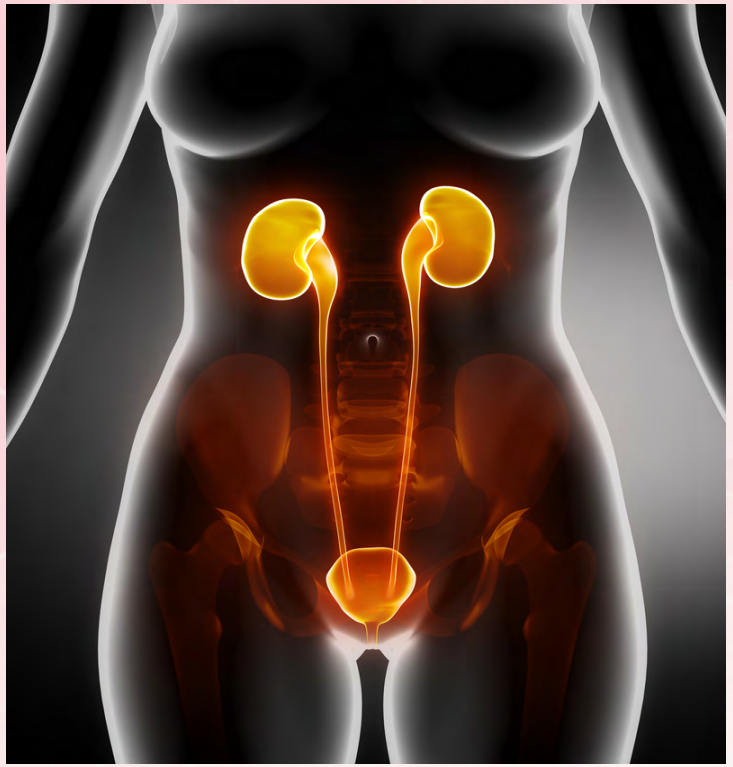
Kidneys

- Bean-shaped highly vascular organs - primary function is to eliminate waste products
- Protected by 12th ribs, fat pads, and anchored by Gerota's fascia
- Left: protected by spleen, chest wall, diaphragm, pancreatic tail, descending colon
- Right: lower than left due to position of liver; protected by diaphragm, liver, duodenum



Bladder, Ureters, Urethra





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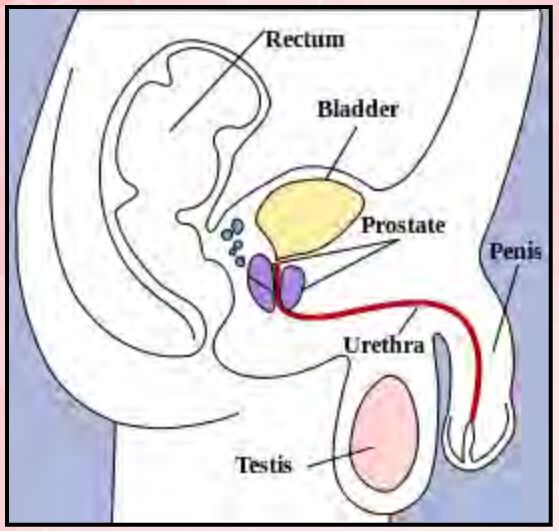
Urethra



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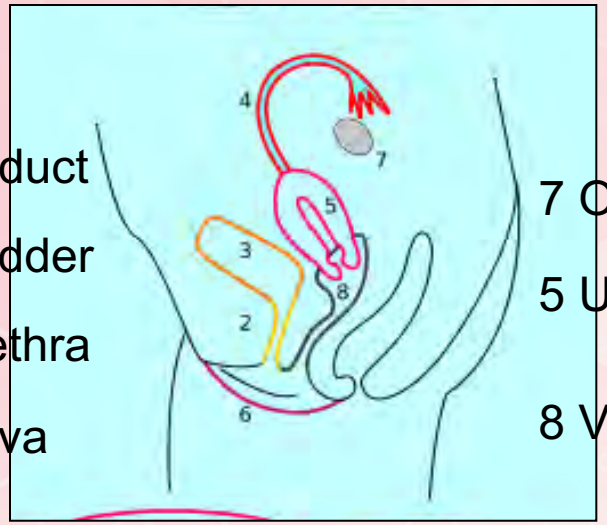
4 Oviduct

3 Bladder

2 Urethra

6 Vulva



7 Ovaries

5 Uterus

8 Vagina

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Life Span Concerns

Geriatric Renal

- Impaired ability to concentrate urine
- Decreased glomerular filtration rate
- Slight increases in blood urea nitrogen and creatinine expected; need to be cognizant of changes when using contrast media and certain drugs

Life Span Concerns

- Pediatrics
  - Bladder is considered an abdominal organ in those less than 6 years of age
  - Kidneys have less protection and are larger

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General Concepts

Follow ABC's, perform primary and secondary surveys as per ATLS, CATN, TNCC recommendations

Consider the possibility of GU injuries when diagnostic testing orders are being submitted

Talk to the patient and find out what happened, what bothers them, what feels better, is the pain the same or getting worse

Nursing Care – Past Medical History

- GU History
  - Congenital anomalies
  - Past injury; surgery
  - Chronic renal failure
  - Renal artery stenosis
  - When paitent last voided
  - Dialysis

Nursing Care - Physical Assessment

- Inspection
- Palpation
- Gray Turner's Sign
- Percussion

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Nursing Care - Physical Assessment

- **Perineal area**
  - Bleeding from urinary meatus
  - Butterfly pattern ecchymosis
  - Scrotal edema
  - Prostate

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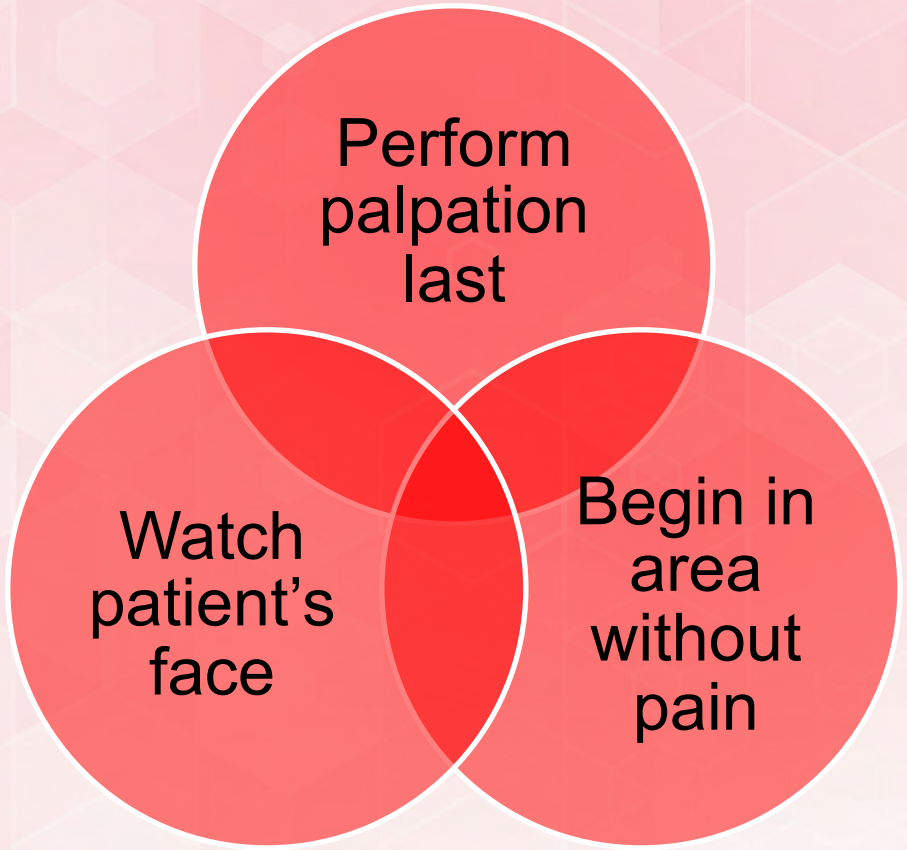
Nursing Care Physical Assessment



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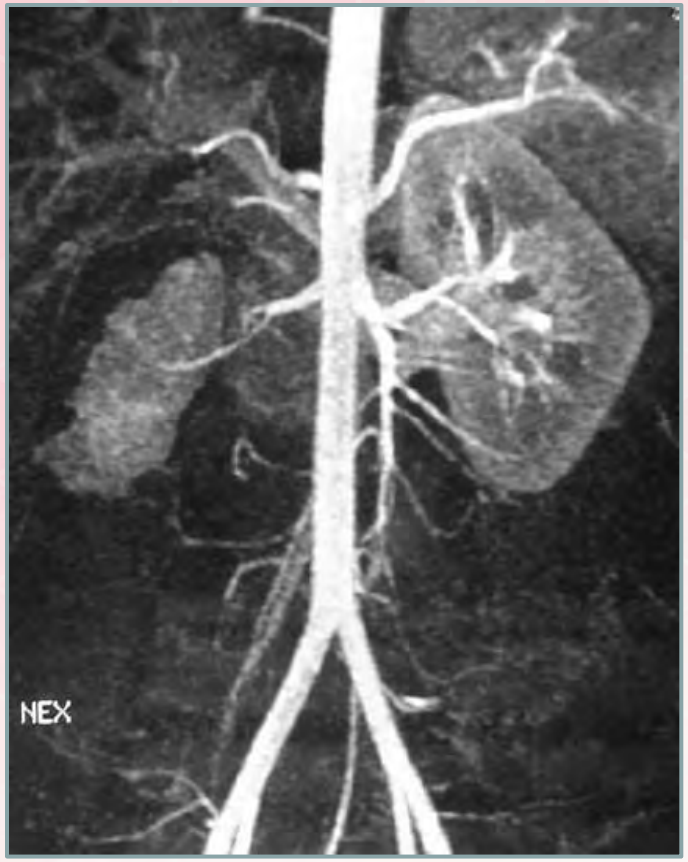
Renal Trauma and Diagnostic Imaging

- Discover fluid, foreign bodies and tissue damage
- Demonstration of a functioning contralateral kidney
- Evidence of ipsilateral renal function
- Correlation of the assessed damage with the extent of hematuria



Diagnostic Imaging

CT scan

- The preferred imaging study is contrast-enhanced CT
- Highly sensitive and specific (staging)
  - Extravasation of contrast-enhanced urine
  - Associated injuries

Diagnostic Imaging

- Cystogram/urethrogram
  - Hematuria
  - Bladder injury
    - Intraperitoneal
    - Extraperitoneal
- Retrograde urethrogram (RUG)
  - Urethral injuries
  - Blood at urinary meatus
  - High prostate in males

Diagnostic Imaging

Angiography and Interventional Radiology

- Role has increased as endovascular strategies have been successful in management of all grades of renal injuries.

(Colaco, Navarrete, MacDonald, Sitizel, & Terlecki, 2017)

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Diagnostic Radiologic Procedures for GU Trauma

- Excretory urography or intravenous pyelogram (IVP)
- Renal ultrasound

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Diagnostic Laboratory Procedures for GU Trauma

- Remember the absence of gross or microscopic hematuria does not rule out an injury
- Myoglobinuria can result in Acute Tubular Necrosis (ATN)
- Urine dipstick and UA are poor indicators of the degree of GU injury

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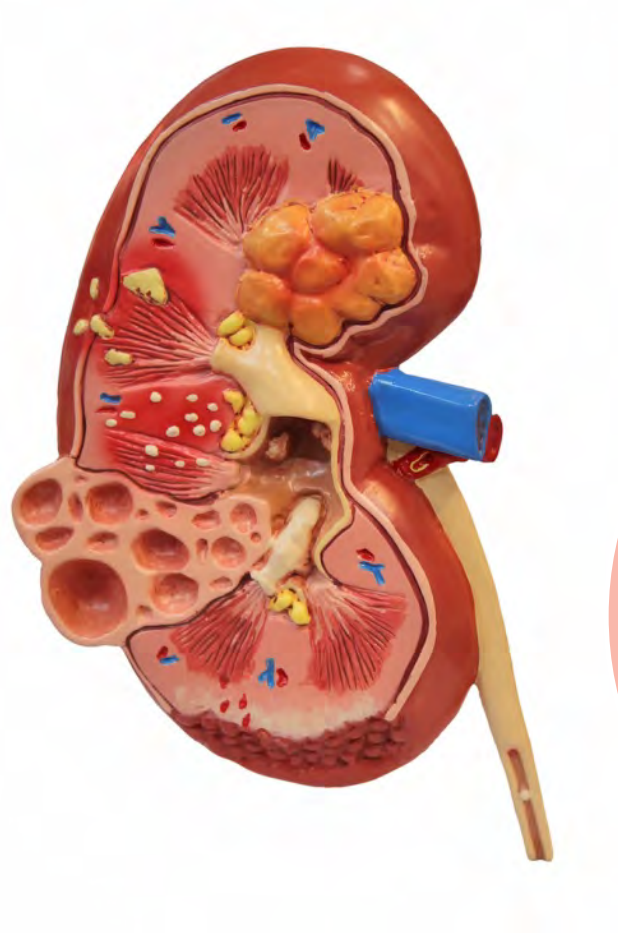
Specific GU Injuries

- Pathophysiology
- Clinical Evaluation
- Diagnostics
- Management
  - Non-operative
  - Operative
  - Complications

Renal Trauma



Occurs in ~10% of patients with abdominal trauma

Accounts for ~50% of all GU trauma

Most common organ damaged by blunt trauma in the pediatric population

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Renal Trauma

Penetrating – GSW or Stab wound

- Across all age groups, right renal and hepatic injuries co-exist in ~70% of cases
- Nearly 30% of penetrating trauma has left renal and splenic injuries

Clinical Evaluation Signs and Symptoms

- Ecchymosis over flank
- Flank and abdominal tenderness during palpation
- Gross or microscopic hematuria, absence does not rule out injury
- Depending on extent of injury/injuries, may display signs and symptoms of shock

Hematuria

- Gross microscopic hematuria following abdominal trauma indicates renal injury.
- 80% of all renal trauma cases have it
- It is common even with minor renal trauma (i.e. contusions)
- Absence of hematuria does not exclude a renal injury
- Gross hematuria usually diminishes dramatically 2-6 hours after injury

AAST Renal Injury Scale

Grade		Injury Description
I	Contusion	Microscopic or gross hematuria, urologic studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematoma confined to the renal retroperitoneum
	Laceration	< 1 cm parenchymal depth of renal cortex without urinary extravasation
III	Laceration	> 1 cm parenchymal depth of renal cortex without collecting –system rupture or urinary extravasation
IV	Laceration	Parenchymal laceration extending through the renal cortex, medulla and collecting system
	Vascular	Main renal artery or vein injury with contained hemorrhage
V	Laceration	Completely shattered kidney
	Vascular	Avulsion of renal hilum which devascularizes kidney

(Moore et al.,1989)

Renal Trauma Management

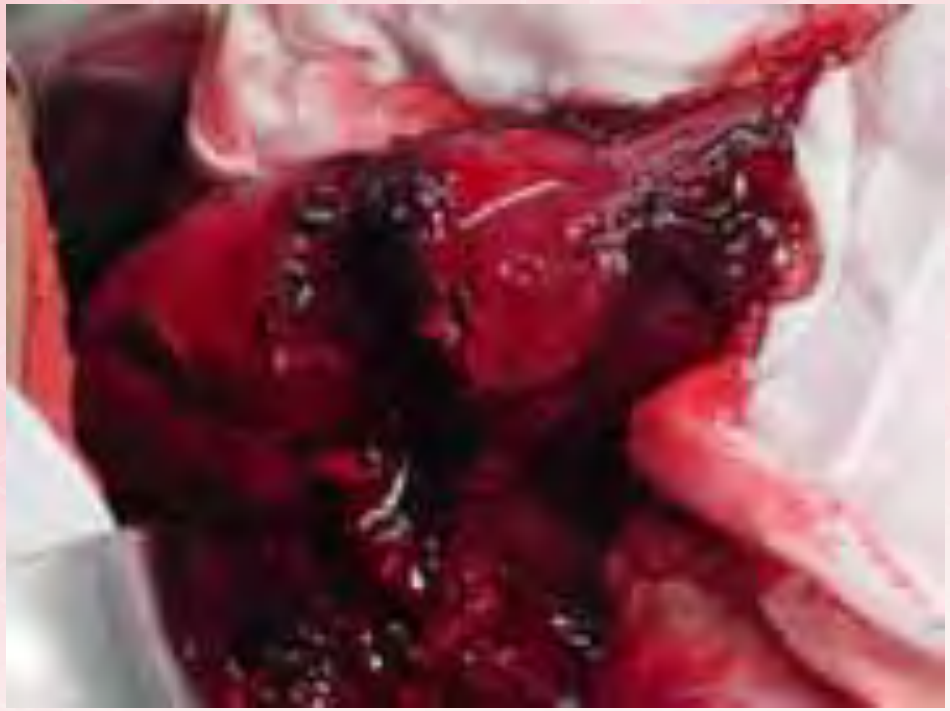
Grade I: Managed conservatively with management plans similar to other blunt trauma solid organ treatment plans

Grade II: Usually resolve spontaneously; surgery or embolization only for persistent hemorrhage or extravasation

Renal Trauma

Grade III:

- Shattered kidneys may be removed to control hemorrhage
- Kidneys with pedicle injuries may be removed but non-removal does not routinely result in late sequelae (i.e. pain, HTN)



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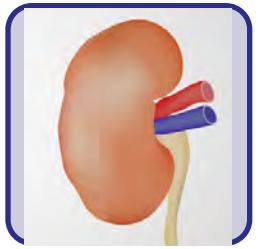
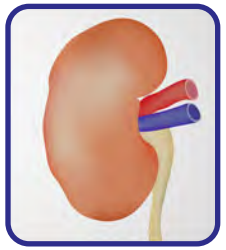
Grade IV and V Injuries

- **Renal damage**
  - Partial nephrectomy
  - Renorrhaphy
  - Nephrectomy
- **Renovascular Injury**
  - Shattered kidney, renal pedicle damage
  - Intimal tears-thrombosis in renal pedicle

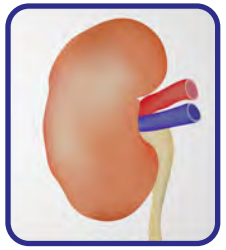
Nonoperative Management



Hemodynamically stable with an injury well staged by CT can usually be managed nonoperatively



98% of renal injuries can be managed nonoperatively



Grade IV and V injuries more often require surgical exploration

Renal Trauma Complications

Minor Trauma

- Sepsis
- Decreased H/H
- Expanding perirenal mass
- Hemodynamic instability

Major Trauma

- Abscess/urinomas
- Sepsis
- Fistula
- Renal atrophy
- Rhabdomyolysis/myoglobinuria
- Renal HTN
- Renal Failure

Renal Trauma Complications

- **Rhabdomyolysis-Myoglobinuria**
  - From direct or indirect muscle injury
  - Myoglobinuria is a marker of rhabdomyolysis
  - Renal tubulotoxic effect
  - Manage with diuresis and alkalinization of urine

Complications of Renal Trauma

Post-Traumatic HTN

- Caused by excess of renin excretion, infarct, and renal scarring
- Can occur in 0-30 % of renal trauma cases
- Most are managed conservatively with a low-dose medication regimen

Acute Renal Failure (ARF)
Prerenal Failure

Prerenal ARF

- Etiology
  - Profound hypotension
  - Inadequate kidney perfusion without actual renal damage

Diagnostics

- Urine sodium < 10 mEq/L
- Fractional sodium excretion < 1%
- Specific gravity > 1.020
- Increase BUN > creatinine
- Minimal or no proteinuria
- Possible myoglobinuria

Acute Renal Failure (ARF)
Intrarenal Failure

Etiology

- Direct insult to renal parenchyma
- Cortex injury due to infection, autoimmune disease, hypertension
- Medullary injury due to nephrotoxins, prolonged ischemia, rhabdomyolysis
- Acute damage to renal capillary bed and tubules

Diagnostics

- Abnormal specific gravity
- Fractional excretion of sodium > 1%
- Elevation BUN and creatinine
- Decreased creatinine clearance
- Proteinuria
- High urine sediment
- Possibly myoglobinuria

Management of Acute Renal Failure

Determining the onset so that treatment can begin

Determining the precipitating event

Phases of Acute Renal Failure

Oliguric phase

- Urinary output < 20 ml/hr
- Labs abnormal
- Lasts 10-20 days

Non-oliguric phase

- Urinary output remains normal to high
- Labs abnormal
- Lasts 5-8 days

Phases of Acute Renal Failure

Diuretic Phase

- After both oliguric and non-oliguric
- As renal function returns
- Urinary output elevated
- Labs normalize

Recovery

- Can take up to 12 months
- Degree determined by amount of damage

ARF Management

- Maximize renal perfusion
- Correct acidosis, electrolyte, and fluid imbalances
- Minimize hypercatabolic state
- Maintain adequate nutrition
- Hemodialysis if indicated

Prevention

- Maintain renal perfusion and intravascular volume
- Avoid nephrotoxins
- Avoid and treat myoglobinuria

Acute Renal Failure (ARF)
Post-Renal Failure

Etiology

- Functional or total obstruction between kidneys and ureters
- Back pressure from urine increases renal interstitial pressure
- Leads to imbalance of filtration pressures at the glomerulus

Diagnostics and Management

- Elevation in BUN an creatinine is possible
- Urine electrolytes less helpful
- Positive urine cultures
- Radiographic evidence of obstruction
- Relieve obstruction

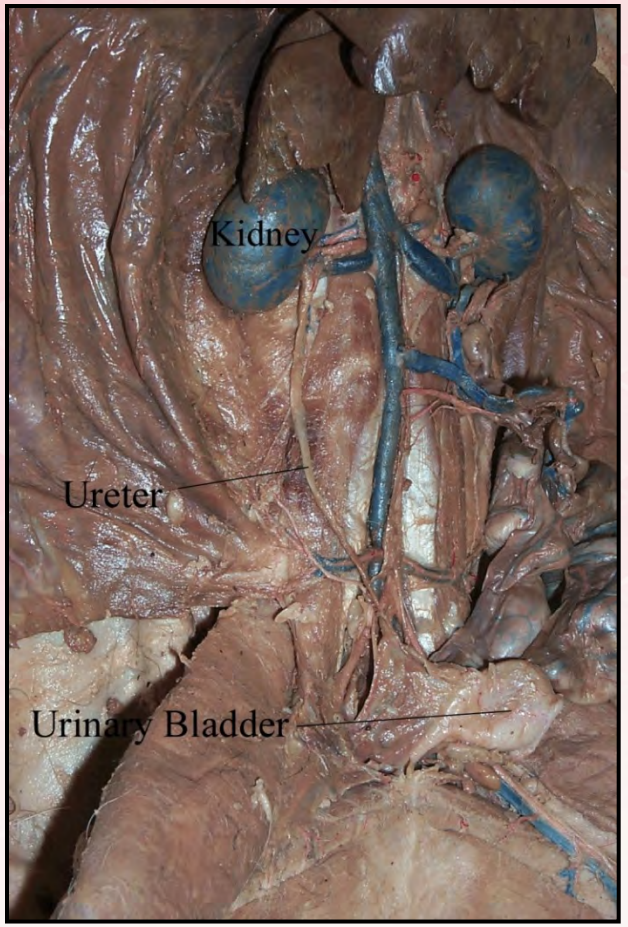
Ureter Trauma

- Occurs in less than 5% of GU trauma
- ~80% of ureter injuries are from GSW
- ~90% of GSW and ~60% of stab wounds that injure ureters also injure the bowel, colon, liver, spleen, blood vessels or pancreas
- Adjacent structures protect ureters from blunt trauma
  - Injury to the distal ureter can occur from fracture of the posterior pelvic ring

Ureter Injuries

Signs and Symptoms

- Often no presenting symptoms
- Pain only in obstructed ureter
- No symptoms with transection
- Possible loss of renal function
- Microscopic hematuria
- Index of suspicion



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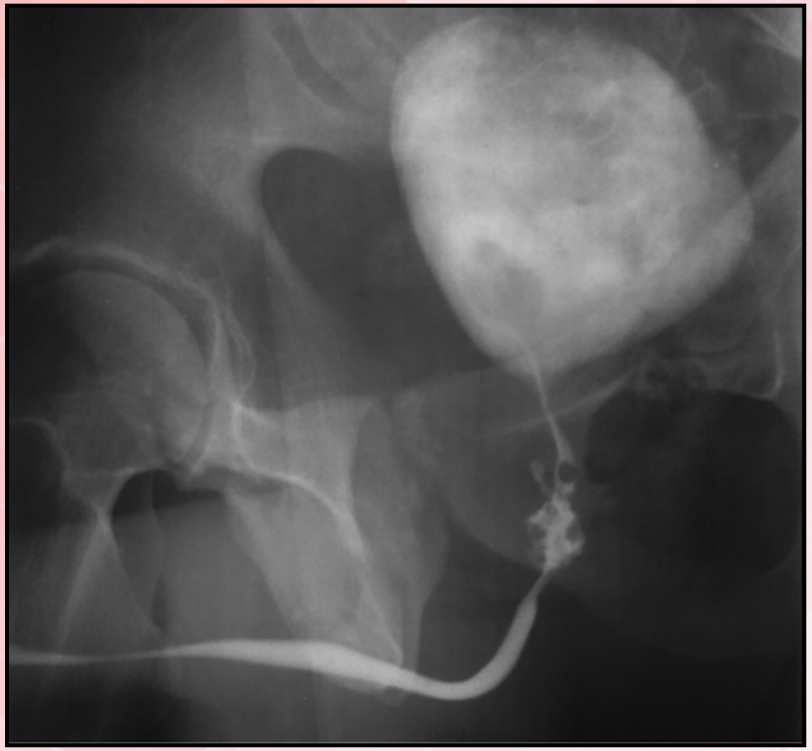
Ureter Trauma and Diagnostic Imaging



- Hematuria is usually microscopic so it is usually not seen
- IVP
- Urethrogram
  - double dose excretory urography
  - RUG (retrograde urethrogram)
- CT with delayed images

Ureter Injury Scale

Grade		Injury Description
I	Hematoma	Contusion or hematoma without devascularization
II	Laceration	≤ 50 % transection
III	Laceration	≥ 50 % transection
IV	Laceration	Complete transection with 2 cm devascularization
V	Laceration	Avulsion of renal hilum which devascularizes kidney

(Moore et al.,1992)

Ureter Trauma Management

- OR
- Ureterostomy
- Irrigation and Drainage
- Antibiotics
- Stenting

Complications of Ureter Trauma

Missed injuries usually manifest by

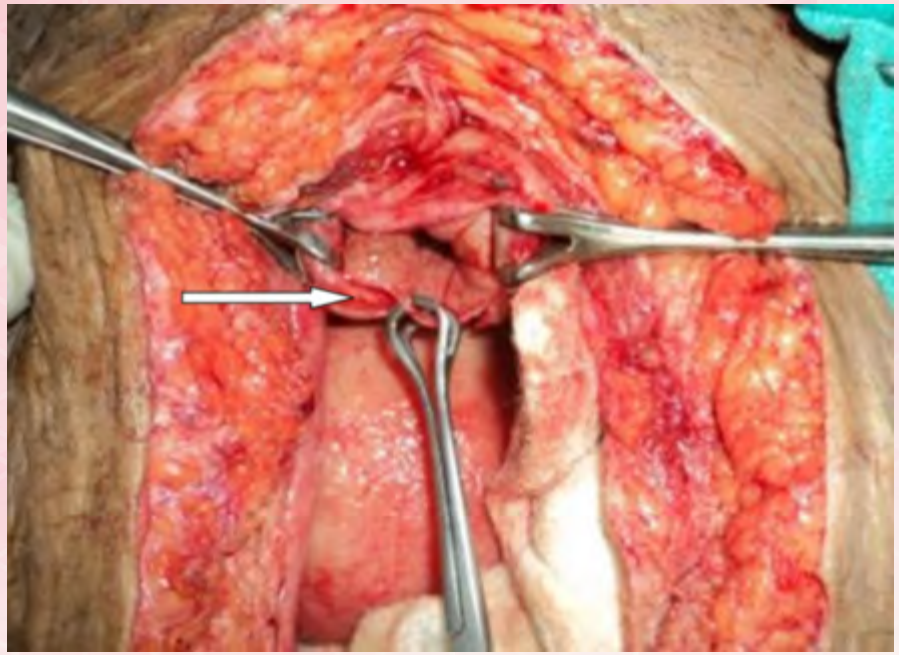
- Fever
- Flank mass or discomfort
- Ileus
- Leukocytosis
- Lethargy
- Urinary fistula to skin or vagina
- Sepsis
- Wound infection

Complications

- Fistula
- Stricture or ureteral obstruction
- Retroperitoneal urinoma
- Infection
- Obstructive hydronephrosis

Bladder Injury

- Most often injured due to blunt trauma
- Full bladder will increase risk of injury
- Two types of bladder injuries
  - Extraperitoneal Bladder
  - Intraperitoneal Bladder



Bladder Injuries

Signs and Symptoms

- Blood at meatus and/ or in scrotum
- Lower abdominal injury
- Pelvic fracture
- Suprapubic pain
- Inability to void despite the urge to urinate
- Gross hematuria

- Rebound tenderness
- Abdominal wall muscle rigidity, spasm, or involuntary guarding
- Displacement of prostate

Extraperitoneal Bladder Injury Signs and Symptoms

- Urine found in umbilicus, anterior thighs, perineum
- Dysuria
- Hematuria
- Suprapubic swelling, redness, tenderness

Intraperitoneal Bladder Injury

- Occurs with penetrating or blunt rupture of distended bladder
- 15-45% of bladder trauma
- Urgency and inability to void
- Signs and symptoms of shock
- Abdominal distension

Bladder Injury Diagnostics

Cystogram helps detect Intraperitoneal and Extraperitoneal problems

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Bladder Injury Scale

Grade		Injury Description
I	Hematoma	Contusion, intramural hematoma
	Laceration	Partial thickness
II	Laceration	Extraperitoneal bladder wall laceration ≤ 2 cm
III	Laceration	Extraperitoneal (≥ 2 cm) or intraperitoneal (≤ 2 cm) bladder wall lacerations
IV	Laceration	Intraperitoneal (≥ 2 cm) bladder wall lacerations
V	Laceration	Intra or extraperitoneal bladder wall laceration extending into the bladder neck or urethral orifice (trigone)

(Moore et al., 1992)

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Complications of Bladder Trauma

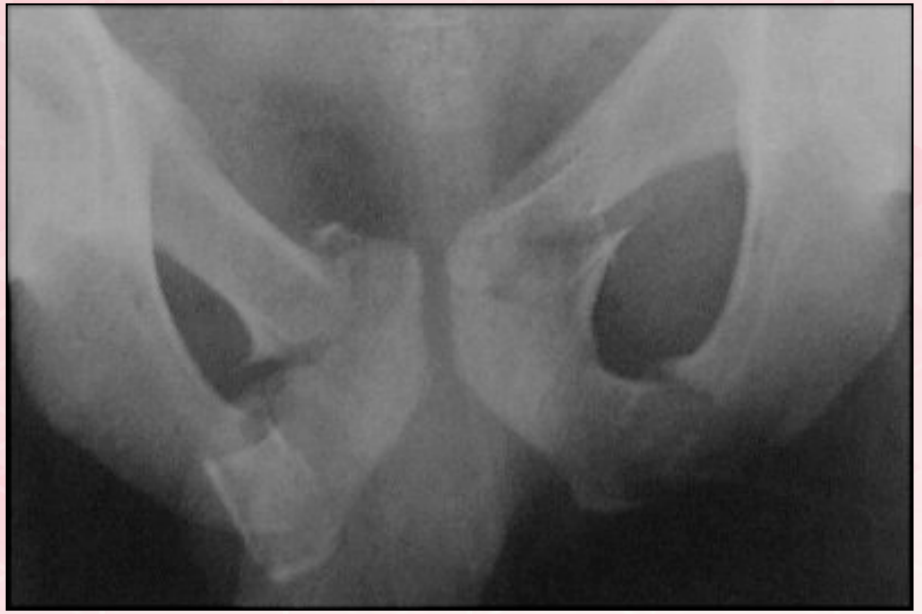
- Mortality associated with bladder injury is estimated at ~10-40%. Higher mortality associated with intraperitoneal rupture.
- Death from a bladder injury is usually attributed to hemorrhage, sepsis or anorectal injury.

Urethral Trauma

- More common in males than females
- Urethra is divided in to the anterior and posterior sections
- The following will all impact on the selection of management for urethral trauma
  - nature of the injury (blunt vs. penetrating)
  - location of the injury (ant vs. post)
  - completeness (partial vs. complete circumferential laceration)
  - presence and seriousness of associated injuries
  - the stability of the patient

Urethral Trauma Mechanism of Injury

- Posterior injury usually accompanies pelvic fx's
- Trauma to anterior urethra usually isolated
- Trauma to posterior urethra usually co-exists with damage to other structures
- Sudden deceleration injuries (bladder shears off urethra)



Signs and Symptoms of Urethral Trauma

- Suprapubic pain
- Urge to urinate but are unable to
- Hematuria (may be microscopic)
- Blood at external meatus
- Perineal bruising – aka butterfly pattern bruise

- Scrotal Hematoma
- Rebound tenderness upon palpation
- Abdominal wall muscle rigidity, spasm or involuntary guarding
- Displaced/boggy prostate gland (in males) during rectal exam

Urethral Trauma

Urethrogram demonstrating partial urethral disruption

Complete Urethral Disruption

Urethrogram demonstrating complete urethral disruption

Urethral Trauma

Missed injuries usually manifest by

- Fever
- Flank mass or discomfort
- Ileus
- Leukocytosis
- Lethargy
- Urinary fistula to skin or vagina
- Sepsis
- Wound infection

Urethral Trauma Complications

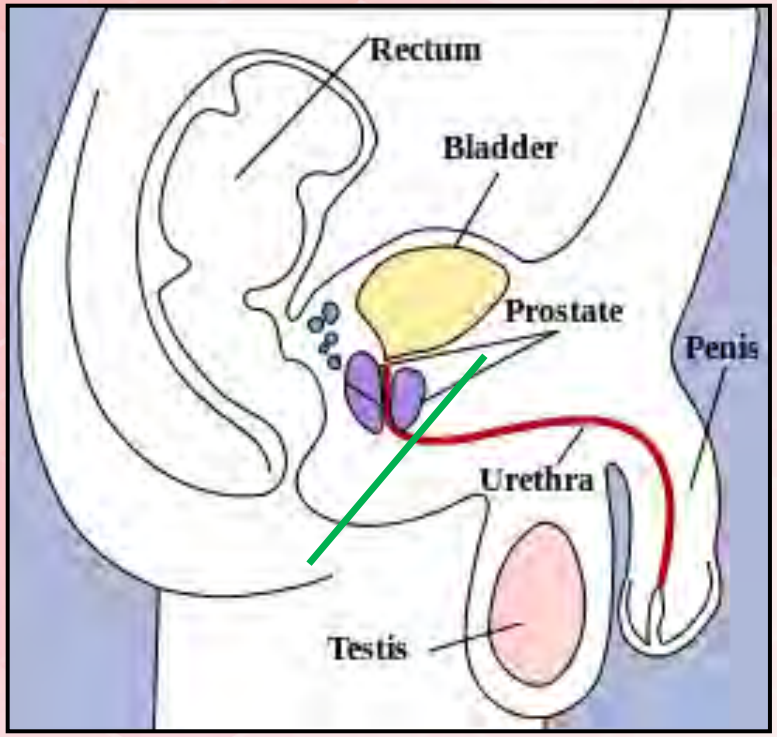
- Impotence
  - ~10-30% of patients with pelvic fracture and urethral distraction injury
- Incontinence
  - Most with significant urethral distraction injury have injury to the external (striated) sphincter, continence is then provided by the bladder neck.
- Stricture

Urethral Injury Scale

Grade		Injury Description
I	Contusion	Blood at urinary meatus, urethrography normal
II	Stretch Injury	Elongation of urethra without extravasation on urethrography
III	Partial Disruption	Extravasation of urethrographic contrast medium at injury site, with contrast visualized in the bladder
IV	Complete Disruption	Extravasation of urethrographic contrast medium at injury site without visualization in the bladder, < 2 cm of urethral separation
V	Complete Disruption	Complete transection with > 2 cm urethral separation or extension into the prostrate or vagina

(Moore et al.,1992)

Male Urethra



Wikimedia.com

The **posterior urethra** consists of the segment that extends from the bladder neck to the distal external urethral sphincter.

The **anterior urethra** extends from the distal external urethral sphincter to the external urinary meatus.

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Urethral Injury: Male Mechanism

Anterior

- Straddle injury
- Crushing of urethra against symphysis pubis
- GSW-stab wound
- Self inflicted instrumentation
- Industrial or farm incidents

Posterior

- Shearing in pelvic disruption pulls prostate and puboprostatic ligaments while membranous urethra and urogenital diaphragm are pulled in opposite direction
- Falls
- Crush
- Sports

Urethral Injury: Male Assessment

Anterior

- Localized pain in perineum
- Perineal or penile swelling
- Extravasation may cause scrotal, lower abdomen, penile swelling
- Butterfly-shaped hematoma under scrotum
- Painful Voiding

Posterior

- Displaced prostate
- Blood at urinary meatus
- Distended bladder
- Inability to void

Urethral Trauma: Male Treatment

Anterior

- Bladder and suprapubic catheter
- Primary end to end anastamosis if no infection
- Contamination requires debridement, I&D and antibiotics

Posterior

- Retrograde urethrogram (RUG) before catheter placement
- Abdomen and pelvic films
- IVP, cystogram
- Suprapubic catheter
- Surgical intervention

Urethral Trauma: Male Complications

Anterior

- Urethral reconstruction can have reanastomosis defects
- Urethral strictures
- Infection from extravasated blood or urine which can lead to necrosis

Posterior

- Permanent impotence
- Permanent incontinence
- Cellulitis
- Sepsis
- Urethral stricture

Urethral Trauma Female - Posterior

- Female urethral trauma usually coexists with vaginal lacerations resulting in a urethrovaginal communication

- Delay in diagnosis may result in:
  - Incontinence - Necrotizing fasciitis, sepsis
  - Uretero-vaginal fistula
  - Dyspareunia, recurrent urethritis
  - Hematuria, cystitis

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Reproductive System Trauma

- Can occur to both external and internal reproductive system
- External
  - Most common
  - Pain, extensive bleeding due to vascularity
- Internal
  - Rarely injured
- Management of specific injuries based on type and severity of trauma

Perineum Injuries: Male Genitalia

- **Testes**
  - Usually spared from injury
  - Direct blow impinges testes against symphysis pubis
- **Penis/Scrotum**
  - Zipper
  - Foreign body
  - Avulsion/Amputation
  - Fracture
  - Strangulation
  - Suction
  - Penetrating injury

Assessment

- **Testes, Penis, Scrotum**
  - Hematocele
  - Large tender, swollen scrotal mass
  - Failure to transilluminate
  - Avulsion injury may be present
  - Pain
  - Swelling, discoloration
  - Deviation away from lesion
  - Possible urethral bleeding, hematuria, extravasation

Perineum Injuries: Male Genitalia

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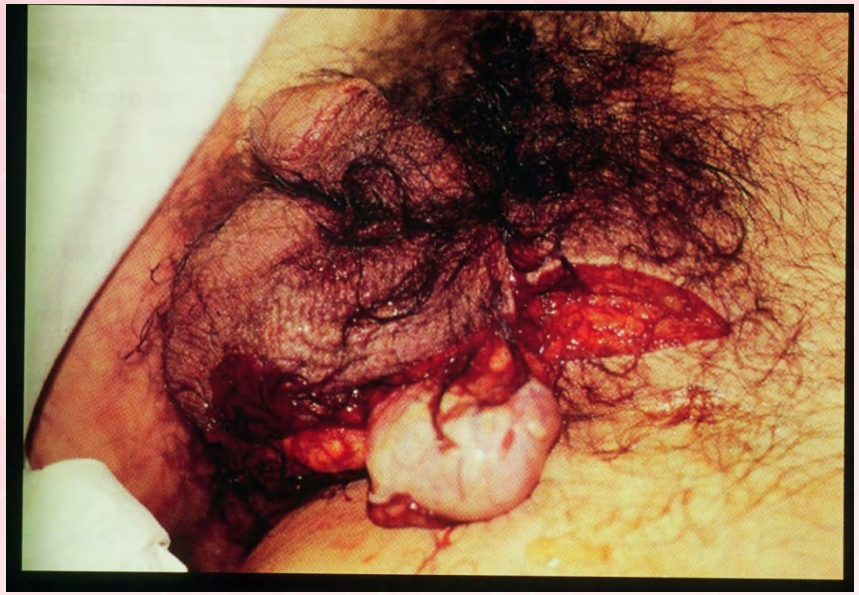
Perineum Injuries: Male Genitalia

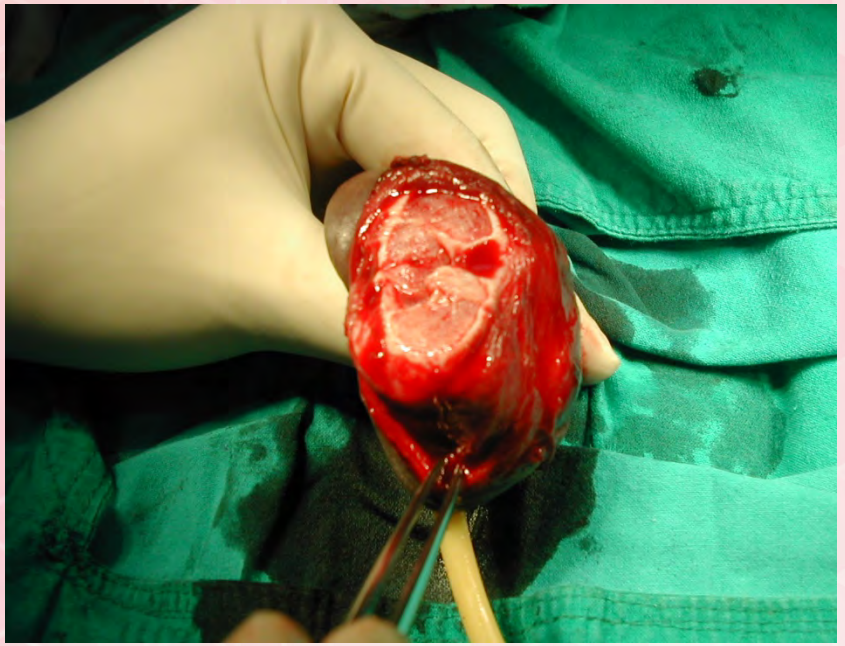
- **Penis Management**
- **Non-operative management**
  - Catheter or suprapubic catheter
  - Elevation and ice
  - Anti-inflammatory medications, analgesics
- **Surgical management**
  - Evacuation of hematoma and repair
  - Surgical reattachment

- **Complications**
  - Infection of hematomas
  - Painful lumps
  - Inadequate erection
  - Permanent deformity

Perineum Injuries: Male Genitalia

- Avulsion of skin of penis, scrotum
  - Cover with a moist, sterile dressing
- Complete amputation of penis
  - Treat as any amputated part





Perineum Injuries: Female Genitalia

- Usually well protected by deep location within the pelvis except when pregnant
- In younger girls most common injuries to external genitalia:
  - Straddle injuries
  - Accidental penetration
  - Tearing due to sudden forced stretching of the perineum when the legs are forced apart (i.e. gymnastics, falls)

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Perineum Injuries: Female Genitalia

Vagina

- Mechanism
  - Pelvic fractures with vaginal and/or perineal injury
  - Penetrating injury to uterus and/or ovaries
- Assessment
  - Vaginal bleeding
  - Speculum exam essential with pelvic fractures
- Management
  - Surgical repair

Perineum Injuries: Female Genitalia

Perineum/Sexual assault

- Straddle injury
- Sexual assault
- May also result in injury
  - Introitus laceration
  - Anorectal lacerations
  - Urethra
- Use colposcope
- Evidence preservation
- Protect safety and psyche

Perineum Injuries: Female Genitalia

Uterus, Ovaries

- Assessment
  - **Signs of peritonitis**
- Management
  - **Surgical repair of minor lacerations**
  - **Hysterectomy and/or oophorectomy for major disruptions**
- Complications
  - **Abscess**
  - **Sepsis**

General Management

- Monitor for bleeding and renal function
- Teach catheter care to family and patient
- Medications
  - Antispasmodics – bladder spasm
  - Phenazopyridine hydrochloride (Pyridium) - cystitis
- Support for sexual function, disfigurement
- Provide information

Summary

- The GU system has both solid and hollow organs
- Injuries are often accompanied by other system injuries, so a high level of suspician is needed
- Kidney injuries can lead to renal failure
- There is a wide array of injuries than can occur to the male and female internal organs and genitalia

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Musculoskeletal Injuries

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Objectives

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

- Identify the initial assessment for patients with musculoskeletal injury
- Describe upper extremity, lower extremity and pelvic musculoskeletal traumatic injuries and implications for nursing care
- Explain indications and strategies for open and closed reduction of fracture/dislocations
- Discuss the prevention, recognition and interventions for compartment syndrome and rhabdomyolysis

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Resuscitation

A diagnosis of musculoskeletal injury may not occur initially, until there is significant blood loss causing hemodynamic instability.

The primary survey in ATLS/ATCN does not include a thorough assessment of musculoskeletal injuries unless gross bleeding causes a concern.

Radiography may/will confirm musculoskeletal injuries.

Prehospital information can help raise the index of suspicion.

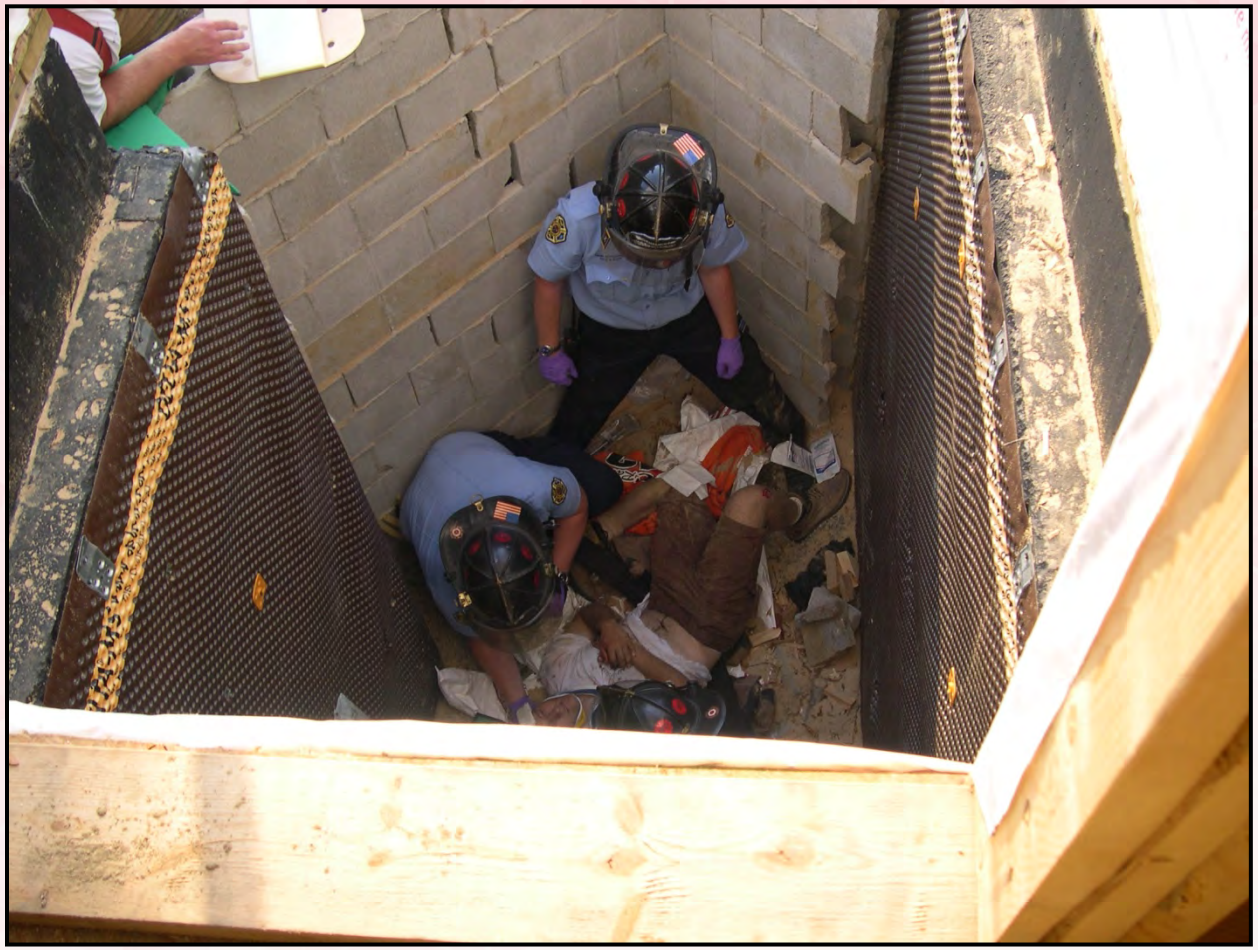
Mechanism of Injury (MOI)

- Understanding the MOI helps the care team:
  - Anticipate potential injuries and injury patterns
  - Anticipate likely sequelae and complications of traumatic injury
  - Prepare interventions and a plan of care based upon expected needs
- Physics of the injury – high energy transfer vs low energy

  How much energy was transferred into that patient's body? What other injuries might be underlying the obvious external injuries?

Mechanism of Injury (MOI)

- How
- What
- Where
- When



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Who needs to go to a Trauma Center?

- Many patients – especially those with isolated, closed, non-comminuted fractures - can be safely managed at community hospitals. However, some patients need the more specialized care of trauma centers.
- Field triage is a process where the level of injury is determined, medical management is provided, and the right hospital is identified.

2011 Field Triage Decision Scheme

Step One:

- Glasgow Coma Scale score of 13 or lower (change from <14)
- Systolic blood pressure of less than 90 mm Hg, or
- Respiratory rate of fewer than 10 or more than 29 breaths/minute (<20 breaths/minute in infants aged <1 year) or **need for ventilatory support** (criterion added).

(Centers for Disease Control, 2012)

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Field Triage Decision Scheme

Step Two:

- All penetrating injuries to head, neck, torso, and extremities proximal to elbow or knee
- Chest wall instability or deformity (e.g., flail chest)
- 2 or more proximal long-bone fractures;
- Crushed, degloved, mangled, or pulseless extremity
- Amputation proximal to wrist or ankle
- Pelvic fractures
- Open or depressed skull fractures; or
- Paralysis

Step Three MOI Criteria

- Falls
- High-risk auto crash
- Automobile vs. pedestrian/bicyclist thrown, run over, or with significant (>20 miles/hour) impact
- Motorcycle crash faster than 20 miles/hour

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Step Four: Special Considerations

- Older Adults
- Children
- Anticoagulants
- Bleeding disorders
- Burns
- Pregnancy

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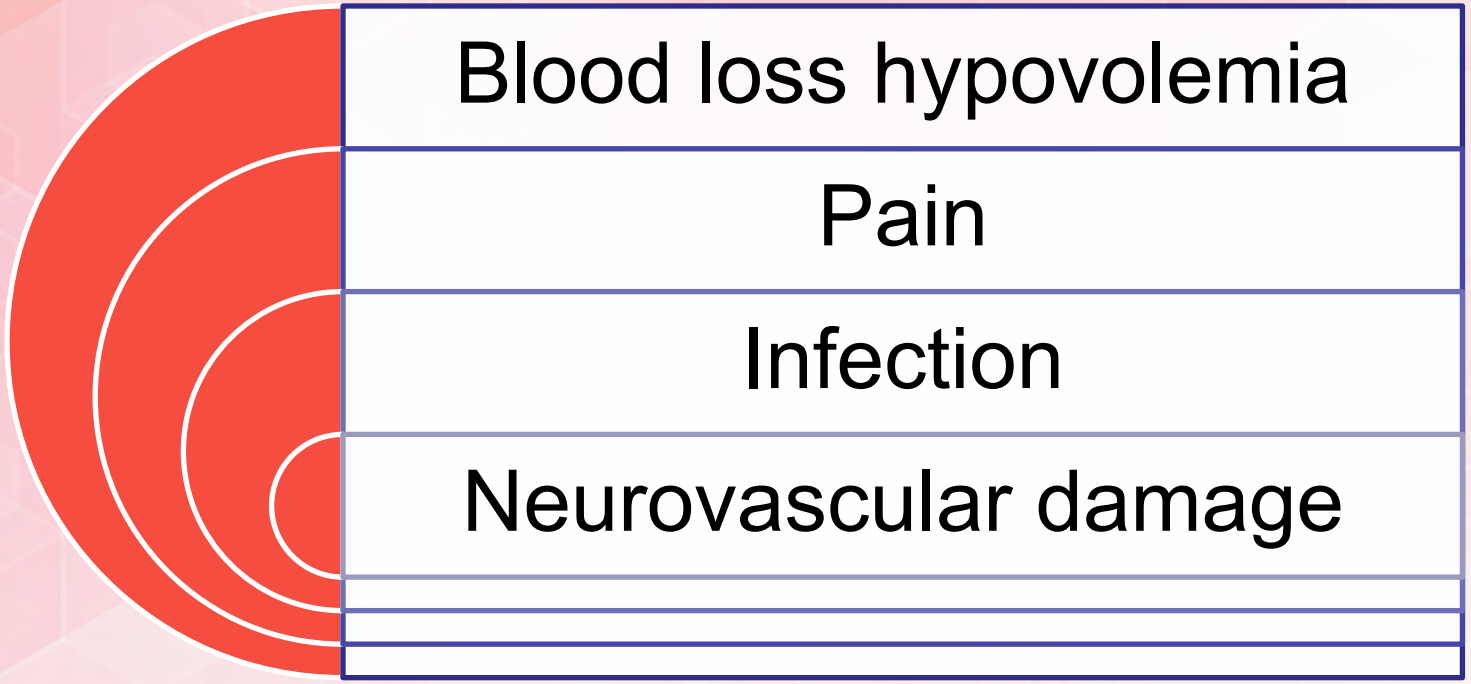
Initial Management of Musculoskeletal Trauma



The four priorities of care

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Blood Loss Hypovolemia

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Tourniquets

Petit Tourniquet - Savigny 1798

Combat Application Tourniquet (CAT) – modern day

Bleeding Control

- Stop the Bleed began in 2015 following the American College of Surgeons (ACS) Hartford Consensus recommendations. The goal is to teach laypeople life-saving bleeding control techniques – including tourniquet use.

STOP THE BLEED

https://www.bleedingcontrol.org/

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Nursing Care for the patient with a tourniquet

- Not intended for long term placement
- Note the time of application – 2 hour goal
- Monitor for bleeding
- Pain management
- Patient reassurance
- **DO NOT REMOVE OR LOOSEN THE TOURNIQUET ONCE IT IS IN PLACE**

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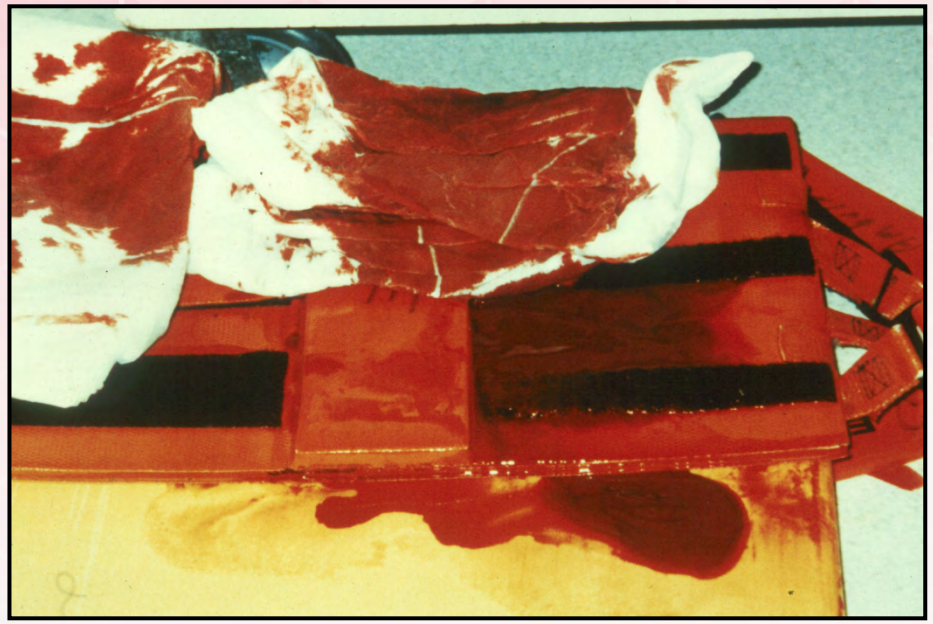
Pelvic Binder

- Temporary measure – until surgical stabilization
- Skin care

Covert Blood Loss

- **Blood Loss Associated with Fracture in Adults**
- Fracture site amount of blood loss in mL
- Radius and ulna 150–250
- Humerus 250
- Tibia and fibula 500
- Femur 1000
- Pelvis 1500–3000



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Blood Loss Hypovolemia

	CLASS I	CLASS II	CLASS III	CLASS IV
BloodLoss (ml) %	<750 15%	750-1500 15%-30%	1500-2000 30-40%	>2000 >40%
HR	<100	>100	>120	>140
BP	normal	normal	decrease	decrease
PP	normal	decrease	decrease	decrease
RR	14-20	20-30	30-40	>35
UOP	>30	20-30	5-15	negligible
CNS	slightly anxious	mildly anxious	anxious confused	confused lethargic

(American College of Surgeons, 2008)

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Volume Resuscitation in Hemorrhage

- Limited crystalloid administration – start with 1 L warmed isotonic crystalloid for the adult or 20 mg/kg for children
- Early initiation of Massive Transfusion Protocol (MTP) with administration of blood products in pre-determined ratios (usually 1 PRBC: 1 Plasma: 1 Platelet)
- Permissive hypotension

(American College of Surgeons, 2018)

Nursing Care for the patient receiving MTP

- Continue administration per order and hospital MTP guidelines
- Blood warmer → Prevent hypothermia
- Prepare patient for definitive care → angiography, OR
- Lab studies → Type and Crossmatch, coagulation studies, Fibrinogen, TEG/ROTEM

Transexamic Acid (TXA)

- TXA dosing –
  - usually load 1 gm over 10 minutes IV
  - then 1 gm IV over 8 hours

Follow your agency standards

(Napolitano et al., 2013)

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Nursing Care for the patient receiving TXA

- Thromboelastography (TEG) or Rotationalthromboelastometry (ROTEM) laboratory monitoring
- Monitor for thrombotic complications – DVT development, PE, thrombotic CVA

Acute Pain from Traumatic Injury

- Leads to stress response that increases heart rate and blood pressure
- Limits recovery
- Improves clinical outcome when managed well

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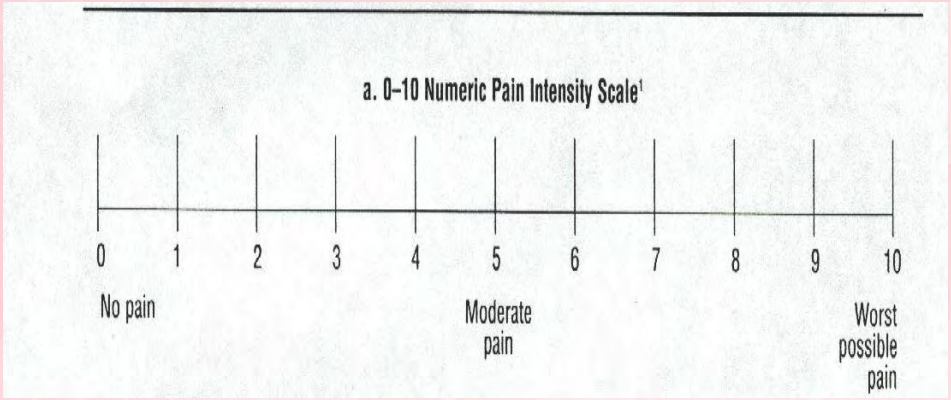
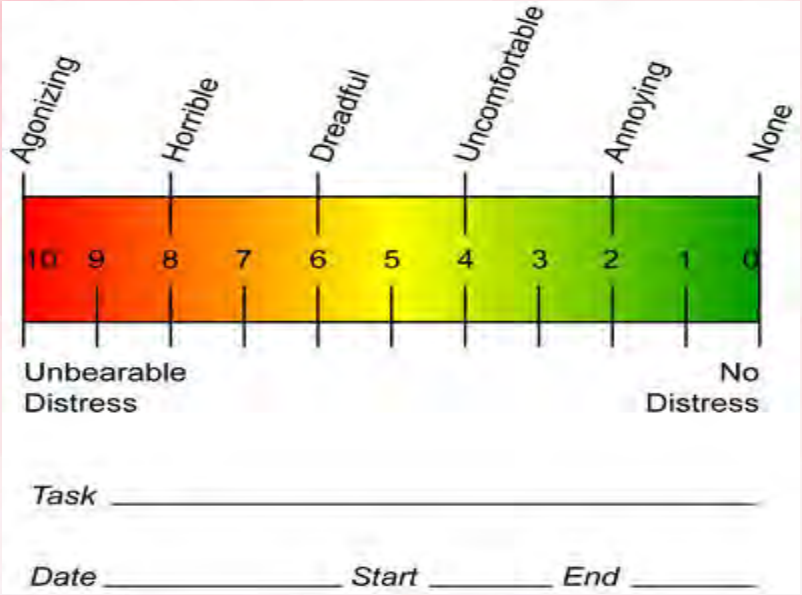
Pain Assessment

- Numeric Scale
- Visual Analogue Scale
- Faces Pain Scale





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Pain Management-General Rules

Appropriate route for administration of analgesics

Analgesics should be given at regular intervals

Analgesics should be prescribed according to pain intensity as evaluated by a scale of intensity of pain

Dosing of pain medication should be adapted to the individual

Analgesics should be prescribed with a constant concern for detail

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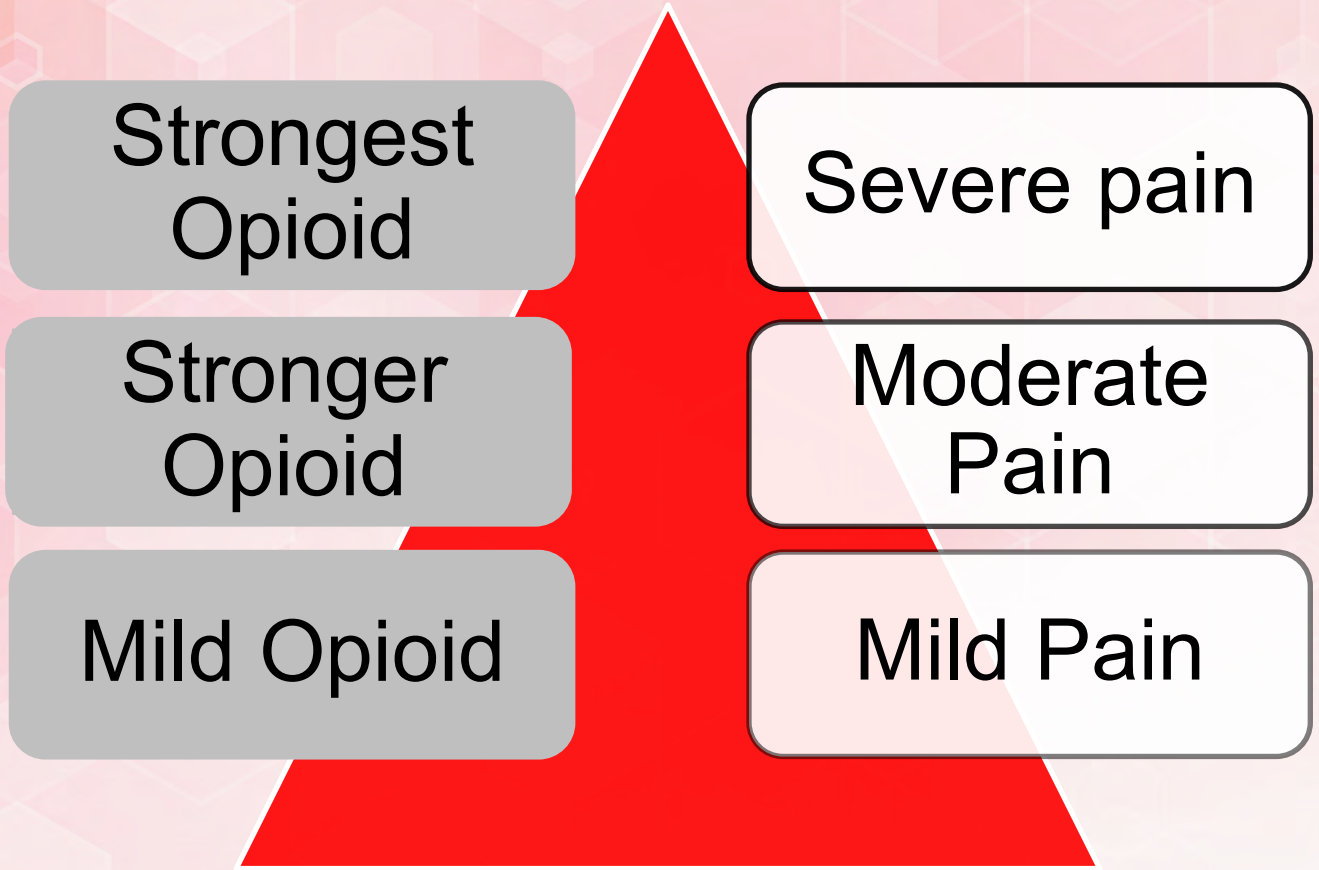
Prehospital

Pain starts at the point of injury (POI) and must be controlled from that initiating event

Prehospital practitioner has the first and perhaps only opportunity to break the pain cascade.

Early, effective pain control is essential to successful outcomes after traumatic injury

Current Acute Care Practice



Postoperative Pain

1. Epidural or intrathecal opioids, systemic opioid PCA, and regional techniques

2. Unless contraindicated, patients should receive an around the-clock regimen of NSAIDs, COXIBs, or acetaminophen

Procedural Medications

- Etomidate
- Midazolam
- Propofol
- Ketamine
- Fentanyl

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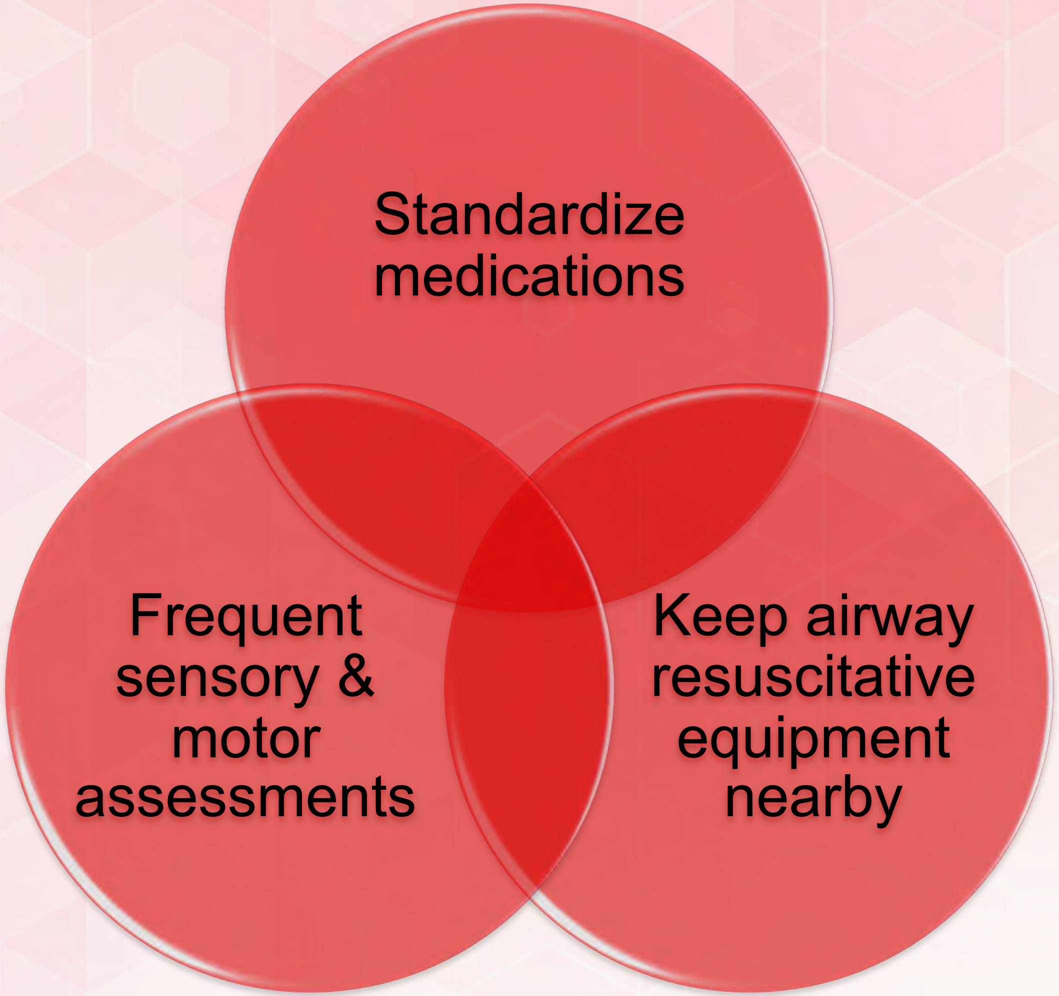
Pain


Standardize medications
Frequent sensory & motor assessments
Keep airway resuscitative equipment nearby

Prevent Infection

Bionixmed.com

ortho.smith-nephew.com

Irrimax.com

Sample of Proprietary Wound Irrigation Systems

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Infection

Antibiotics are often necessary in the prophylaxis and treatment of orthopedic infections post-operatively

The characteristics of implantable materials makes them a generous host for bacterial colonization

Prophylaxis and Surgical Infections

- Staphylococci
- Pseudomonas Aeruginosa
- Klebsiella
- Acinetobacter baumani

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Assessment

- What is baseline status?
- Are splints applied correctly
- Past Medical History

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Diagnostic Studies

- Plain films
- CT, CT angio
- MRI
- Angiography

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3 Views of the Pelvis

AP View

Inlet View

Outlet View

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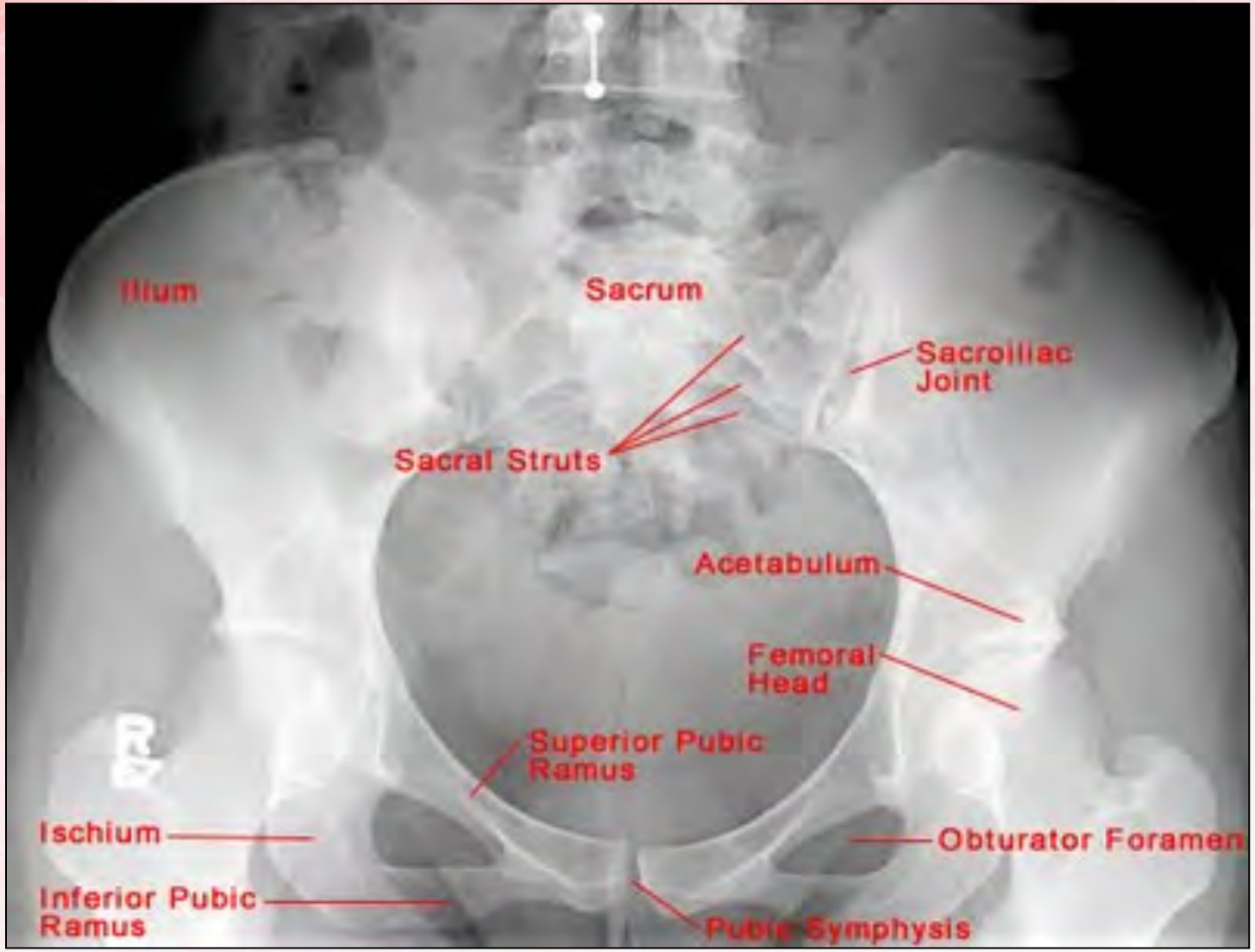
Anterior-Posterior (AP) View of the Pelvis



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Oblique's "Judet"

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AP View of Acetabulum

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Selected Injuries

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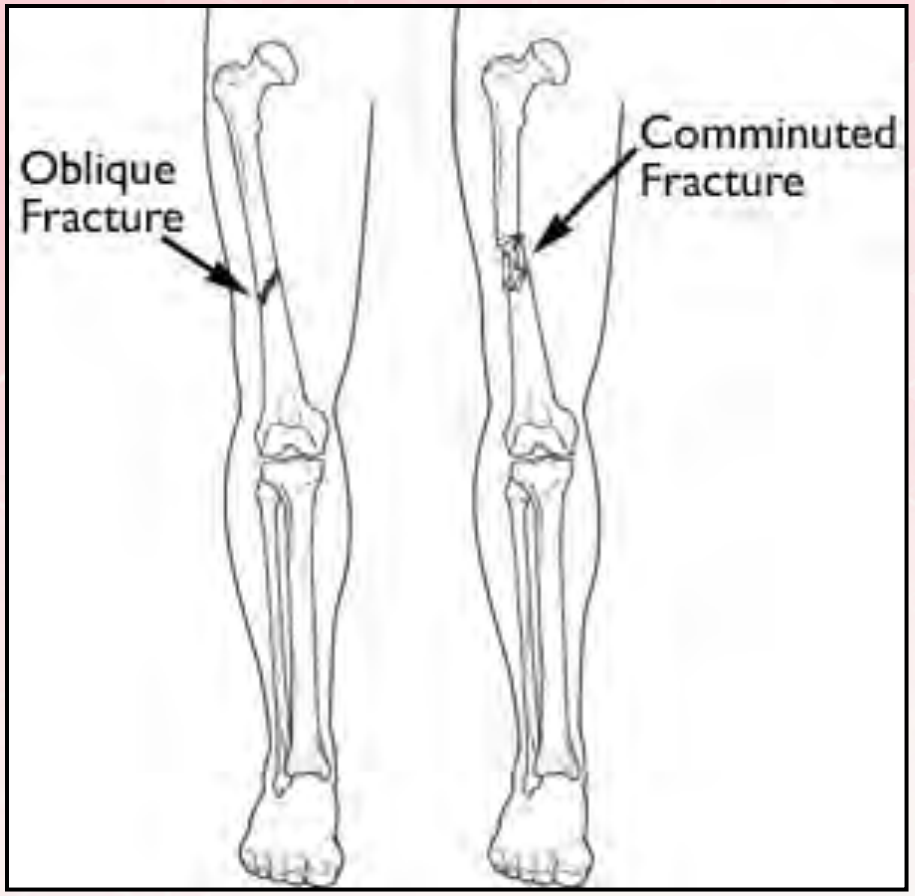
Types of Fractures

Wikimedia.com



Types of Fractures

Non-displaced

Displaced

Drdavidgeier.com

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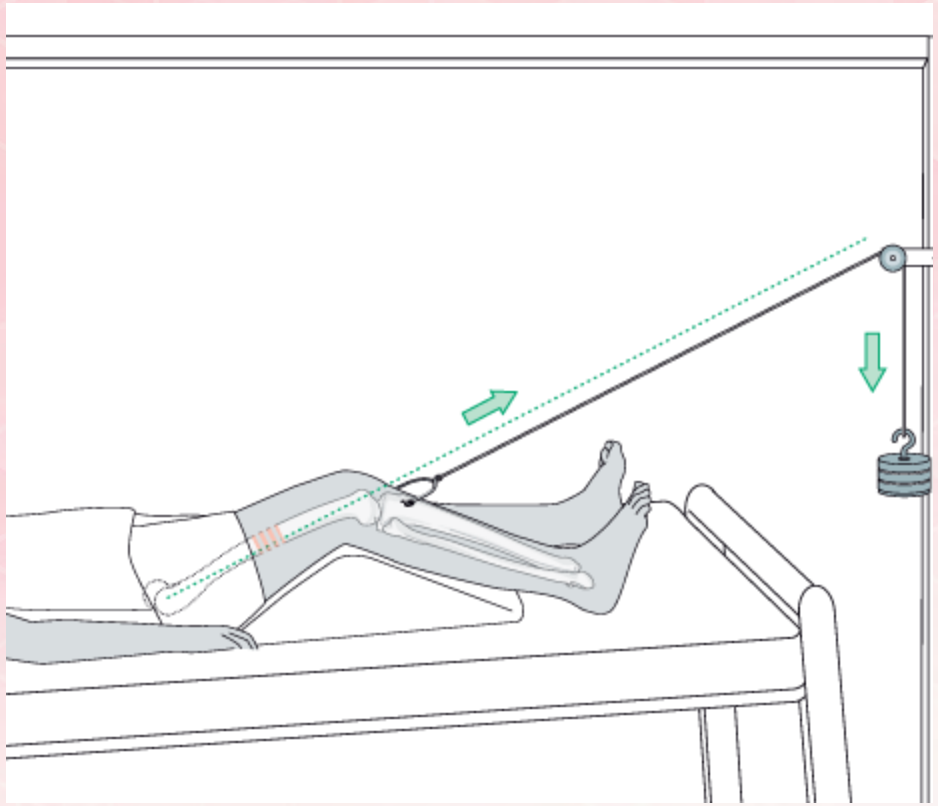
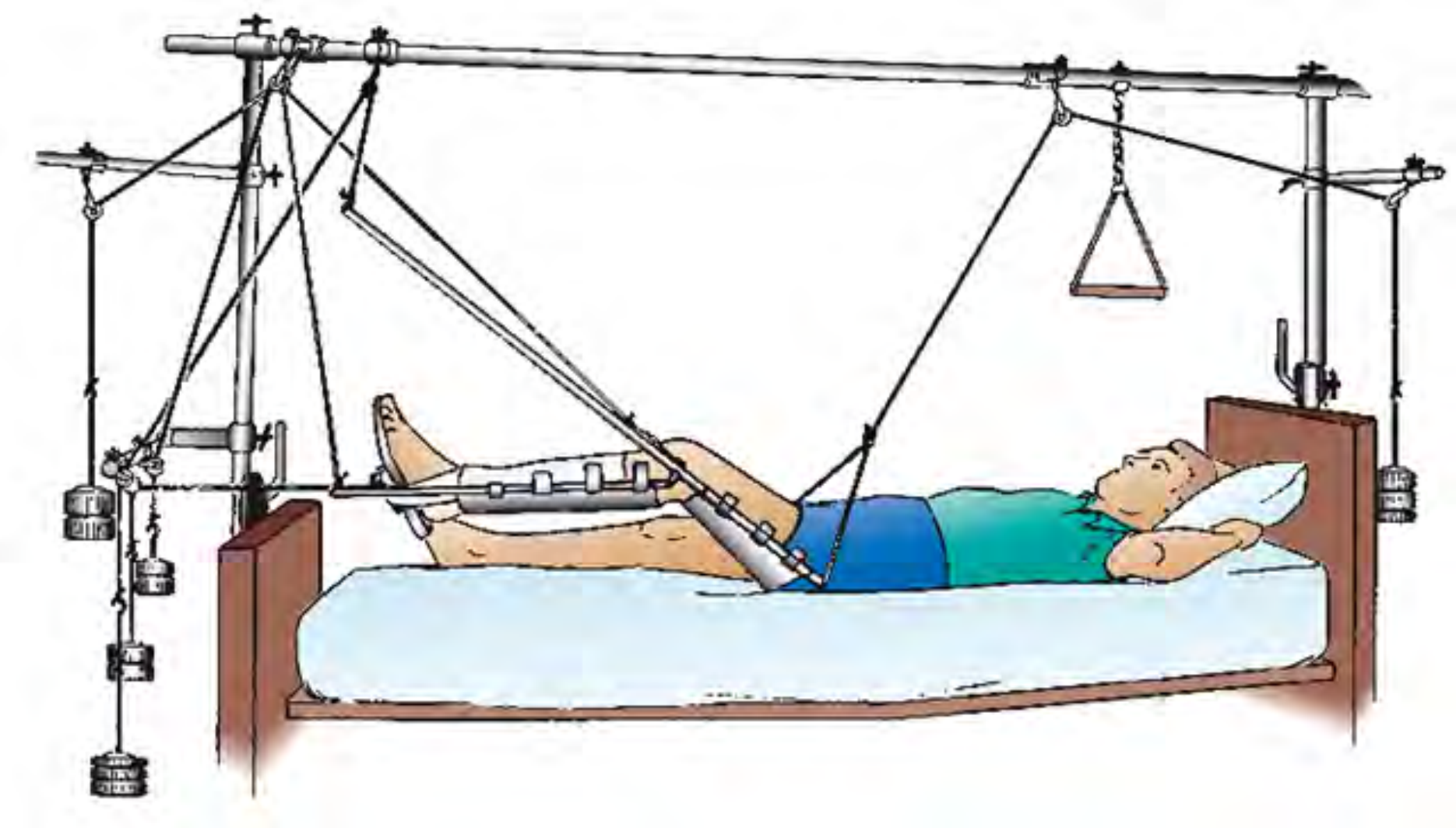
Skeletal Traction

- Indications
  - Unstable patient (damage control)
  - Preparation for surgery



AO Foundation.org

Traction & Immobilization



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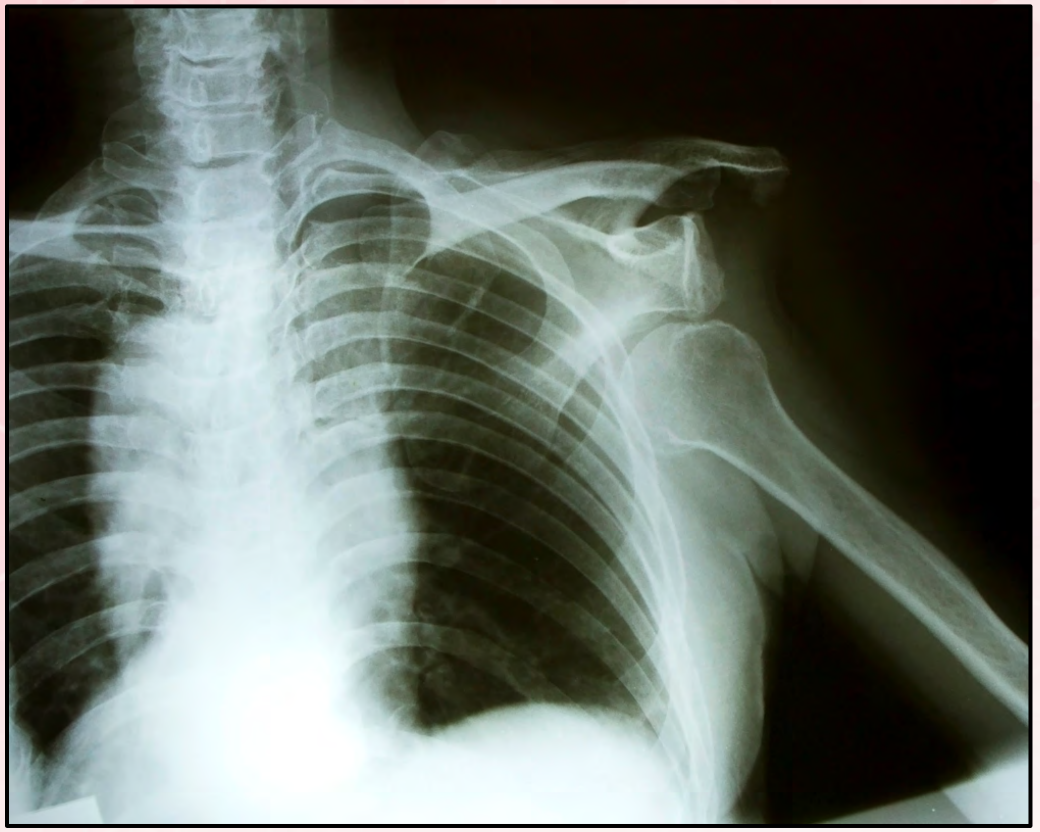
Reduction

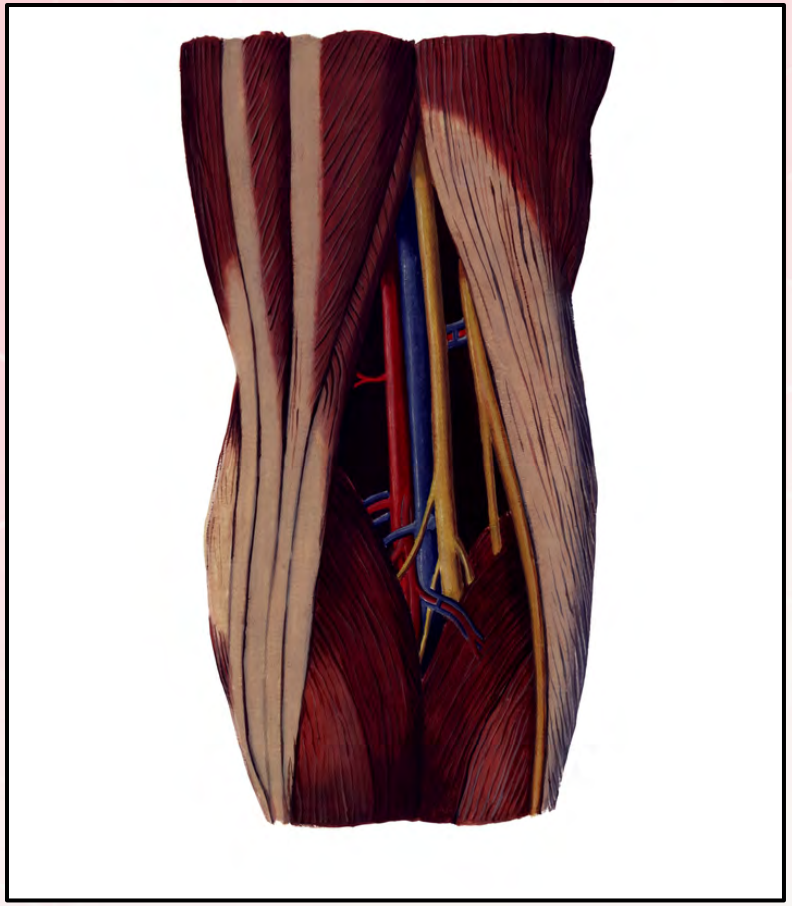
- **Reduction** is a medical procedure to restore a fracture or dislocation to the correct alignment. For the fractured bone to heal without any deformity the bony fragments must be re-aligned to their normal anatomical position

Dislocations

- Shoulder
- Knee
- Hip



Knee Dislocation



Hip Dislocation

Classic presentation of hip dislocation

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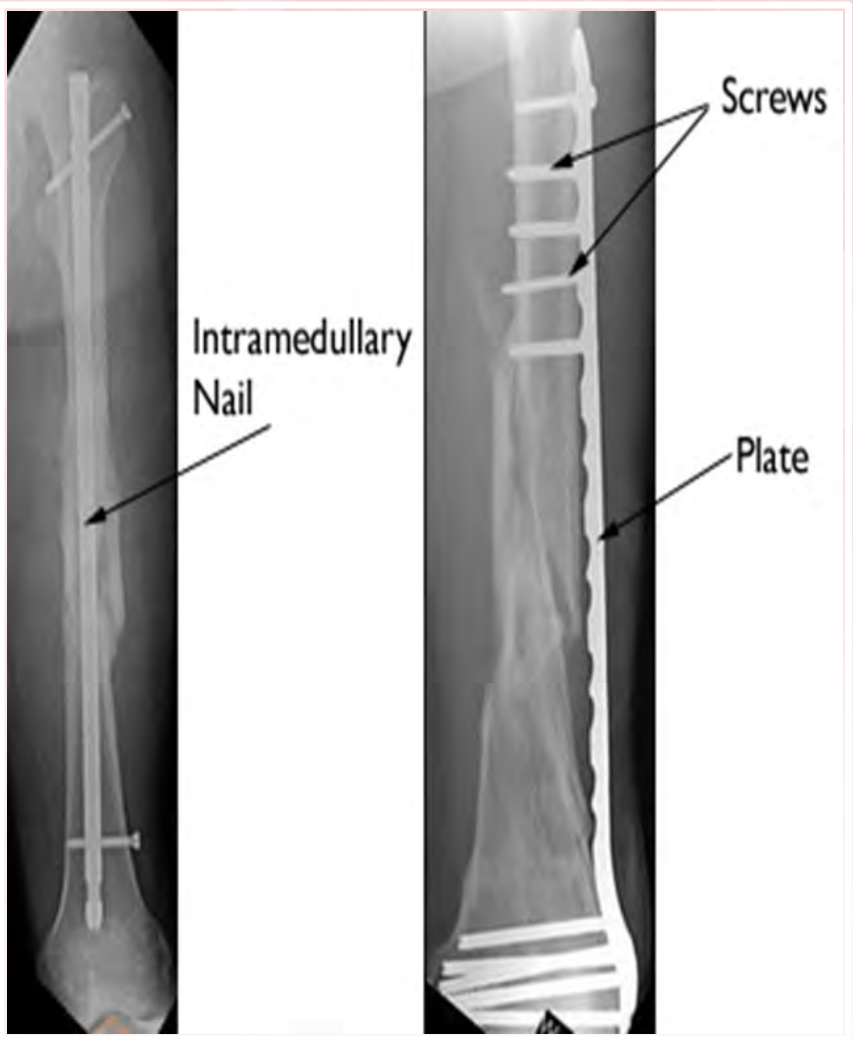
Types of Surgical Treatments for Fractures



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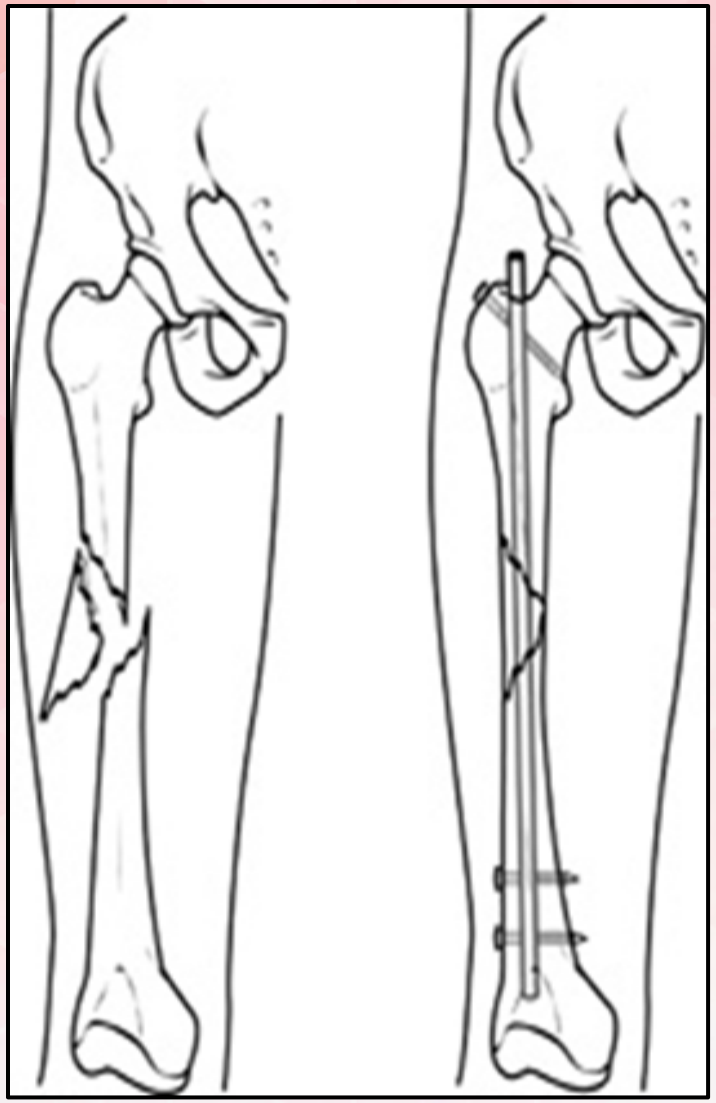
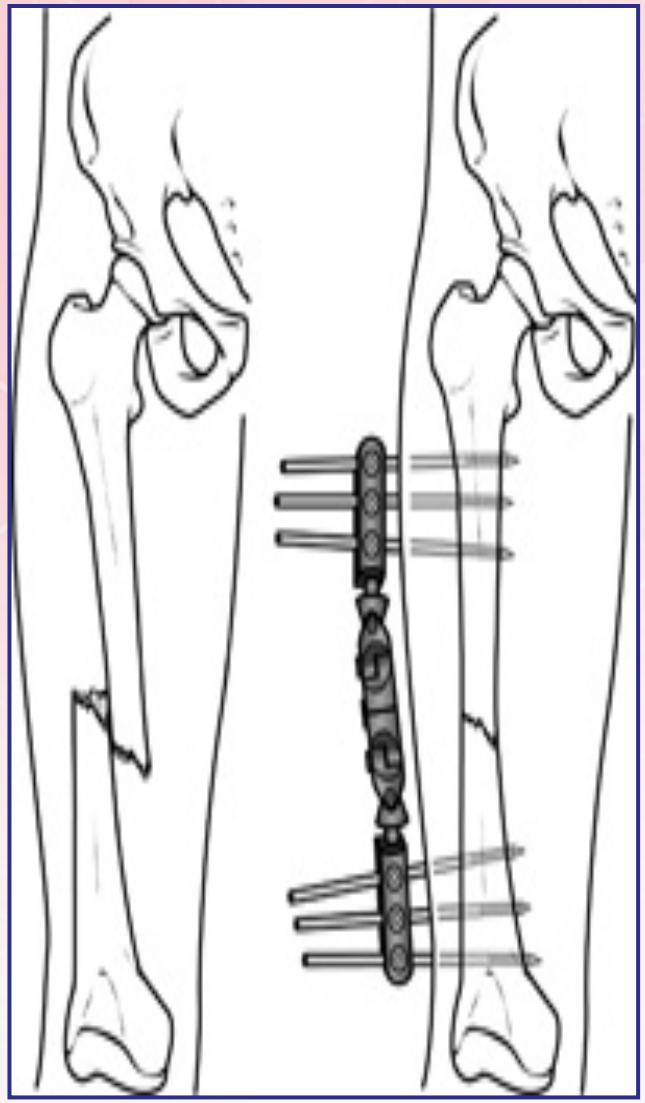
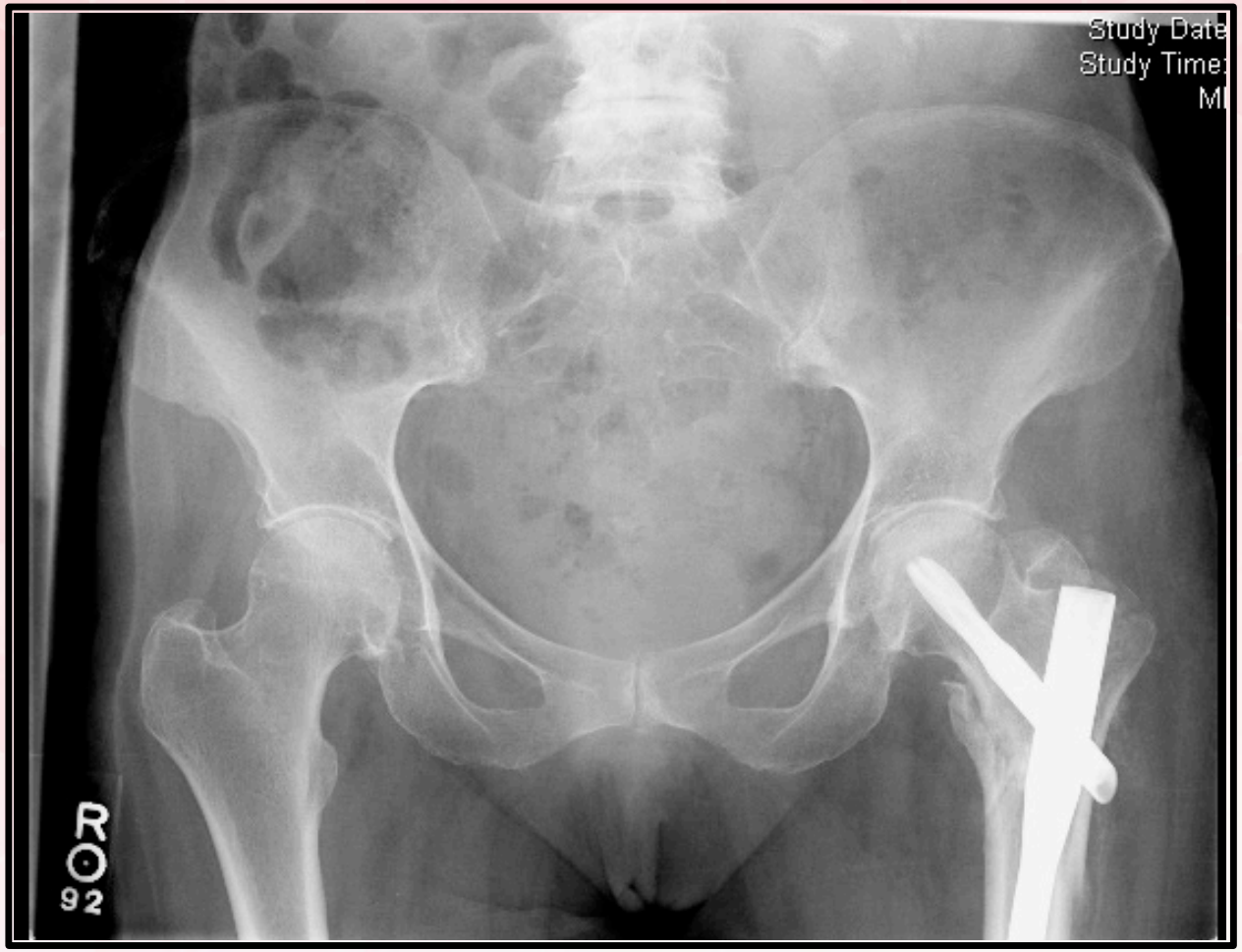
Intramedullary Nails vs. Screws and Plates





Gamma Nail in Femoral Head Intramedullary Nail in Femoral Shaft



Screw Holds Intramedullary Nail in Place to Avoid Migration

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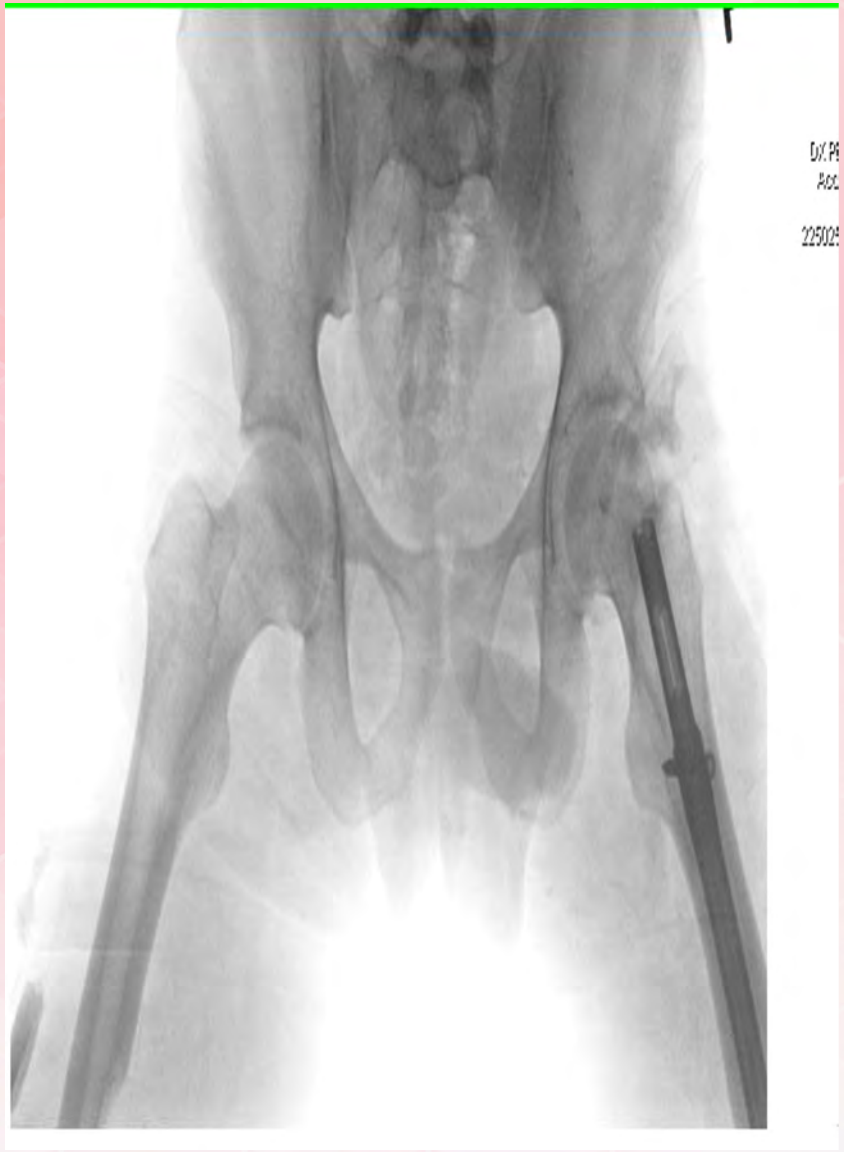
Open Reduction Internal Fixation (ORIF)



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External Fixation

- Indications
- Nursing Care

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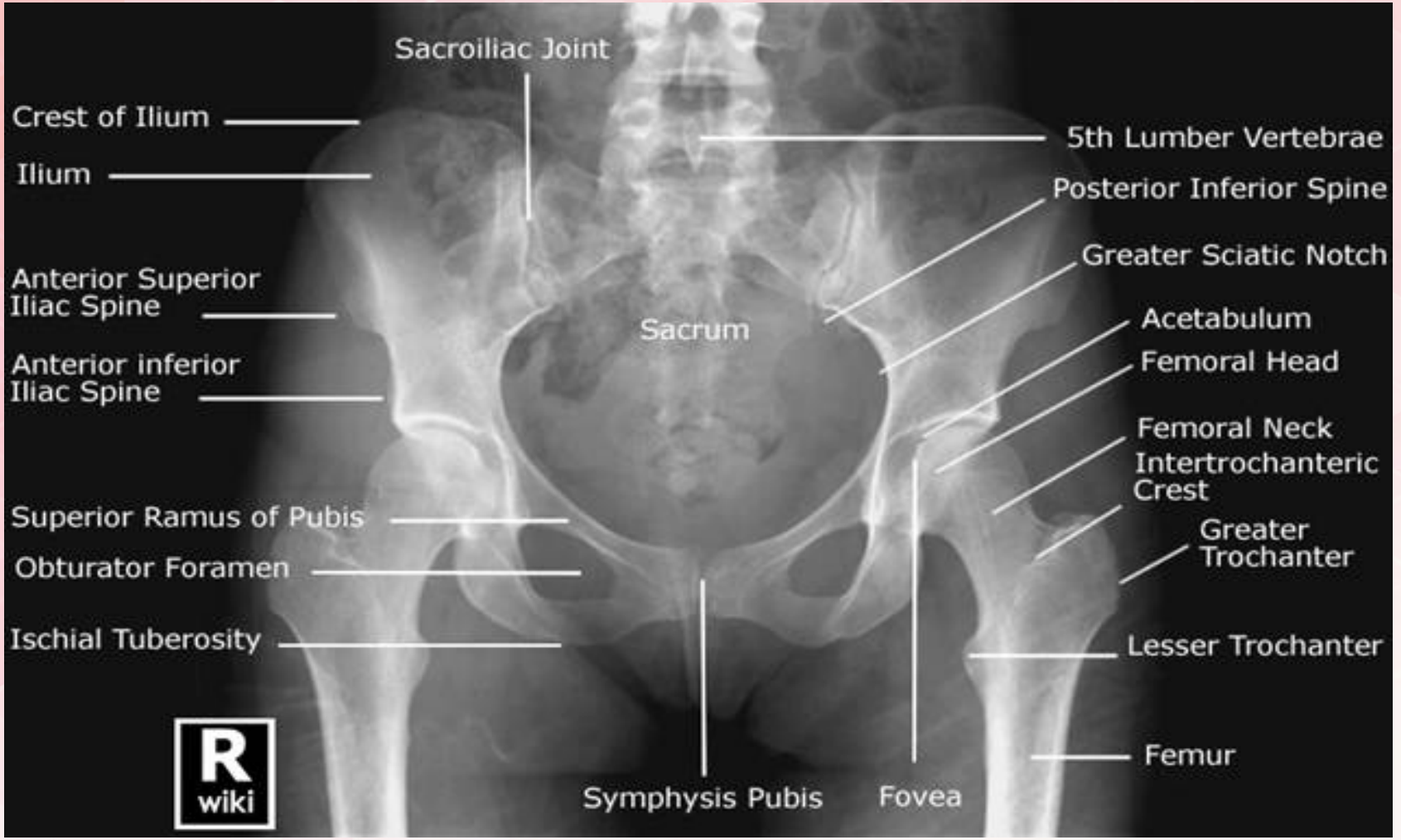
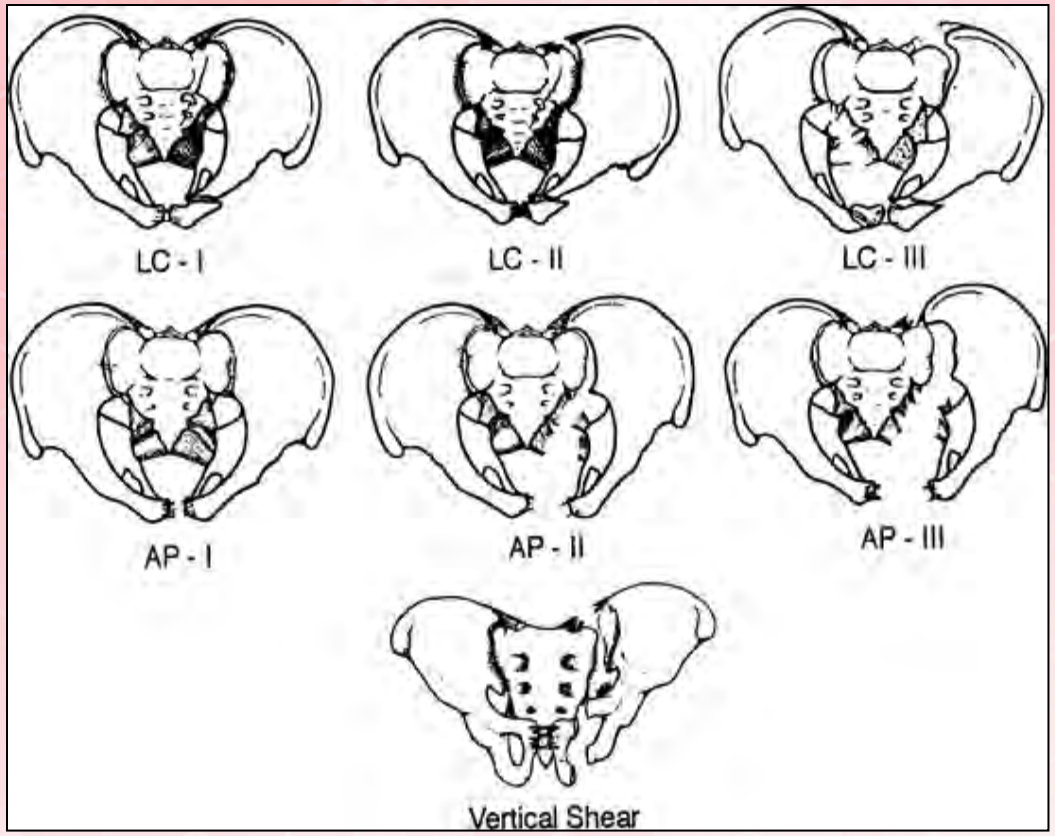
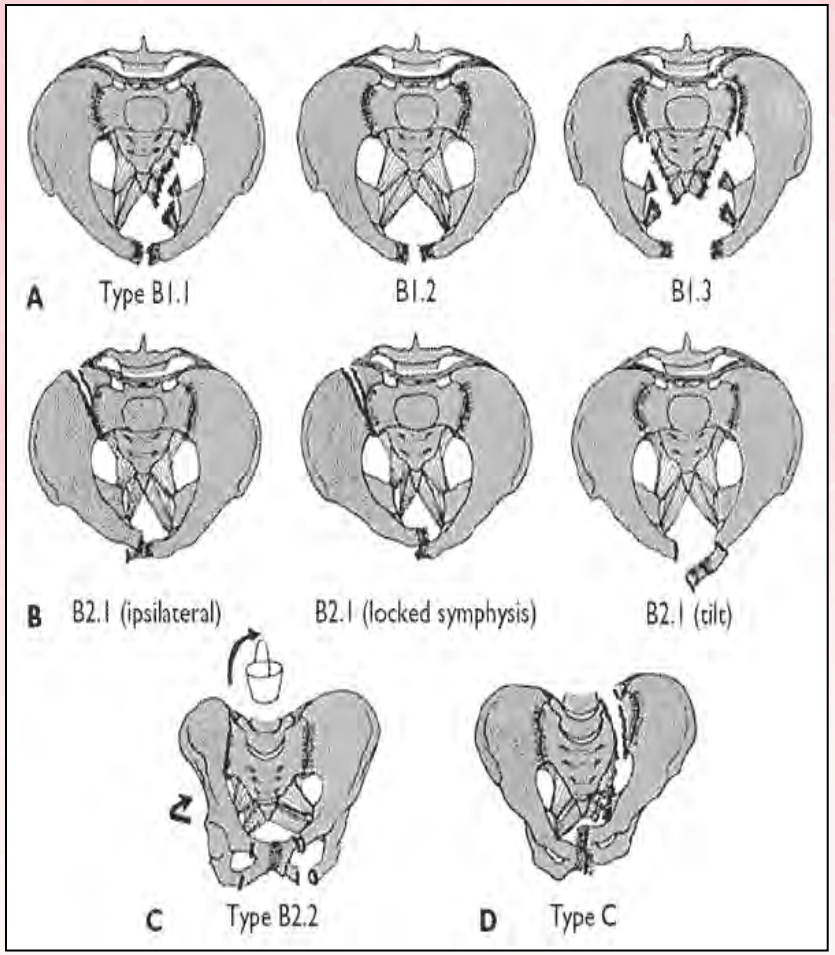
Pelvic Fractures



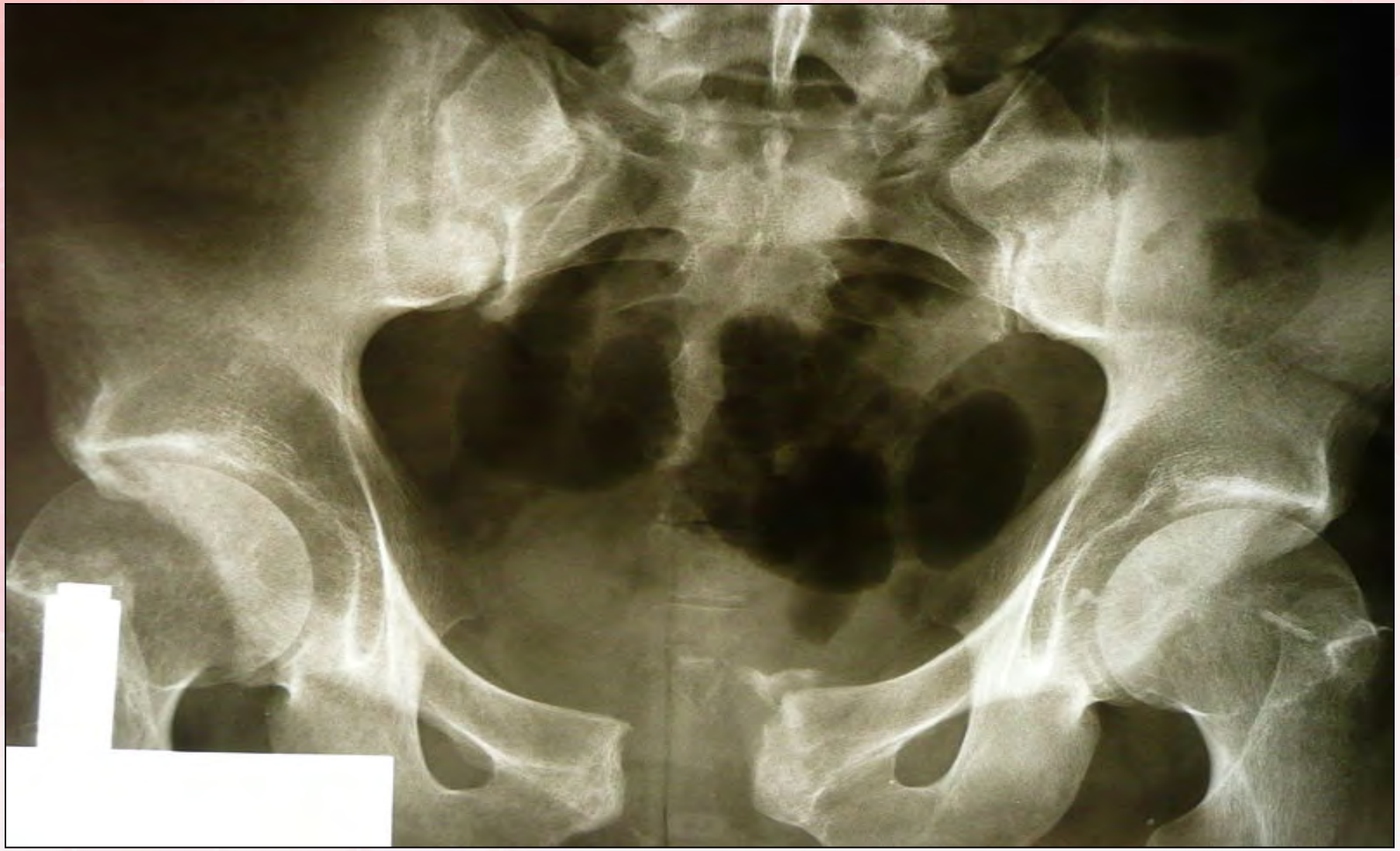
Classification of Pelvic Fractures: Young vs. Tile



(Young & Resnik, 1990; Tile, 1988)



Diastasis Symphysis Pubis



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Associated Injuries in Order of Frequency

- Closed head injury
- Long bone fractures
- Peripheral nerve injury
- Thoracic injury
- Bladder
- Spleen
- Liver
- GI tract
- Kidney, Urethra, Mesentery, Diaphragm

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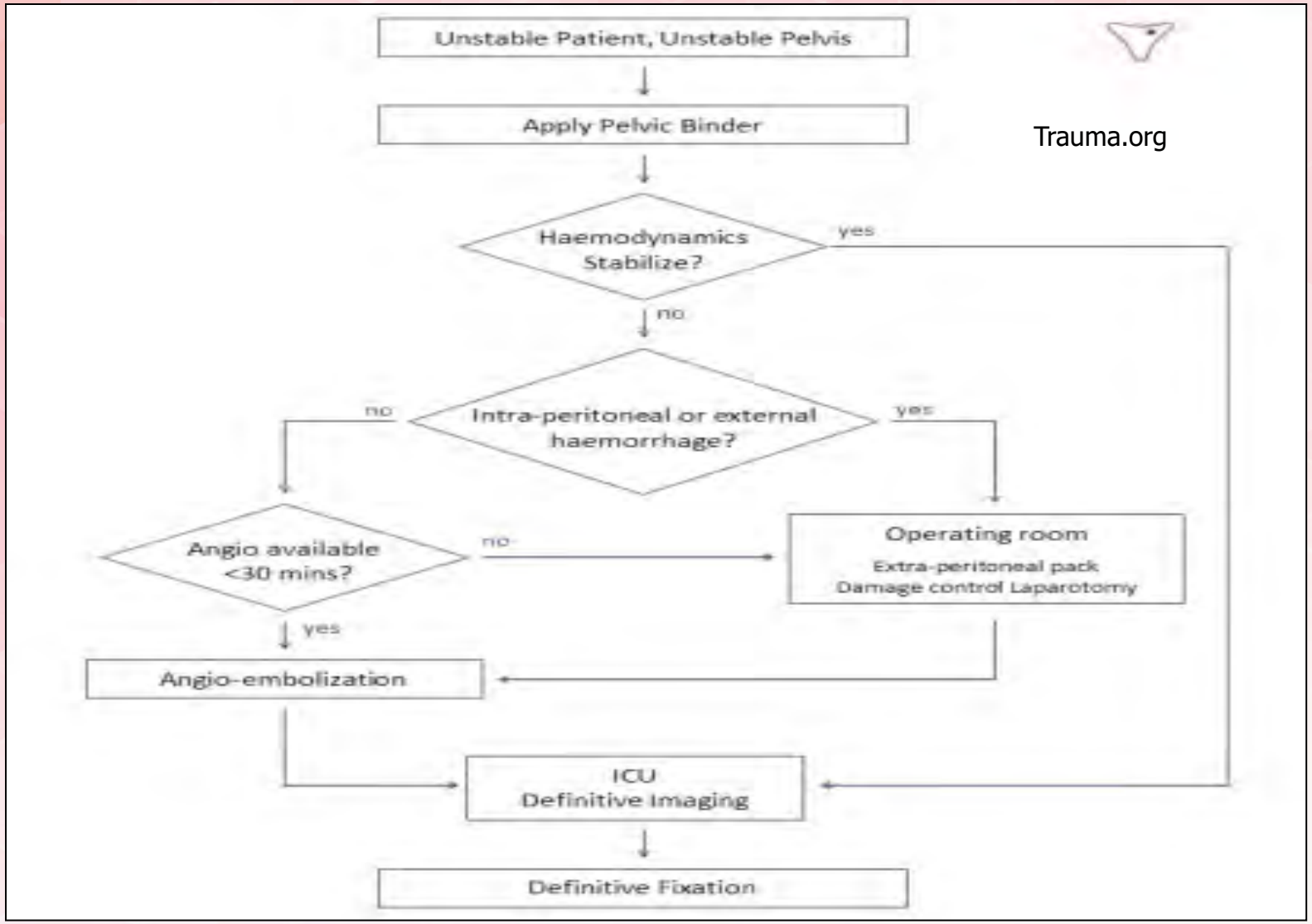
Pelvic Fracture Treatment Protocol



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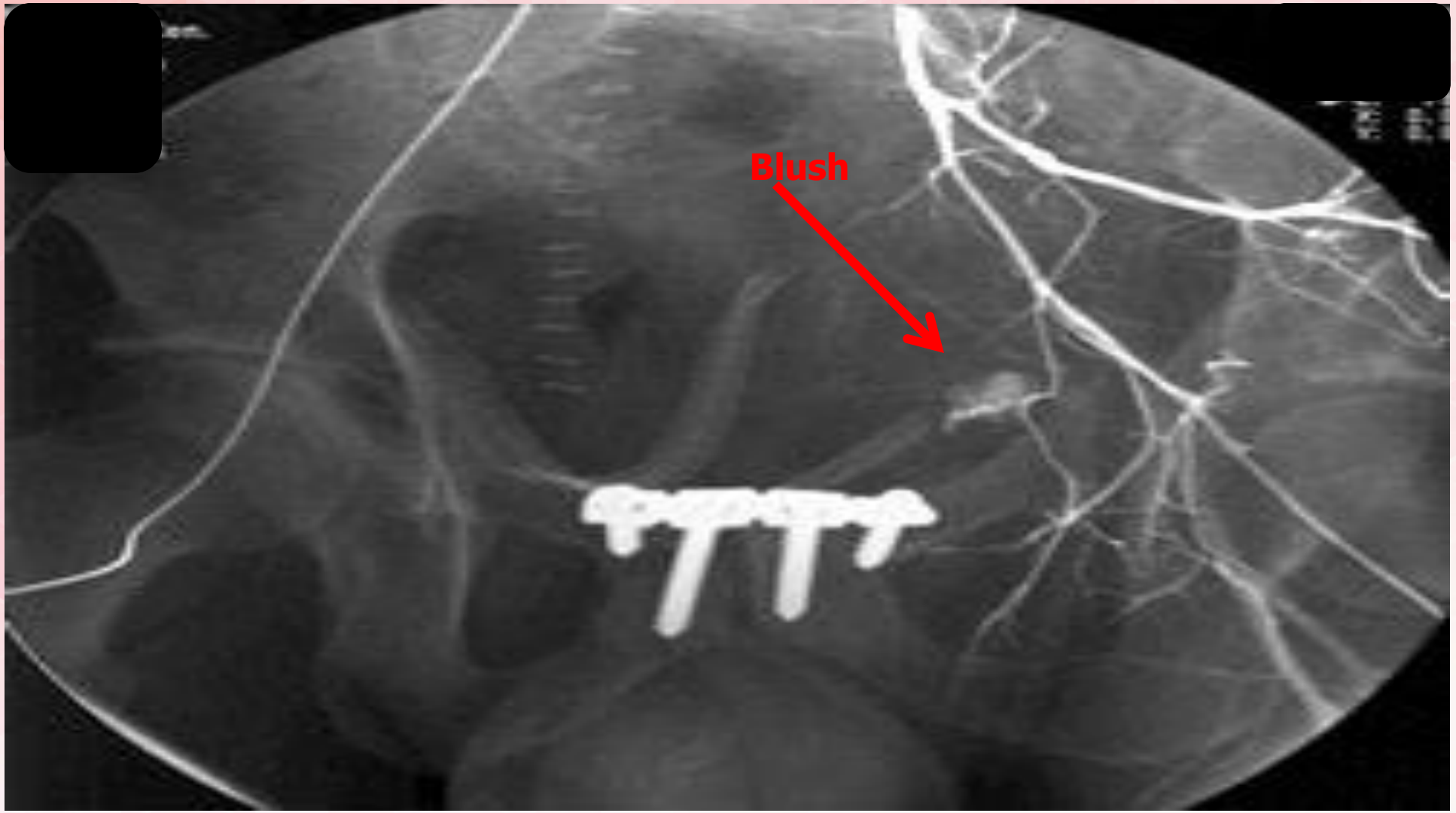
Angiographic Embolization



Complex Open Fractures

- Gustilo I : <1 cm wound over Fx
- Gustilo II: >1cm wound over Fx
- Gustilo III:

A) Extensive soft tissue injury

B) Periosteal stripping

C) Arterial injury needing repair

(Gustilo & Anderson, 1976)

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Gustilo Type 1 & Type 2

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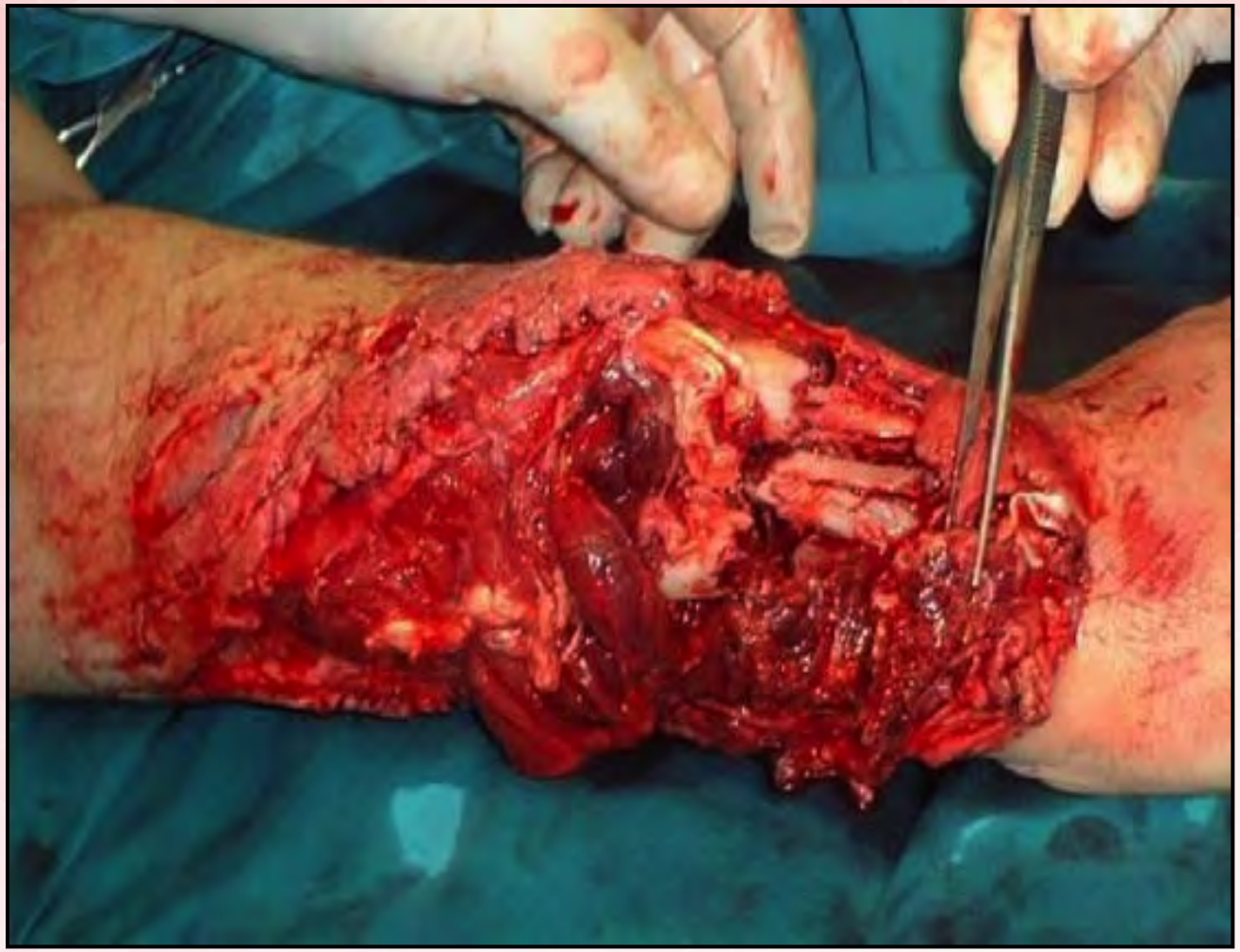
Mangled Extremity Severity Score (MESS)

Type	Characteristics	Injury	Points
1	Low energy	stab wound, simple closed fx, small-caliber GSW	1
2	Medium energy	Open/multilevel fx, dislocation, moderate crush	2
3	High energy	shotgun, high-velocity GSW	3
4	Massive crush	Logging, railroad, oil rig accidents	4
Shock Group			
1	Normotensive	BP stable	0
2	Transiently hypotensive	BP unstable in field but responsive to fliud	1
3	Prolonged hypotension	SBP <90mmHg in field and responsive to IV fluids in OR	2
Ischemia Group			
1	None	Pulsatile, no signs of ischemia	1
2	Mild	Diminished pulses without signs of ischemia	2
3	Moderate	No dopplerable pulse, sluggish cap refill, paresthesia, diminished motor activity	3
4	Advanced	Pulseless, cool, paralyzed, numb without cap refill	4
Age Group			
1	<30y/o		0
2	>30 <50		1

MESS score: six or less consistent with a salvageable limb. Seven or greater amputation generally the eventual result.

(Helfet, Howey, Sanders, & Johansen, 1990)

Mangled Extremity



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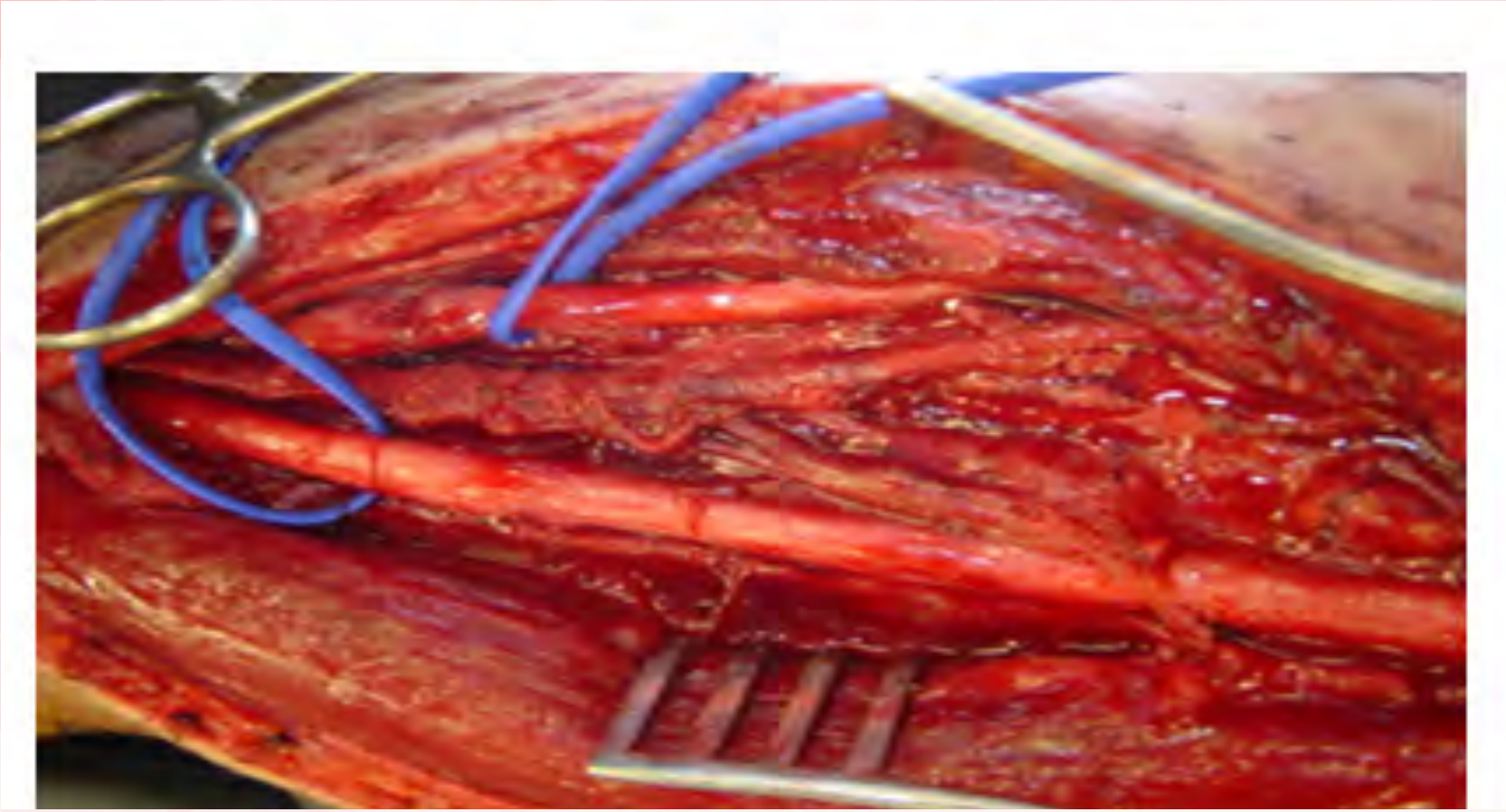
Popliteal Artery and Vein Shunted



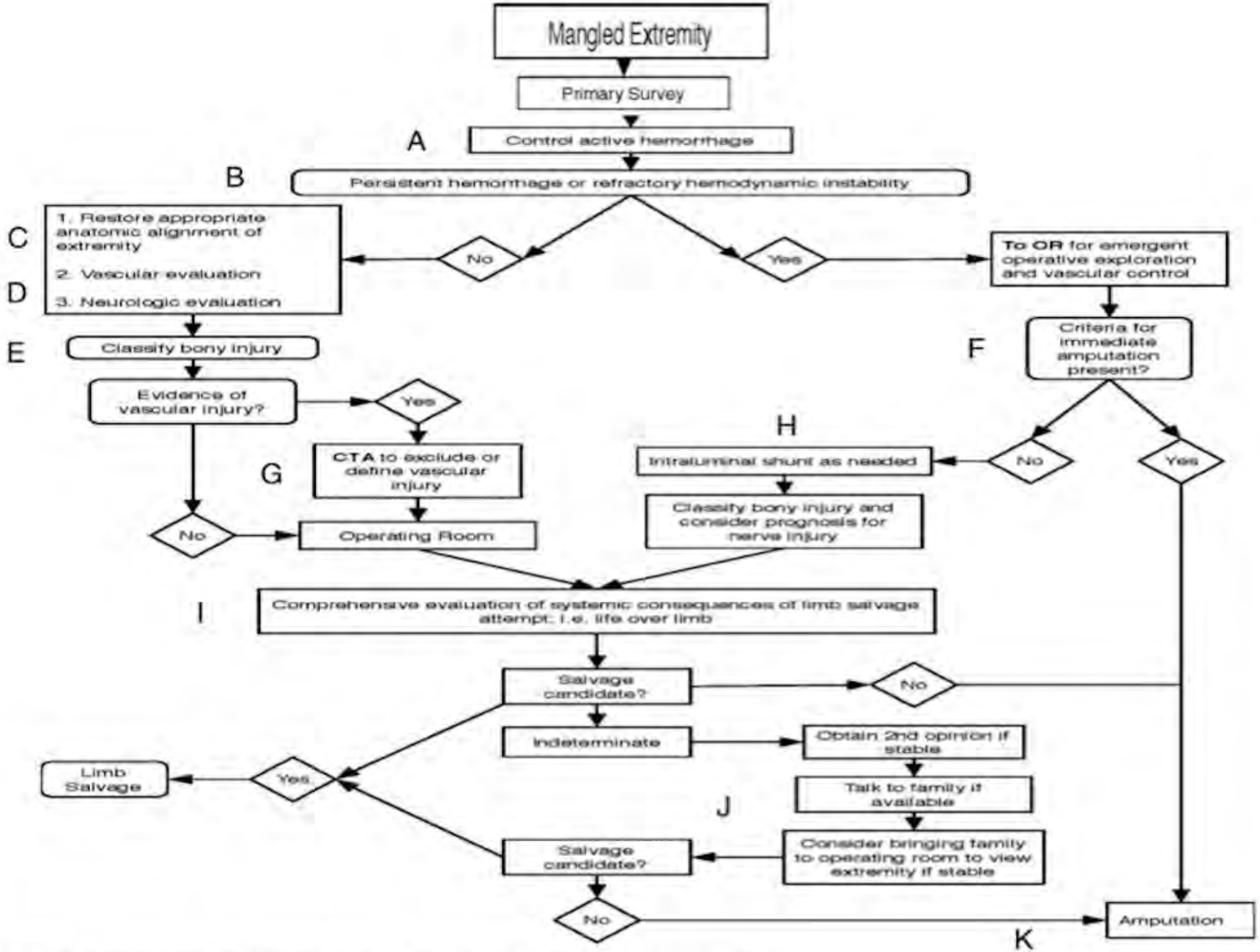
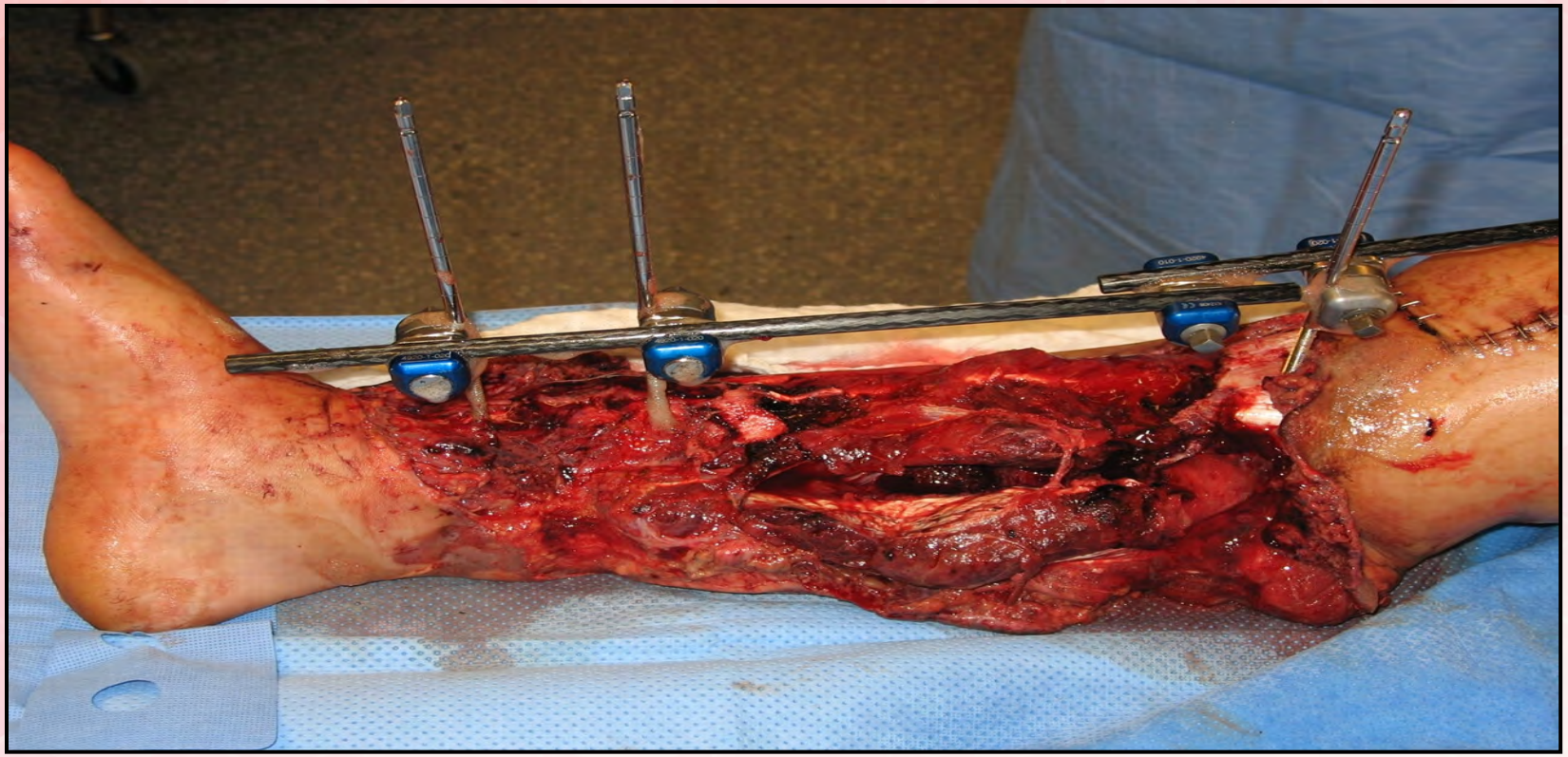


Figure 1. Algorithm for management of patients with mangled extremities.

(Scalea, et al, 2012)

Identify the Zone of Injury



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Compartment Syndrome

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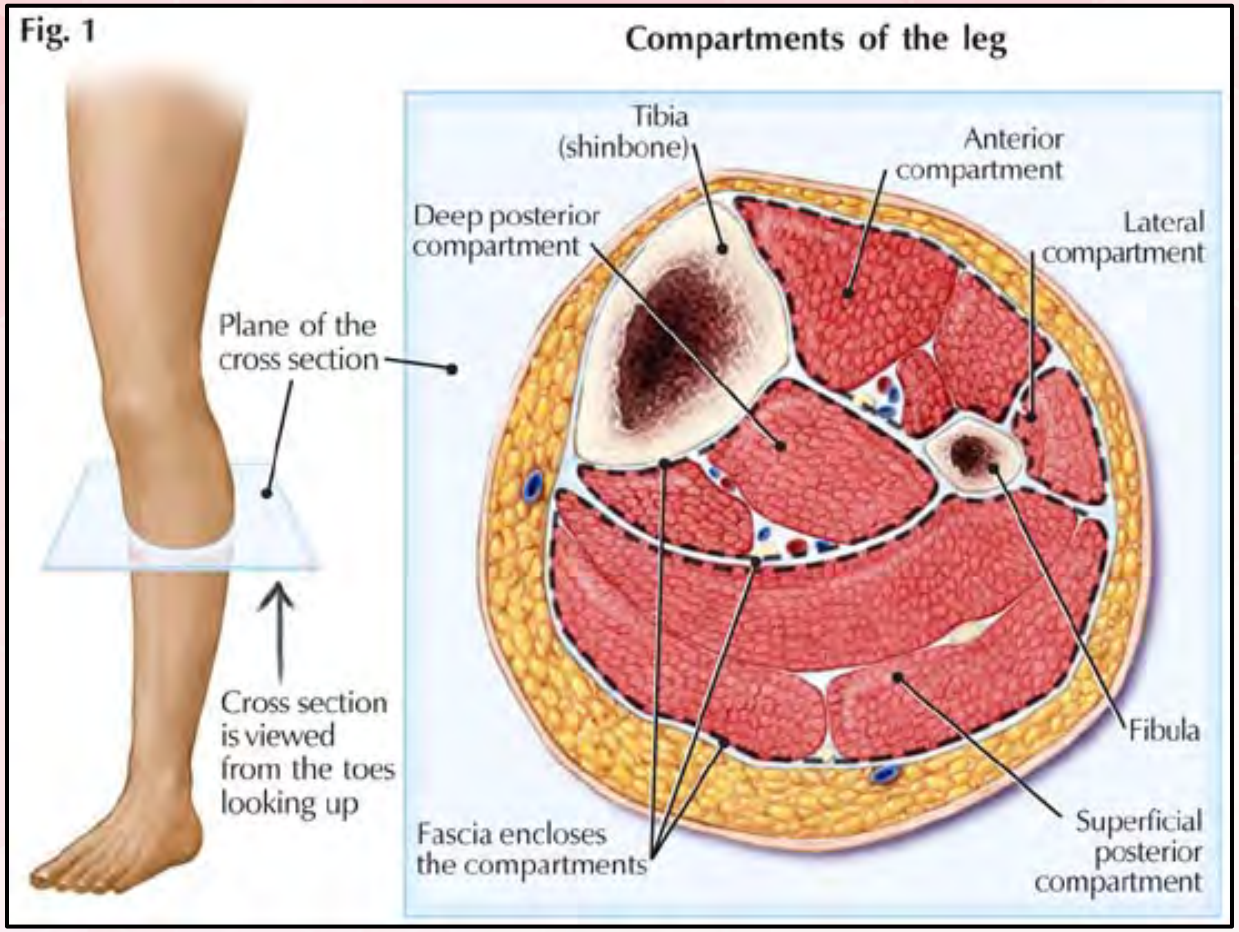
Compartment Syndrome

Capillary Perfusion Pressure- 25 mm Hg

Interstitial Pressure 4-6 mm Hg



http://www.hughston.com/

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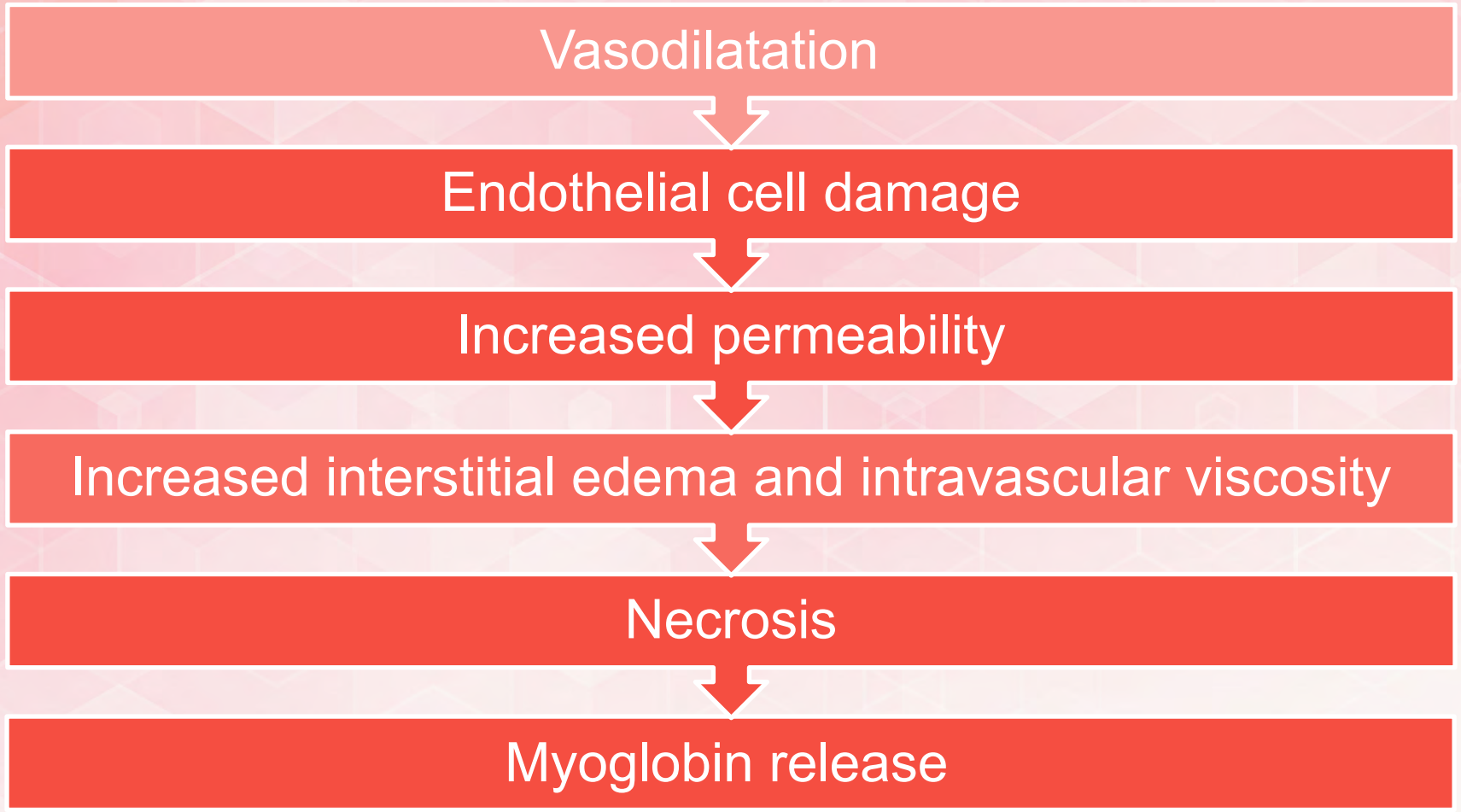
Ischemia



Etiology

Increased fluid content in interstitial space

Decreased compartment size

Signs and Symptoms

Wiki.org

- Pain disproportionate to injury!
- Pain with passive stretching
- Neuro compromise
- Tenseness
- Unilateral size increase

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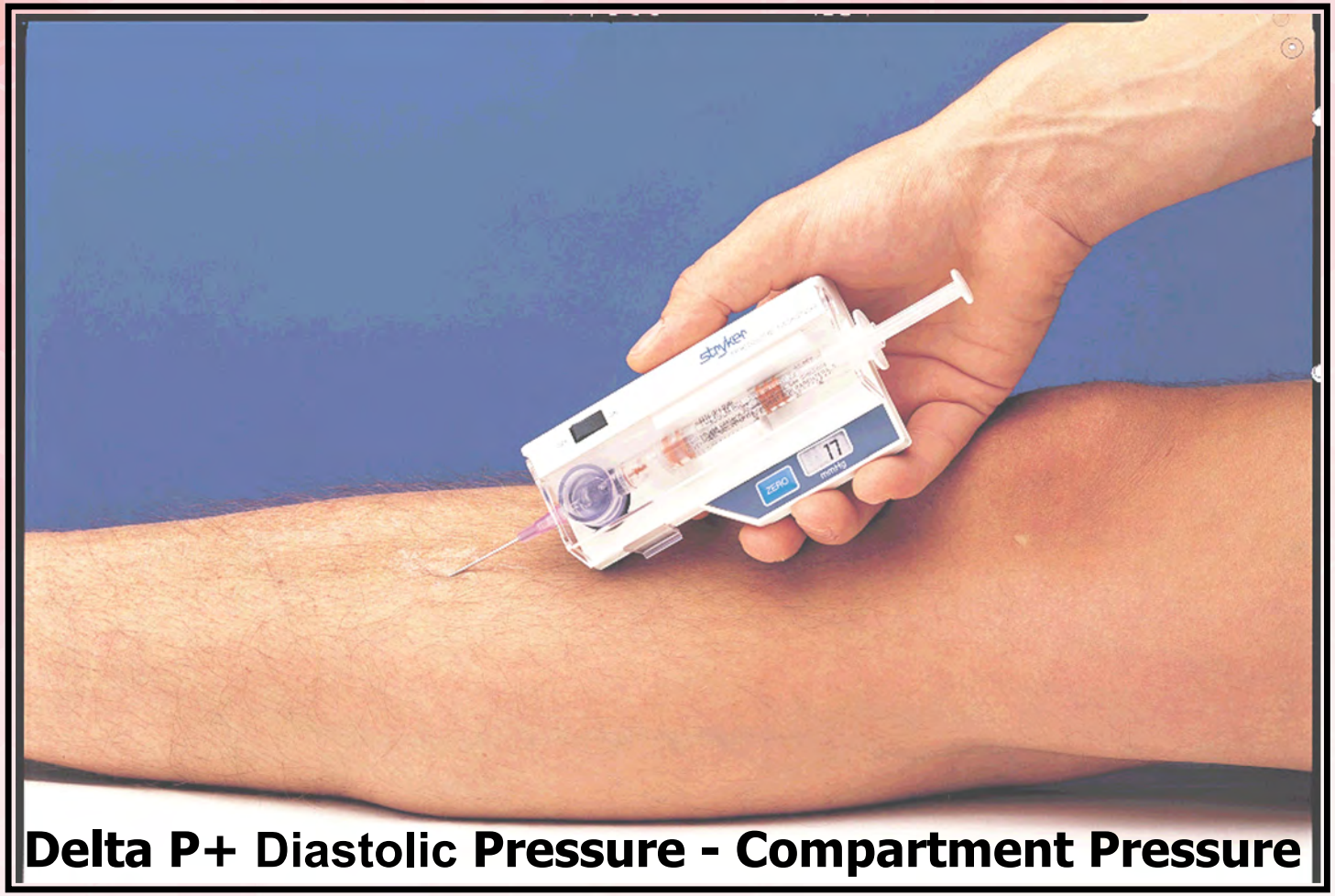
Interventions

- Supplemental O2
- Level extremity
- Routine trauma resuscitation
- Extra vigilance in some patients
- Hydration
- Diuresis
- Alkalinization of urine

Measurement Compartment Pressures



Compartment >45 **Delta P <40**

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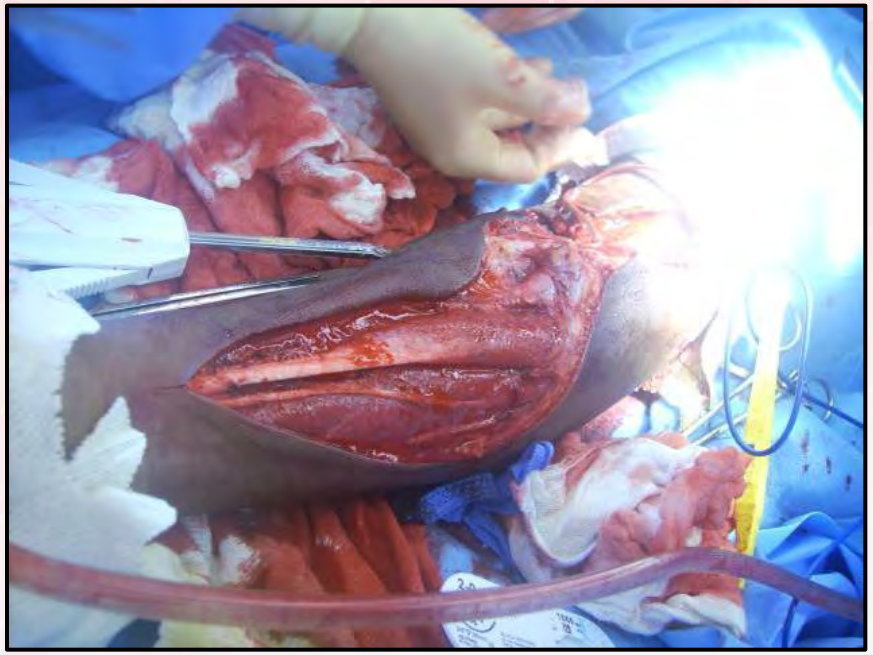
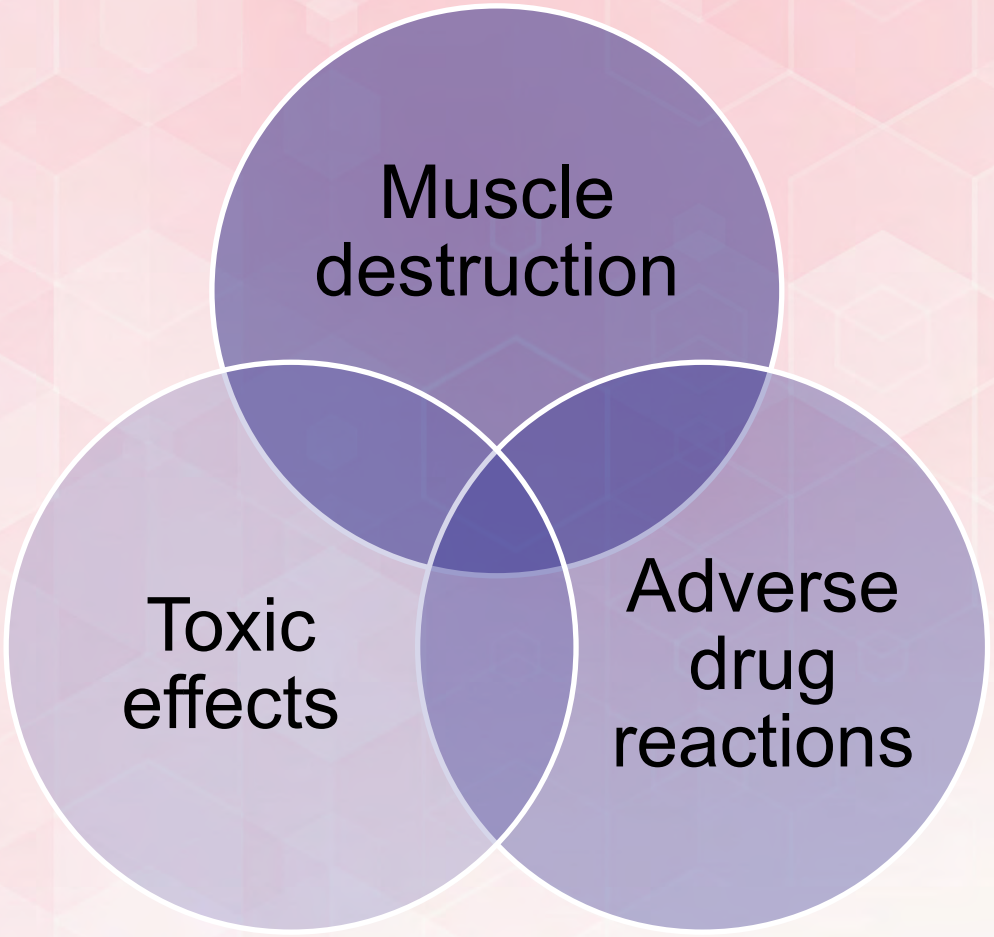
Fasciotomy

- Definitive treatment with limb saving results
- Extends hospital length of stay as it turns a closed injury into an open injury
- Threshold for compartment pressure remains 30 mmHg



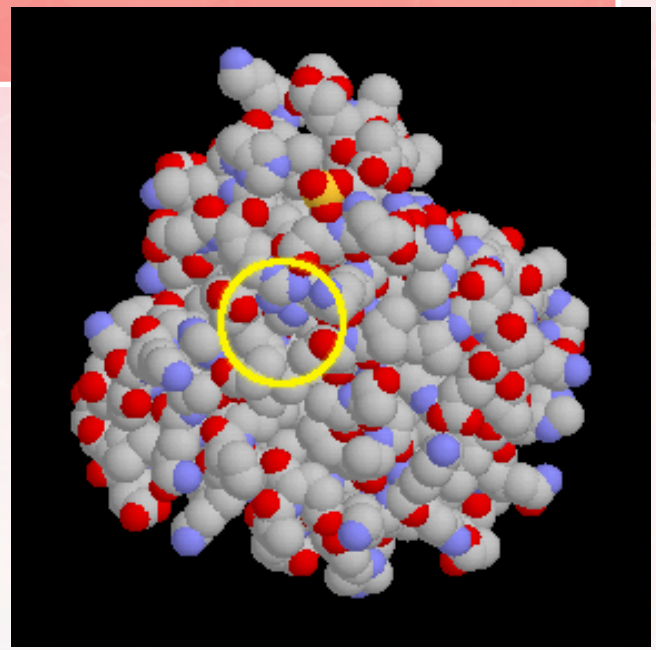
Rhabdomyolysis



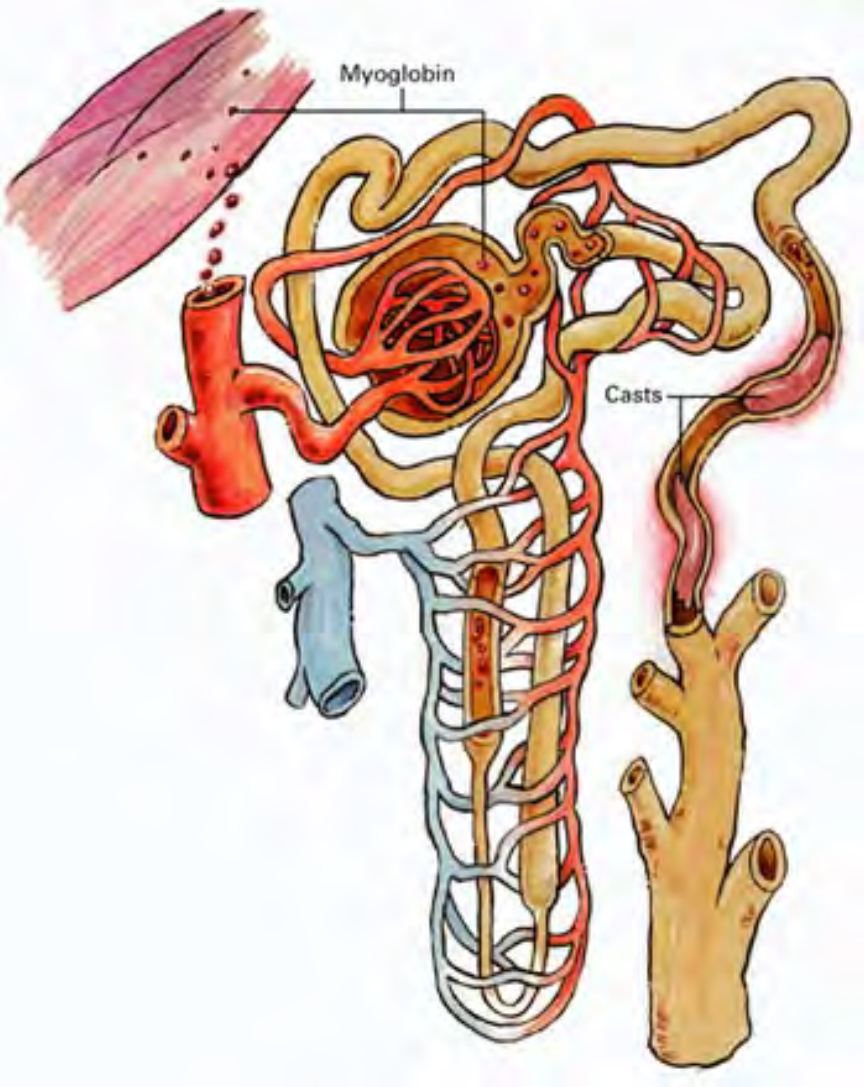
What is Myoglobin?

Iron containing pigment found in skeletal muscle

Especially in those specialized for sustained contraction



Pathophysiology



- Direct toxicity
- Cast formation
- Mechanical obstruction
- Acid urine causes myoglobin to form a gel
- Hypoperfusion from hemorrhage and fluid shifts
- Reperfusion fluid shifts
- Further hypoperfusion

Causes of Rhabdomyolysis

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Rhabdomyolysis

Breakdown of muscle tissue

↓

Results in release of free myoglobin

↓

Myoglobin in the glomerular filtrate precipitates in the tubules and obstructs flow

↓

Precipitation is exacerbated by acidic pH of the urine

Treatment of the E*ffect* of Rhabdomyolysis

- Acute renal failure prevention
  - Monitor CPK, serum and urine myoglobinuria
  - Ensure fluid resuscitation
  - Ensure hyperdynamic urine output
  - Ensure alkaline urine
  - May diurese for mechanical lavage
  - Carbonic anhydrase inhibitor

Key Point

Patient must be volume resuscitated adequately for appropriate “pushing pressure”

Before administering diuretics and mannitol to exert a “pulling pressure”

SCIENCE OF TRAUMA NURSES

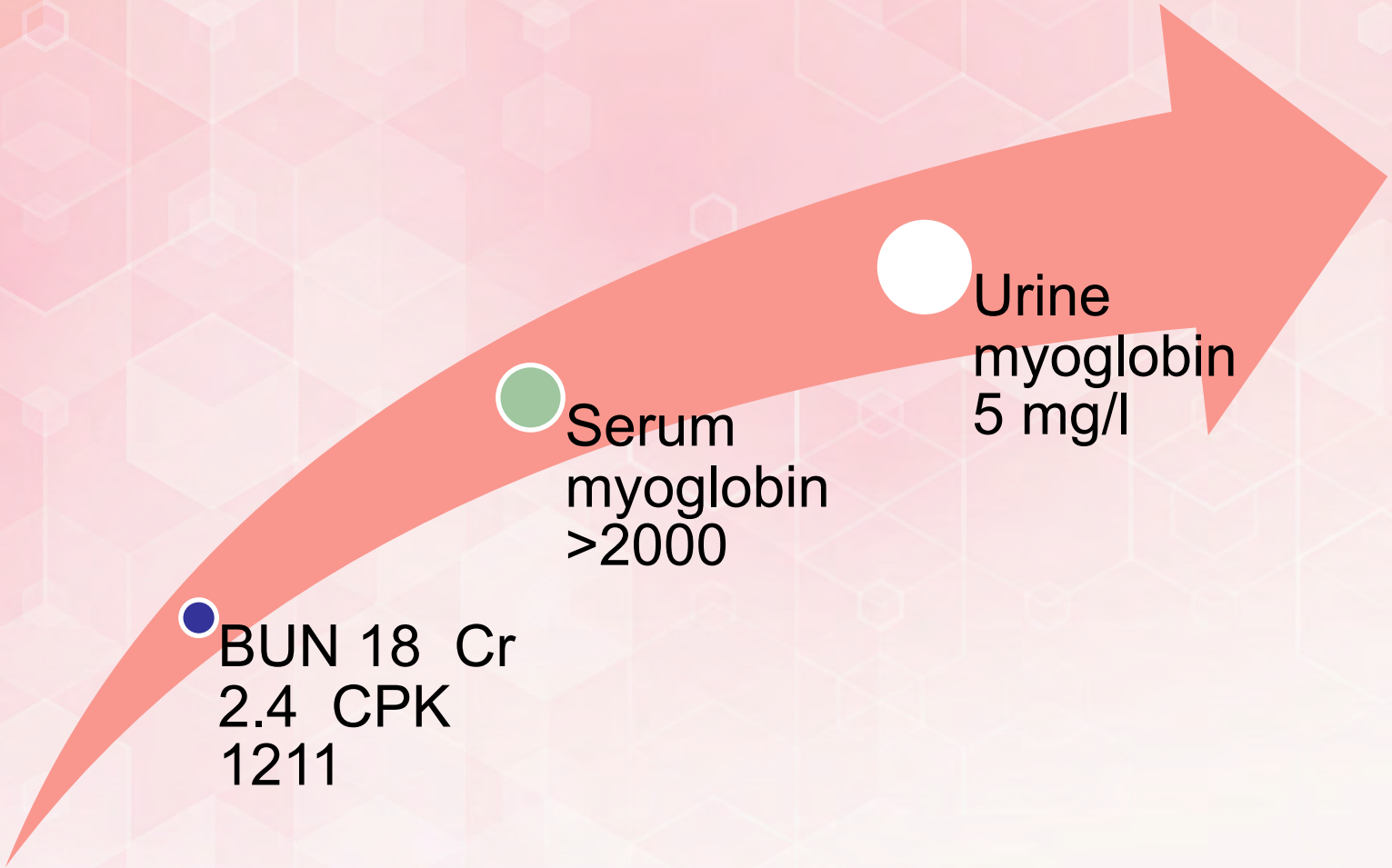
Propofol Infusion Syndrome (PRIS)

- Adverse drug event with high doses
- Not recommended for infusions > 48 hrs
- Signs of PRIS: hyperkalemia, metabolic acidosis, lipemia, renal failure, cardiovascular collapse, hepatomegaly, rhabdomyolysis

Case Study

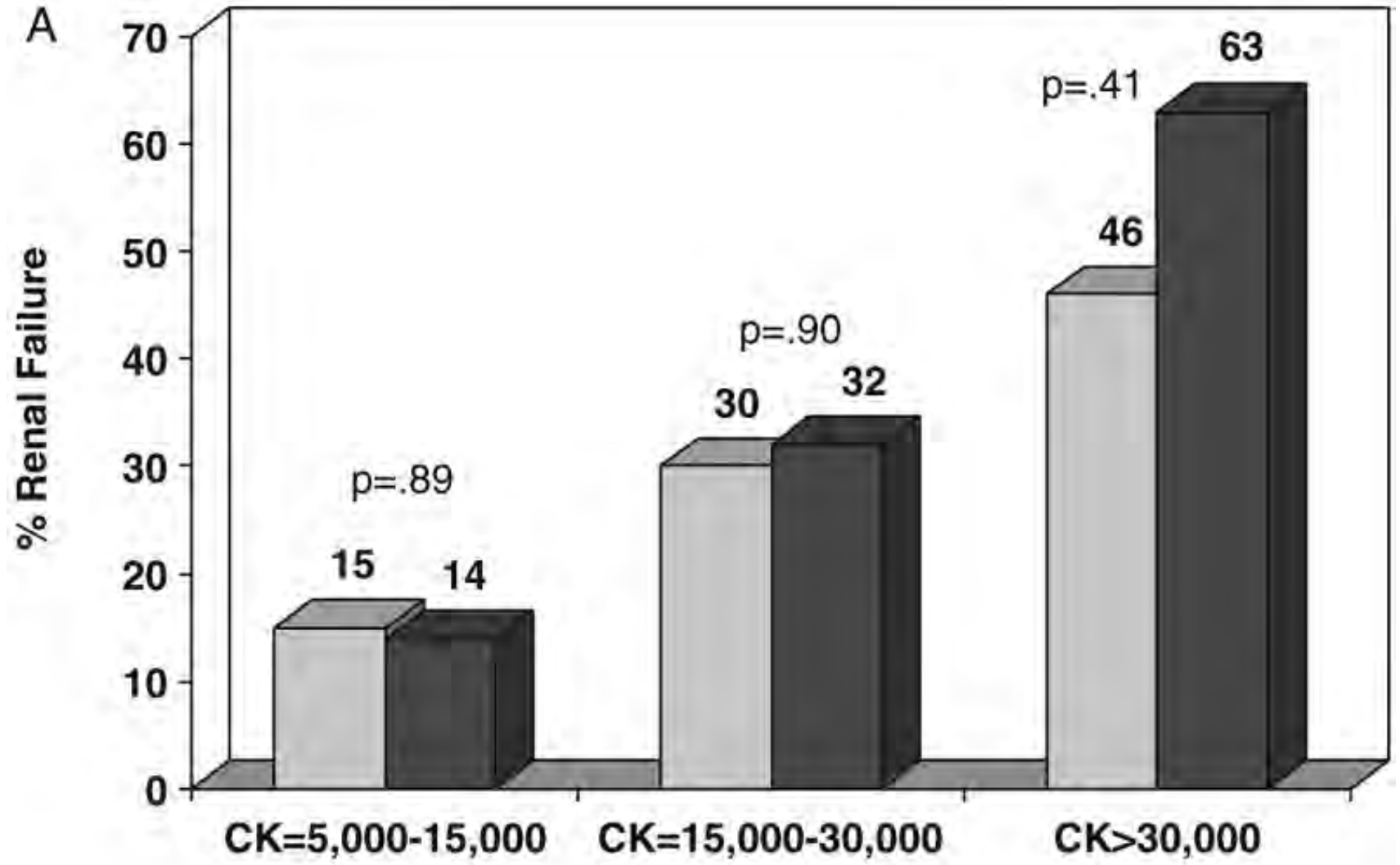
- 18 year old dirt bike vs. car crash
- Previous MVC 12 months ago
  - SVC filter and ORIF left femur
  - On coumadin, nephrogenic DI
  - Hypertrophied bladder, frequent UTI and chronic renal failure
- This admission has fx right femur and bladder rupture along with left ankle injury and closed head injury

Admission Labs



Diagnosis

- Precipitating factor
- Serum myoglobin
- Urine myoglobin >15 mg/l
- +heme in absence of RBC in yellow urine
- CPK >5000 u/l incidence of ARF becomes significant



(Sahjian & Frakes, 2007)

Hospital Course

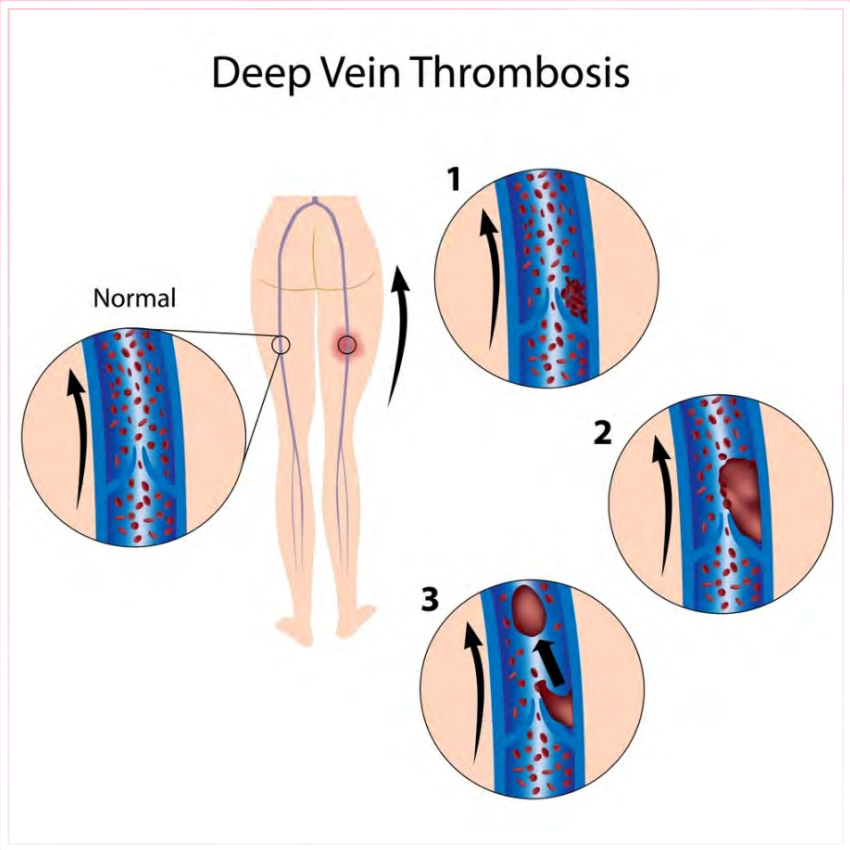
- PTD 2 BUN 29 Cr 4.5 CPK 5807
- Urine myoglobin 5
- Dialysis begins
- Dialyzed (RRT)
- By PTD 15 creatinine is 1.5
- Discharged on PTD 31

Early Dialysis

- ARF pts who require RRT have increased morbidity and mortality
- Averting continued rises in creatinine might improve outcome in critically injured trauma patients

Deep Vein Thrombosis

- Incidence
- Signs
- Diagnosis
- Prophylaxis



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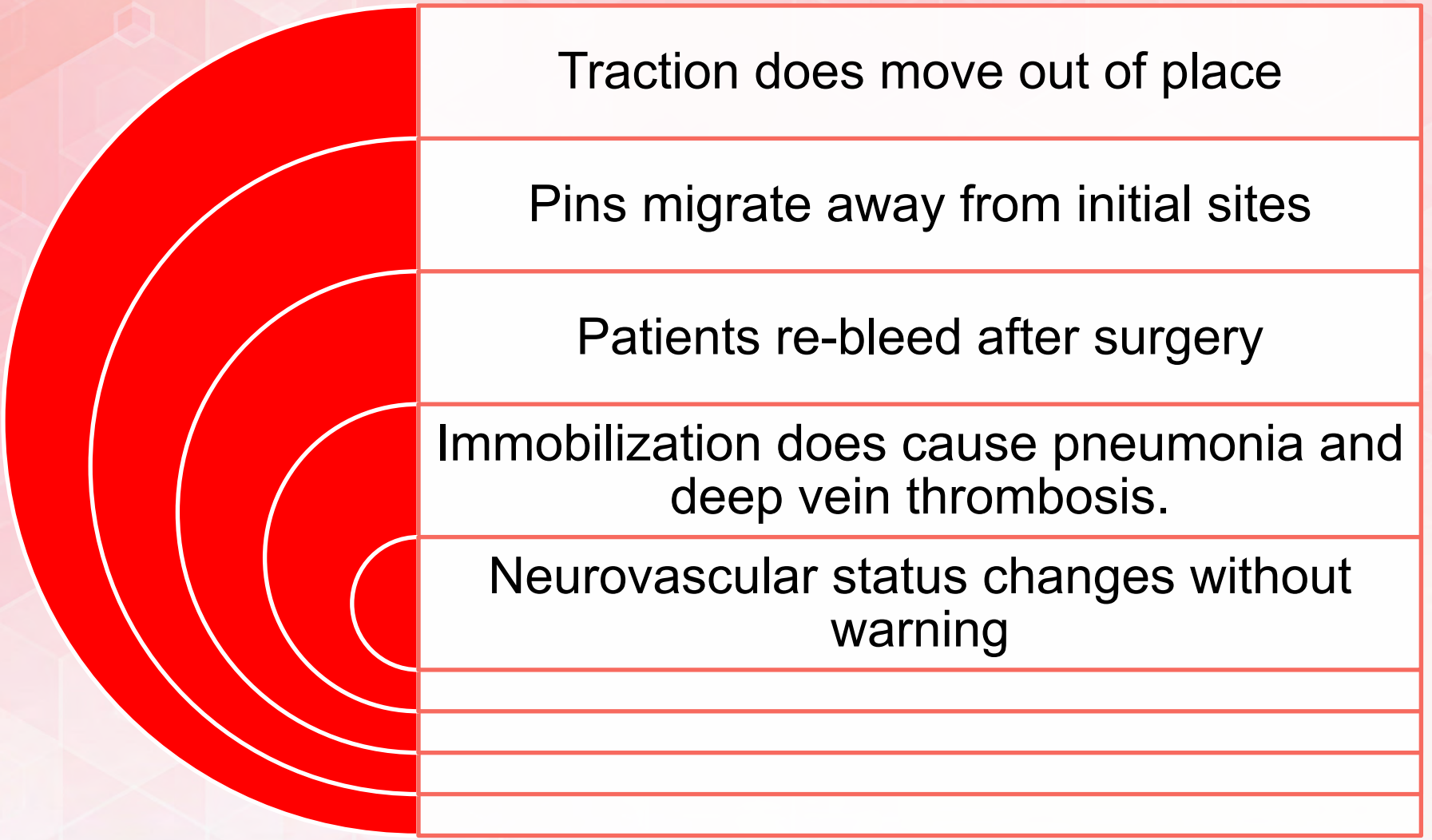
Ongoing Assessments



Summary

- Trauma care begins with standard process for care and destination protocol for pre-hospital personnel
- The initial management of the patient consists of a thorough assessment of the type and degree of injury, and the need for damage control surgery to maintain homeostasis
- Pain management is a critical aspect in the care of the patient with musculoskeletal injury

Summary continued…

- The trauma nurse must be familiar with the types of radiographic studies performed and the need for follow studies in certain situations
- Multi-orthopedic injuries require different treatment strategies: traction, and open or closed reduction
- The nurse must identify limb-threatening compartment syndrome and patients at risk for rhabdomyolysis
- The nurse must protect the patient from infection, which may progress to osteomyelitis

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TRAUMA LECTURES

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Soft Tissue Injuries

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Objectives

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

- Define the major phases of wound healing
- Identify host determinants of wound healing
- Describe surgical and non surgical treatments of soft tissue injuries

Incidence

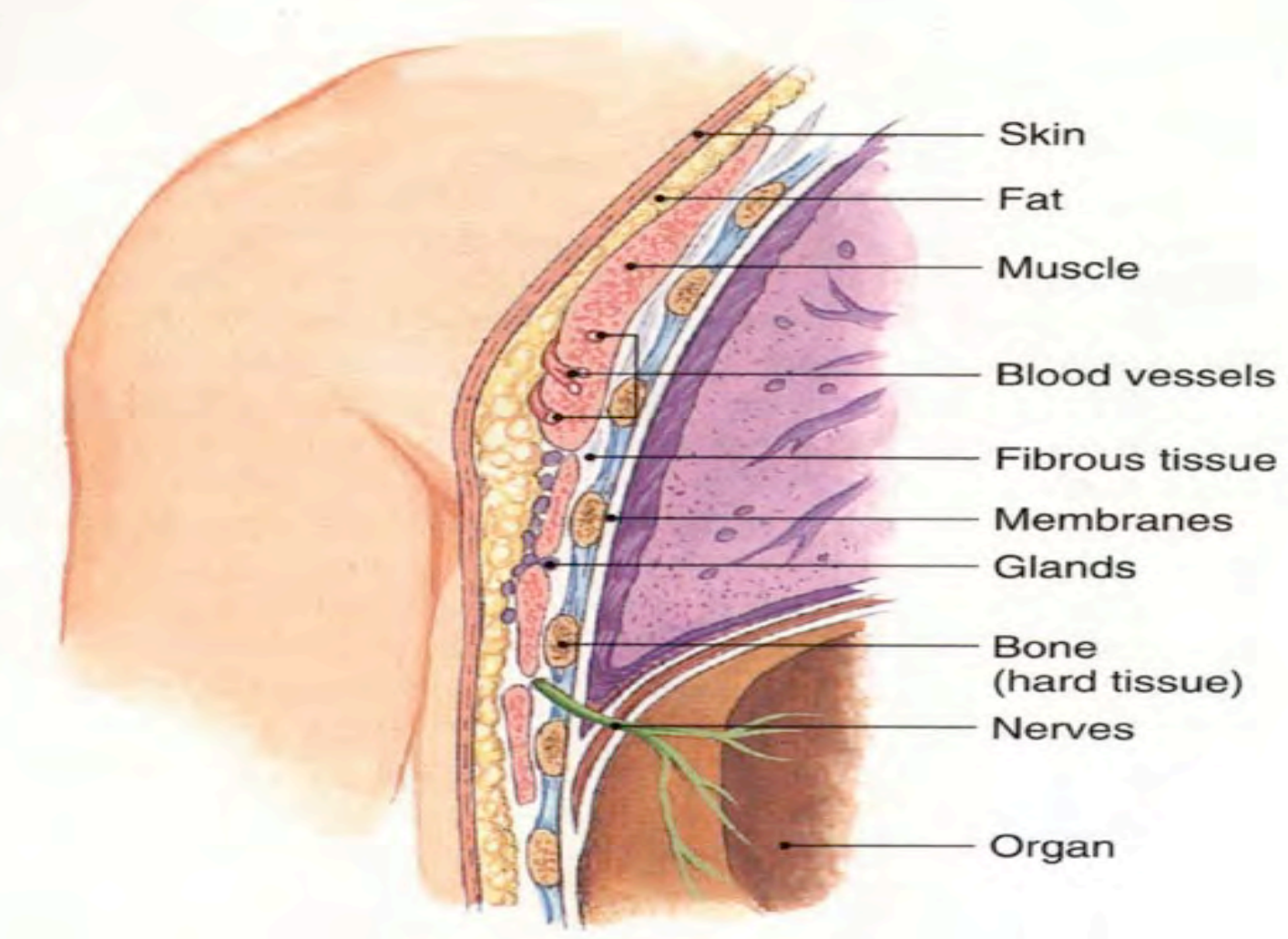
- Wounds account for more than 10% of all ED visits
- Skin first line of defense, therefore, prone to injury

Mechanism of Injury

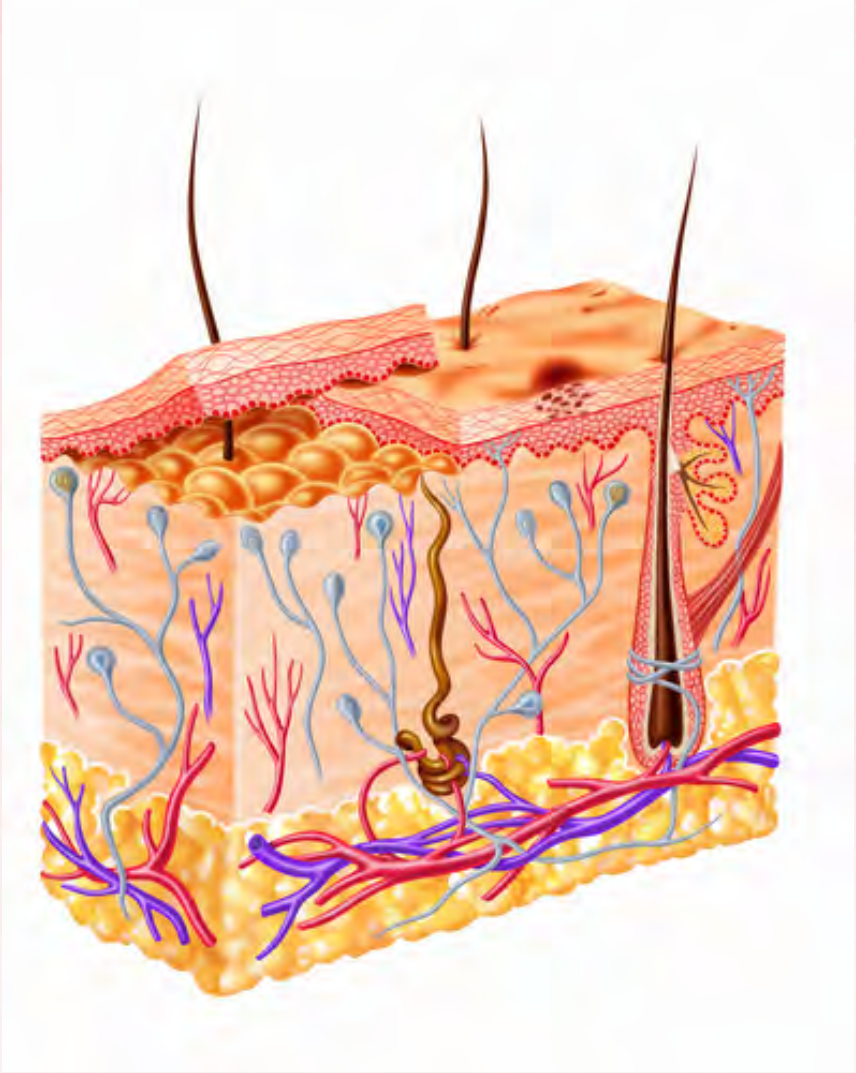
Special Considerations

- Tissue Injury Common - blunt & penetrating
- Injury Environment - dirt, debris, ditch water
- Occupational Injury - chemical exposure
- Foreign Body Risk - ex motorcycle road rash
- Bite Injuries - highly infectious
- Pressure Injection Injuries- surgical emergency
- Compression injuries - high risk for necrosis

Soft Tissue Layers



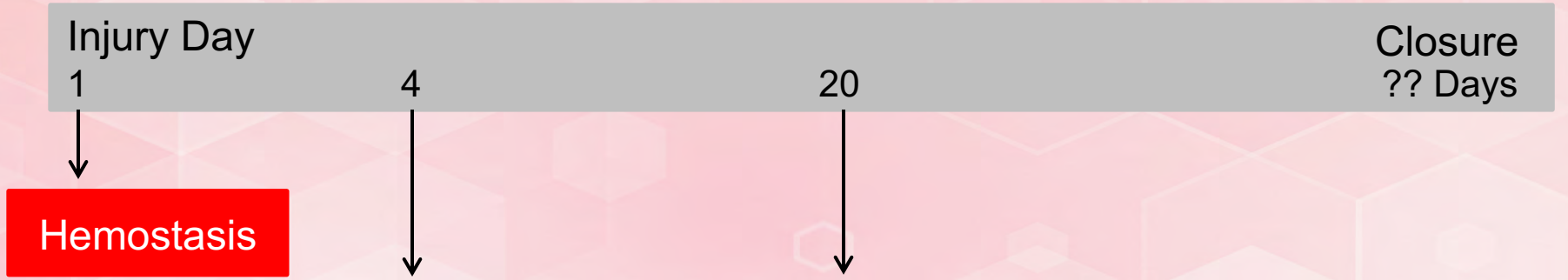
Soft Tissue Anatomy



Soft Tissue Functions

Skin	**Barrier** **Thermal regulation** **Homeostasis**
Subcutaneous Tissue	Adipose - thermal regulation & shock absorption Wound Healing
Muscles	Mobility Highly Vascular High metabolism
Nerves	Afferent = sensation Efferent = action
Blood Vessels	Nutrient & gas exchange

Phases of Wound Healing



Inflammation

- Neutrophils secrete chemicals to kill bacteria
- Macrophages engulf and digest foreign particles and necrotic debris
- Macrophages release engiogenic substances to stimulate capillary growth

Proliferation

- Fibroblasts proliferate in the wound and secrete glycoprotein & collagen
- Epidermal cells migrate from the wound edge
- Granulation tissue is formed from macrophages, fibroblasts & new capillaries

Remodeling

- Fibroblasts secrete collagen to strengthen wound
- Wound remodeling occurs to reorganize fibers
- Wound contracts increasing tissue integrity
- Epidermal cells grow over connective tissue to close wound

Wound Healing – By Intention

Primary Intention	Clean wound with limited tissue loss Wounds edges easily approximated Classic surgical wound closure Using suture, staples, adhesive tape
Secondary Intention	Large tissue loss / heavy contamination Wound cleaned & left open to granulate Surgeon may pack & place drain Wound care q day promotes granulation
Tertiary Intention	Also called: Delayed primary closure Often used with heavy bacteria counts Wound is cleaned, debrided, left open Typically 4-5 days-then surgical closure

Determinants of Wound Healing

Severe Anemia	Oxygen is transported primarily by hemoglobin: • Severe anemia defined as: Hematocrit of 15 –18% • *Impairs wound healing*
Nutritional Status	Inadequate nutrition is associated with: • Impaired healing • Impaired collagen formation • Delayed development of wound tensile strength • Increased risk of infection

Determinants of Wound Healing

Age	Aging skin associated with : • Slower cellular activity •↓ Elastin fibers •↓ Dermal thickness
Perfusion	Decreased perfusion noted in trauma: • Vasoconstriction • Shock states • Excessive catecholamine release • Hypothermia

Determinants of Wound Healing

Temperature	Hypothermia •Vasoconstriction → impaired healing •Leukocyte activity inhibited •Associated with ↑ wound infections
Smoking	Peripheral vasoconstriction ↓ tissue oxygenation ↑ platelet aggregation ↑ blood viscosity ↓ collagen deposition *Significantly impairs wound healing*

Determinants of Wound Healing

Pain	↑ sympathetic nervous system ↑ catecholamines and vasomotor tone Vasoconstriction, ↓ tissue oxygen tension Cortisol is released ↓ collagen synthesis
Stress	Physical Stress: • Can precipitate wound separation Psychological Stress: • Evokes neuroendocrine response • ↑ sympathetic nervous system • ↓ tissue oxygen tension & perfusion

Determinants of Wound Healing

Pre-existing Disease	Diseases which compromise wound healing include: • Vascular diseases • Immune disease • Malnutrition states • Diabetes • Keep serum glucose < 150 mg/dl
Healing Response to Past Injury	• Keloids (hypertrophic scarring) • Genetic predisposition • More in dark skinned individuals

Initial Assessment

Soft Tissue Injuries

- Rarely life-threatening alone
- Always start with ABCDEs
- Do not be distracted by the wound or injury before addressing the ABCDEs

Controlling External Bleeding

- Direct pressure
- Elevate the wound
- Pressure points
- Tourniquets

Stop the Bleed

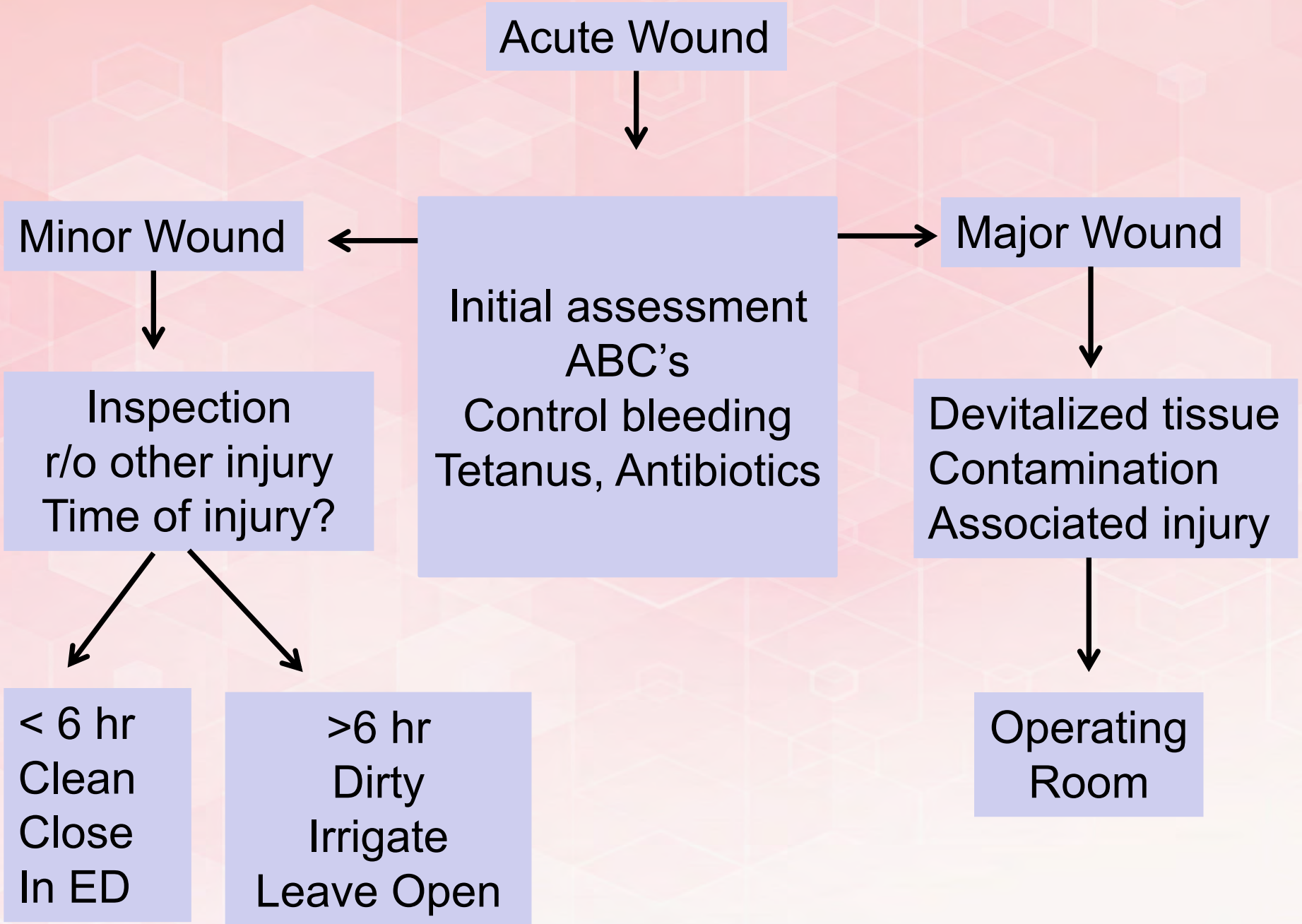
- Launched in 2015 by the federal government in collaboration with the American College of Surgeons and others, *Stop the Bleed* is a national awareness campaign and a call to action.
- *Stop the Bleed* is intended to cultivate grassroots efforts that encourage bystanders to become trained, equipped, and empowered to help in a bleeding emergency before EMS

https://www.bleedingcontrol.org/

Stop the Bleed

- For more information on *Stop the Bleed* or to find out how you can help spread the word, please visit: https://www.bleedingcontrol.org/

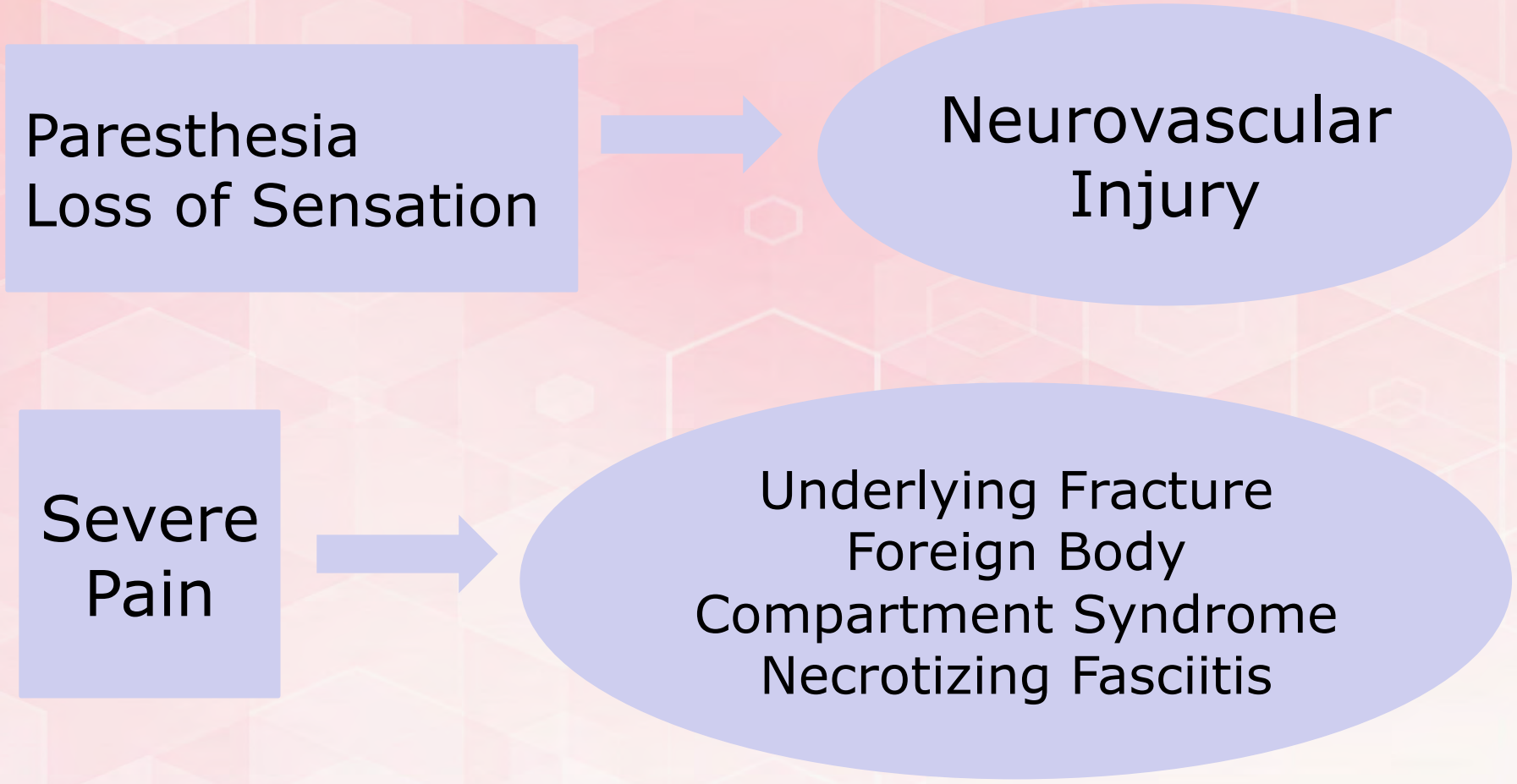
STOP
THE BLEED


Acute Wound
Initial assessment
ABC's
Control bleeding
Tetanus, Antibiotics
Minor Wound
Inspection
r/o other injury
Time of injury?
< 6 hr
Clean
Close
In ED
>6 hr
Dirty
Irrigate
Leave Open
Major Wound
Devitalized tissue
Contamination
Associated injury
Operating
Room

Assessment

- Medical history
- Time of injury
- Allergy history
  - Antibiotics
  - Latex
  - Local anesthetics
- Tetanus history
- Occupation
- Hand dominance

Patient Symptoms



Physical Examination

- ✓ Hemostasis
- ✓ Local anesthesia
- ✓ Size/Depth
- ✓ Location
- ✓ Circulation
- ✓ Nerve function
- ✓ Motor function
- ✓ Injury to underlying structures

Time of Injury to Closure

- Wound infection risk increases with increased time from injury to repair
  - **6-8 hours** acceptable
- Clean face lacerations
  - Can close up to 24 hrs post injury

Injury Location Significance

Face/neck:

- Greater blood flow (lower infection risk)

Lower extremities

- Less blood flow (infection prone)

Wounds involving

tendons, joints, bone

- Infection prone

Anesthesia

Local

- Infiltration into wound

Field Block Method

- Inject through intact skin at wound edge
- Preferred for grossly contaminated wounds

Regional Nerve Block

- Smaller volume required
- Less tissue distortion
- Used for digit lacerations

Topical Anesthetic For Wounds

- **LET (gold standard)**
  - **L**idocaine 4%
  - **E**pinephrine 0.1%
  - **T**etracaine 0.5%
- **Solution or Gel**
  - Saturated gauze on wound
  - 15-30 minutes
- **Avoid**
  - Eyes/Mucous membranes
  - End-arteriolar areas-digits

- **Ideal for lacerations**:
  - Small & superficial
  - Scalp and face
- **Advantages:**
  - No pain of injection
  - No tissue swelling
  - Minimize bleeding
  - Safe

Topical Anesthetics For Intact Skin

- **Uses:**
  - Venipuncture
  - Minor procedures
- **Forms:**
  - Gels, sprays, creams, patches
- **Onset Time:**
  - Varies by product
  - Short as 5 minutes
  - Long as 60 minutes

Some Examples:

- Eutectic Mixture of Local Anesthetics (EMLA)
  - Lidocaine & Prilocaine
  - 60 minutes to onset
- Liposomal Lidocaine
  - ELA-Max or LMX4
  - 30 minutes to onset
- Lidocaine/Tetracaine patch
  - Syntegra (20 minute onset)

Irrigation

- Highly effective cleaning
- Pressure more important than volume
- Sterile saline common
- Tap water as effective
- Avoid providone-iodine, hydrogen peroxide, or detergents (tissue toxic)

Initial Debridement

- Removing devitalized tissue
- Pressure irrigation preferred
- Mechanical debridement if necessary
- Caution if extent of tissue devitalization unknown:
  - Wait and see approach

Hair Removal

- Pros and Cons
- Removal to ease wound closure
- Others advocate presence of hair to assist guiding edge approximation
- Avoid eyebrow removal
    - Inconsistent regrowth

Foreign Body

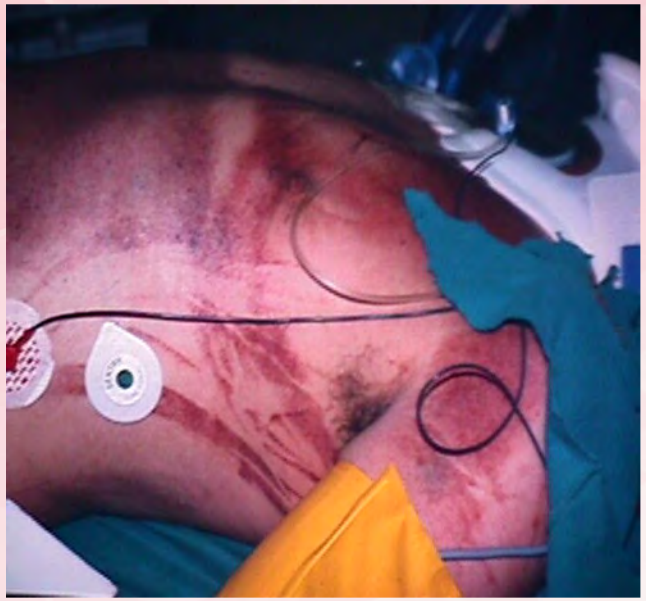
- Retained foreign body
  - Inflammation/Infection
  - Delayed wound healing
  - Loss of function
- Litigation if missed
- X-ray /CT helpful
- Most difficult to identify
  - Small glass
  - Plastic
  - Wood

Closed Injuries (skin intact)

- **Contusion**
  - Epidermis intact
  - Swelling and pain

- **Hematoma**
  - Blood collection under skin
  - Larger tissue damage

Abrasion



Contusion

Hematoma

Laceration

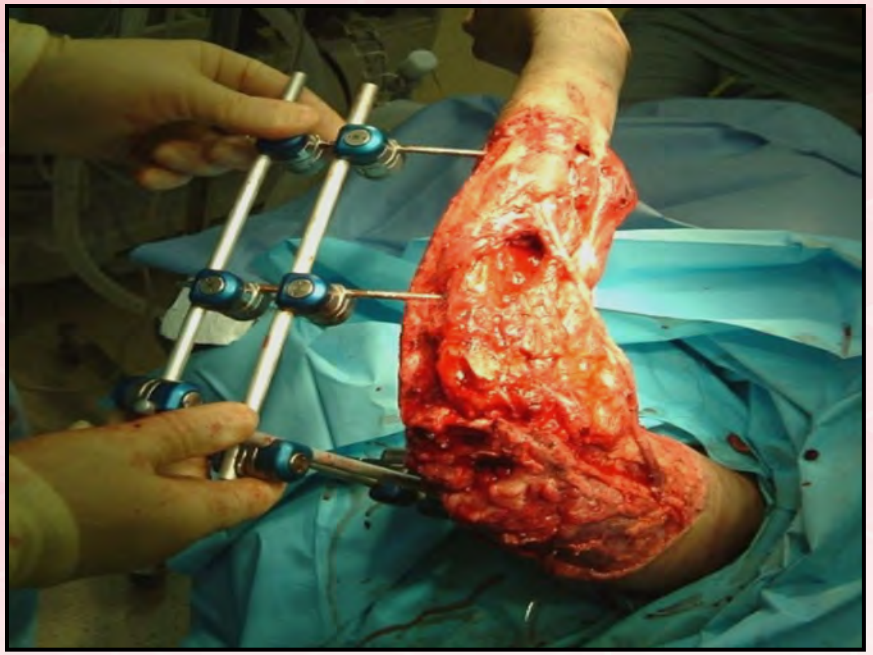
- Vary in depth:
  - Superficial
  - Deep tissue
- Vary in appearance:
  - Linear (regular)
  - Stellate (irregular)
- Assess
  - Underlying damage
  - Contamination
  - Foreign bodies

Avulsion

- Tearing, stretching mechanism
- Full thickness loss of tissue; wound edges cannot be approximated
- Assess degree of injury, underlying damage

Degloving

- Type of avulsion
- Shearing mechanism
- Assess degree of tissue loss, underlying injury



Puncture Wounds

- Small external opening, deep tissue penetration
- High risk for infection/ contamination
- Check tetanus status

Bite Wounds

- Infection Risk:
  - Human > Animal
  - Cats > Dogs
- Assess:
  - Tetanus status
  - Rabies risk
- Treatment:
  - Elevate area
  - Incision & drainage
  - Antibiotics

High Pressure Injection Injuries

- Potentially devastating
  - Prompt surgical debridement
  - Extremity – risk for amputation
- Damage results from:
  - Impact
  - Ischemia due to swelling
  - Chemical inflammation
  - Secondary infection

Wound Treatment General Concepts

No single treatment for entire healing process

- Antibiotics
- Debridement
- Dressings
- Surgical Closure
- Skin Grafts
- Skin Flaps
- Nutritional Support

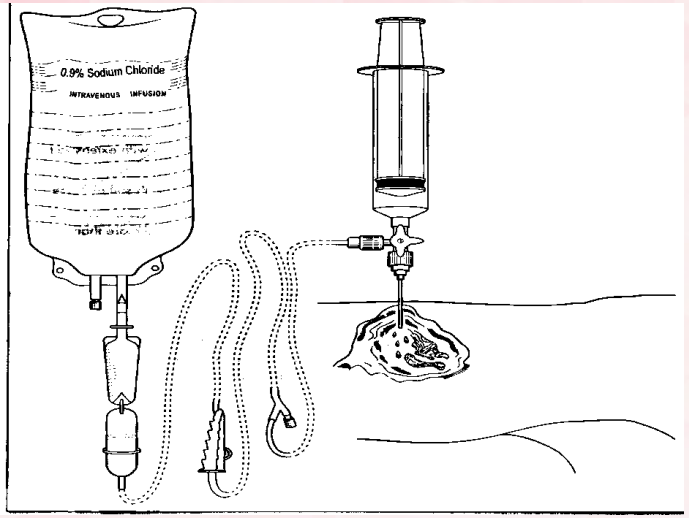
Which Wounds Need Antibiotics?

- Highly contaminated wounds
- Human & animal bites
- Crush Injuries
- Stellate lacerations
- Puncture Wounds
- Intraoral Lacerations
- Wounds over open fractures, exposed joint and tendons

Mechanical Debridement

Types:

- Wet to dry dressings
- Hydrotherapy
- Wound Irrigation



- More painful than other methods
- May require specialized equipment
- Nonselective
- May lead to bleeding, trauma

Surgical Debridement

- Use of scalpel, scissors or lasers to remove dead tissue
  - Gold standard of debridement
  - May require serial treatments
  - Dependent on practitioner expertise

Dressings

Type	Advantages / Considerations
Transparent 	-transmits moisture vapor; semipermeable to gases -no absorption capability -provides protection from friction -aids in autolytic debridement
Hydrocolloid 	-impermeable to gases and water vapor -provides moist environment -excessive granulation and maceration can occur
Hydrogel 	-water in a gel form -facilitates autolysis and removal of devitalized tissue -hydrates dry wound beds -may require daily changes

Dressings

Type	Advantages / Considerations
Foam 	-highly absorbent, used in moderate to heavy exudate -permeable to gases and water vapor -can be used on infected wounds if changed daily -available with ionic silver
Calcium alginate 	-absorbent, non-adherent, biodegradable -forms a soluble alginate gel when in contact with wound drainage promoting moist wound bed -available in various sizes -requires a secondary dressing
Hydrofiber 	-forms a gel when interacts with wound fluid -maintains a moist environment -requires a secondary dressing -should not be used on dry wound or heavy bleeding

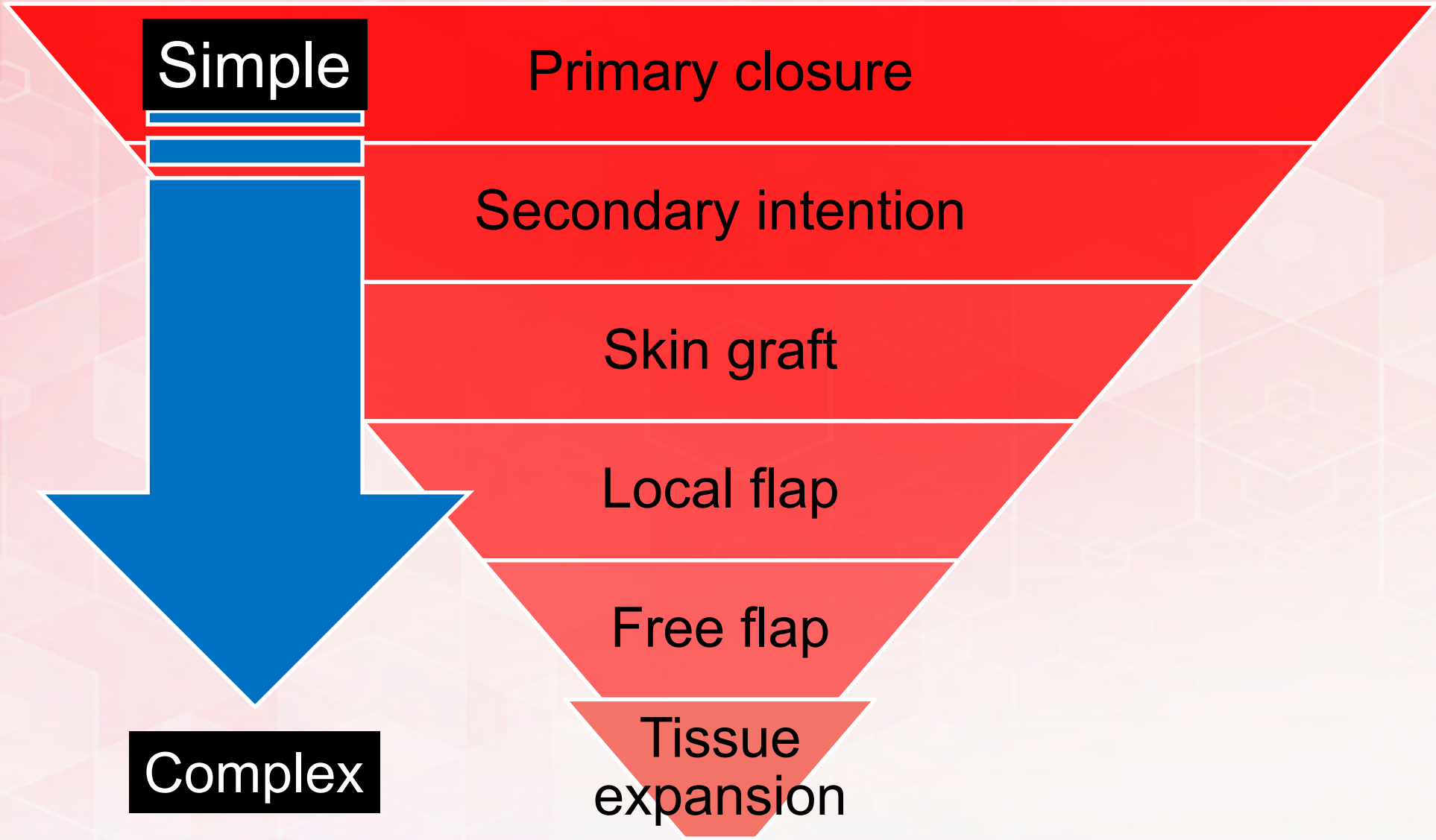
Dressings

Type	Advantages / Considerations
Collagen 	-highly absorptive, hydrophilic (contains bovine) -can be used on granulating or necrotic wounds -changed every 7 days (daily if infected) -requires a secondary dressing
Composite 	-a combination of materials make up a single dressing -may adhere to wound bed: remove with caution -may be used on infected wounds -may facilitate autolytic debridement
Contact Layer 	-low adherence material of woven net -acts as a protective layer between wound and secondary dressing -used with ointments or other topical agents -not recommended for dry wounds or third-degree burns

Dressings

Type	Advantages / Considerations
Gauze 	• can be used as packing, primary or secondary dressing • does not provide moist wound environment • may traumatize wound bed upon removal • requires frequent changes
Antimicrobial 	• provides antimicrobial effect against bacteria • available in a variety of forms (transparent, foam, fillers) • some may remain in place for 7 days • does not replace need for systemic antibiotics

Reconstructive Ladder: Surgical Wound Coverage



Surgical Interventions

Wound Closure

- Primary
  - Minimal tissue loss
  - Edges well approximated
- Secondary
  - Wound granulates and closes on its own
  - Larger scar
- Tertiary
  - Used with contaminated wounds

Skin Graft

Indications

- Permanent replacement for missing or damaged skin
- Temporary wound covering to protect against infection.
- Reconstruction for extensive wounds
- Closure of extensive wounds

Full Thickness Grafts for Extensive Tissue Loss

Flaps

Local Flap:

- Tissue rotated to adjacent area but retains original blood supply
- Used when tissue “bulk” is needed to fill contour defects

Free flap:

- Tissue from one area detached and transplanted to another
- Blood supply then surgically reconnected to blood vessels adjacent to the wound

Flap Coverage of the Elbow: Latissimus Dorsi Local Transfer Flap

Negative Pressure Wound Therapy

Wound VAC

- Temporary management
- Removes fluid from extravascular space
- Reduced edema
- Improves microcirculation
- Enhances proliferation of granulation tissue
- Open cell polyurethane foam dressing ensures an even distribution

Injury Impact on Nutrition

- Energy Expenditure
- Protein & Amino Acid Requirements
- Metabolic Demand

Essential Nutrients for Wound Healing

- Calories
- Carbohydrates
- Protein
- Fats
- Vitamin A
- Vitamin C
- Zinc
- Water

Summary

- Meticulous care of soft tissue injuries can have a tremendous impact on patient outcomes
- Utilization of appropriate measures during each phase of the healing process can prevent complications and promote normal healing process of soft tissues injuries

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Chapter 5 - Traumatic Brain Injury Test Questions

1. A trauma patient presents s/p assault to the head with LOC. Patient is mumbling and incoherent, eyes open to painful stimuli and withdraws to pain. What is the next step for this patient?

    a. Call a Neurosurgical consult
    b. Given one amp of IV dextrose
    c. Prepare for intubation
    d. Give valium 5mg IV

2. How do you assess that the above ventilation rate is in a safe range for a TBI patient and is not causing secondary injury?

    a. Capnometer
    b. Capnography
    c. Pulse Oximetry
    d. Serial ABG's

3. Hyperventilation in severe TBI patients causes:

    a. Increase in delivery of oxygen to damaged brain tissue
    b. Manages metabolic acidosis thus assisting with oxygen delivery
    c. Cerebral vasodilation and increases cerebral perfusion
    d. Cerebral vasoconstriction and reduced cerebral perfusion

4. The recommended range for PCO2 in a patient with a severe traumatic brain injury is:

    a. 10-15mmHg
    b. 30-40 mmHg
    c. 25-35mmHg
    d. 35-45mmHg

5. During transport of a traumatic brain injured patient who is intubated and on a ventilator, the pulse oximeter shows 97% and the ETCO2 shows 26. You would:

    a. Reduce the ventilator rate slightly until I reach my goal
    b. Leave things alone – everything is o.k.
    c. Increase the ventilator rate slightly until I reach my goal
    d. Reduce the tidal volume slightly until I reach my goal

6. A patient presents s/p fall with a head injury. On arrival his eyes open to painful stimuli, he is confused and withdraws to pain. What is the GCS for the patient?

    a. 7
    b. 9
    c. 10
    d. 11

7. The severity of head injury for this patient would be classified as

    a. Severe
    b. Moderate
    c. Mild
    d. Concussion

8. Normal ICP ranges are

    a. 1-20mmHg
    b. 0-5mmHg
    c. 25-35mmHg
    d. 0-15mmHg

9. The Monroe Kellie doctrine describes

    a. Cerebral perfusion
    b. Pressure volume relationship within the intracranial cavity
    c. Physiological electrical function of the brain cells
    d. Classification of injury

10. The most prevalent traumatic brain injury is

    a. Minimal
    b. Mild
    c. Moderate
    d. Severe

Chapter 5 - Traumatic Brain Injury Answer Key

1. c
2. b
3. d
4. d
5. a
6. c
7. b
8. d
9. b
10. b

Chapter 6 - Maxillofacial and Ocular Injuries Test Questions

1. A common complication of nasal fractures that must be urgently treated is:

    a. Loss of sense of smell
    b. Septal hematoma
    c. Periorbital edema
    d. Subcutaneous edema

2. A patient presents to the emergency department after being assaulted in the face. He has periorbital edema of the right eye and enophthalmos. Patient teaching for this patient would include:

    a. Avoid blowing the nose
    b. An eye patch should be worn for at least 1 week
    c. Cycloplegic drops will be necessary to prevent glaucoma
    d. Surgical management will be required

3. Cribriform plate fractures are commonly associated with:

    a. LeFort I fractures
    b. LeFort II fractures
    c. LeFort III fractures
    d. Mandible fractures

4. A patient presents to the emergency department after having lye splashed in his eyes. Irrigation of the eye should continue until:

    a. Two liters have been instilled
    b. The pH reaches 6.8
    c. All evidence of burned tissue has been washed away
    d. The pH reaches 7.3

5. The normal intraocular pressure is:

    a. 30 mmHg
    b. 25 mmHg
    c. 5 mmHg
    d. 20 mmHg

6. A 24-yr-old male is brought to the trauma room after a high-speed motor vehicle collision with obvious trauma to the left side of his face. He has ptosis of the left eye and a palpable deformity of the left zygoma. His airway is patent and he is receiving supplemental oxygen. Upon further examination you note the left side of his face appears to have a "droop." Based on this assessment finding, you anticipate:

    a. An injury to cranial nerve V
    b. An injury to cranial nerve VII
    c. An injury to cranial nerve III
    d. An injury to cranial nerve IV

7. A 32-year old female presents to the trauma room after being shot in the face with a small caliber handgun. There is a wound inferior to the right zygomatic arch. She is complaining of diminished vision in the right eye. A ruptured globe is suspected. Anticipated assessment findings include:

    a. Complete blindness, bleeding from the eye and inability to open the eye
    b. Bleeding into the anterior chamber and proptosis
    c. Asymmetry of the globes, teardrop shaped pupil and diminished vision
    d. Elevated intraocular pressure, diminished vision and extreme pain

8. A patient with a mandible fracture will likely complain of:

    a. Inability to swallow and abnormal taste
    b. Paresthesias of the tongue and upper lips
    c. Malocclusion and paresthesias of the lower lip and chin
    d. Trismus

Chapter 6 - Maxillofacial Trauma Answer Key

1. b
2. a
3. c
4. d
5. d
6. b
7. c
8. c

Chapter 7 - Spinal Column and Spinal Cord Injuries Test Questions

1. Spinal cord injury is significant in the United States because:

   a. Despite low incidence, it carries a high economic burden
   b. Primarily is the result of a violent event
   c. Reduced life expectancy is common
   d. It primarily occurs in older persons

2. The Autonomic Nervous System (ANS) is important in acute spinal cord injury because:

   a. The parasympathetic branch is disrupted producing neurogenic shock
   b. The sympathetic branch is disrupted producing neurogenic shock
   c. The hypothalamus is injured producing neurogenic shock
   d. The ANS is not important because it is part of the peripheral nervous system

3. The five major mechanisms of injury are:

   a. Flexion, extension, axial loading, distraction, and laceration
   b. Concussion, flexion, extension, rotation, and penetration
   c. Flexion, extension, axial loading, rotation and penetration
   d. Flexion, extension, concussion, distraction, and penetration

4. Central cord syndrome is:

   a. A result of forces producing an injury in the periphery of the spinal cord
   b. Most commonly occurs in older persons with degenerative changes of the cervical spine
   c. Characterized by a disproportionate loss of lower extremity versus upper extremity function
   d. Most often associated with penetrating injuries

5. The sensorimotor exam is performed:

   a. To evaluate function of the lateral corticospinal, the lateral reticulospinal, and the lateral spinothalamic tracts
   b. To assess sensory and motor function and strength bilaterally
   c. Upon admission only to help localize level of injury
   d. Routinely to assist patient's in recognizing the extent of their injury

6. The cardiovascular consequences of neurogenic shock include:

a. Hypertension, tachycardia, and hyperthermia
b. Hypotension, bradycardia, and hypothermia
c. Hypotension, tachycardia, and hyperthermia
d. Hypertension, bradycardia, and hyperthermia

7. The signs and symptoms of autonomic dysreflexia include:

a. Hypotension, tachycardia, sweating, and pallor
b. Hypertension, bradycardia, pallor, and flushing
c. Hypertension, tachycardia, flushing, and hyperventilation
d. Hypotension, tachycardia, pallor, and goosebumps

8. Frequent respiratory assessment is important in acute spinal cord injury because:

a. Loss of defensive respiratory muscles places them at high risk for respiratory failure
b. Arterial blood gas results can be inaccurate in these patients
c. They frequently develop phrenic innervation, which can be worsened by the use of steroids
d. It is the third leading cause of death for quadriplegic patients

9. Which of the following statements is true regarding acute spinal cord injury and deep venous thrombosis?

a. Infrequently at risk for DVT
b. Patients are at greatest risk the first two weeks post-injury
c. Prophylaxis need only be managed with anti-coagulation
d. All patients must have a prophylactic vena cava filter placed

10. Gastrointestinal management of a patient with an acute spinal cord injury should include:

a. Gastric decompression, steroids, and gastric prophylaxis
b. Gastric decompression, steroids, and bowel stimulants
c. Gastric decompression, delayed nutrition due to risk of ileus, and bowel stimulants
d. Gastric decompression, gastric prophylaxis, early enteral feedings, and bowel stimulants

11. Unopposed vagal outflow places the acute spinal cord injured patient at greater risk for ulcer formation.

a. True
b. False

12. Which of the following statements are true regarding bladder management of the acute spinal cord injured patient?

a. Initial management avoids placement of an indwelling catheter
b. Bladder management is dependent upon level of injury, lifestyle, and gender
c. Urinary tract infections are an infrequent complication for SCI patients
d. 4000 ml/day fluid ingestion is encouraged during bladder training

13. A urinary tract infection (UTI) is definitively diagnosed by the presence of bacteriuria in SCI patients.

a. True
b. False

14. Musculoskeletal implications of spinal cord injury include:

a. Flaccidity, spasticity, and increased bone density
b. Spasticity, heterotopic ossification, and contractures
c. Heterotopic ossification, contractures and increased bone density
d. Flaccidity, contractures, and increased bone density

15. In acute spinal cord injury, pain is:

a. Not an issue due to the loss of sensation
b. Should be treated with long-acting medications
c. Is frequently exacerbated by fear and anxiety
d. Should not be treated to preserve exam

16. Chronic pain is a significant issue for spinal cord injured patients because:

a. It may enhance ability to perform ADLs
b. Medication side effects are imagined
c. It diminishes the quality of life
d. It is not “real” pain

17. Which of the following statements regarding sexual function of the cervical spinal cord injured person is true?

a. Persons retain their psychogenic abilities
b. Females cannot experience normal fertility and pregnancy
c. Most males can achieve erection, but will not experience reflexive ejaculation
d. The physical act of intercourse remains impossible for most individuals

Chapter 7 - Spinal Column and Spinal Cord Injuries Answer Key

1. a
2. b
3. c
4. b
5. b
6. b
7. b
8. a
9. b
10. d
11. a
12. b
13. b
14. b
15. c
16. c
17. c

Chapter 8 – Neck Trauma Test Questions

1. Mr. R. has sustained a stab wound to the neck in Zone 1. Name three anatomic structures that could potentially be injured in Zone 1 of the neck.

    a. _____
    b. _____
    c. _____

2. Ms. K, a 23 year old female has been in a car crash. She was unrestrained and struck the steering wheel with her neck. She arrives with stridor, drooling, and hoarseness. Answer the following questions:

    a. What is the most likely structure(s) to have been injured by this mechanism? _____.
    b. What is the most likely impending life threatening condition? _____.

3. Mr. S. is a 30 y/o male in a car crash with a seatbelt mark across his neck. He arrives with a GCS of 3 and is already intubated. His brain CT does not show any abnormality. Over the next 48 hours, his neurologic status does not improve.

    a. What is the possible injury that was missed by the trauma team?_____.
    b. What is the "appropriate" diagnostic study to use in the above case?_____.

4. The majority of neck trauma is a result of blunt trauma (True or False?)

    a. True
    b. False

5. Which injury pattern(s) would have a high risk of airway compromise?
    a. Tracheal injury
    b. Expanding hematoma in neck
    c. Mandibular fracture
    d. All of the above

6. The Eastern Association for the Surgery of Trauma (EAST) penetrating neck trauma guideline mandates that all penetrating injuries to the Zone II region of the neck MUST be explored in the operating room.

    a. True
    b. False

7. Why is it imperative to identify esophageal injuries within the first 24 hours?_____.

8. What is the thick, fibrous muscle sheath over the neck that, if violated, indicates that the patient has a higher risk for serious injury?

    a. The sternocleidomastoid muscle
    b. The trapezius muscle
    c. The platysma

9. Which of the following physical findings are specific for esophageal injury
    a. Hematemesis, odynophagia, dysphagia
    b. Tracheal deviation, hoarseness, dysphonia
    c. Hemoptysis, subcutaneous emphysema, tenderness

Chapter 8 – Neck Trauma Answer Key

1. Subclavian vessels, aortic arch, lung apices
2. a. Larynx and trachea
   b. Airway compromise
3. a. Carotid or vertebral artery injury
   b. CT angiogram
4. b. False
5. d
6. b
7. Risk of necrotizing infections, mediastinitis
8. c
9. a

Chapter 9 - Thoracic Injuries Test Questions

1. Which injuries are considered life-threatening requiring immediate intervention?
    a. Tension pneumothorax and pericardial tamponade
    b. Cardiac contusion and rib fractures
    c. Clavicle fracture and pulmonary contusion
    d. Pneumomediastinum and subcutaneous emphysema

2. What is an early sign of tension pneumothorax?
    a. Tracheal deviation
    b. Respiratory distress
    c. Increased cardiac output
    d. Epistaxis

3. What is the immediate management of tension pneumothorax
    a. Chest tube placement in 7th intercostal space
    b. Place a three-sided dressing over chest tube site
    c. Needle decompression above the 3rd rib, mid-clavicular line
    d. ED thoracotomy

4. Flail chest is defined as:
    a. Multiple rib fractures with subsequent subcutaneous emphesema
    b. Chyle in the pleural space
    c. Excess fluid in pericardium
    d. Two or more ribs fractured at two or more points, and subsequent paradoxical motion

5. Which patient would benefit most from an emergent thoracotomy?
    a. 48 year old patient with gunshot wound to the back who lost vital signs upon arrival to the ED
    b. 12 year old patient with traumatic asphyxsia with CPR in progress for past 15 minutes upon arrival to the ED
    c. 16 year old patient with traumatic amputation of arm with CPR in progress for 5 minutes
    d. 19 year old patient with stab wound to chest who arrived with fixed and dilated pupils.

6. A nasogastric tube was inserted in a trauma patient. A follow-up chest radiograph shows abdominal contents in the chest cavity. The nurse should be suspicious of
    a. Diaphragmatic rupture
    b. Chylothorax
    c. Pleural effusion
    d. Tension pneumothorax

7. What is the most appropriate immediate nursing intervention for a patient who has pulled out their chest tube?
    a. Restrain patient and place bed in trendelenberg position.
    b. Cover site with a dressing and contact the physician
    c. Apply oxygen per face mask and order chest x-ray
    d. Monitor for air leaks and report subcutaneous emphesema

8. What is the goal of treatment in patients with rib fractures?
    a. Maintain pulmonary function and relieve pain
    b. Monitoring supplemental oxygen
    c. Application of sequential stockings
    d. Administering cough suppresant medication

9. What is the most common medical intervention required for patients with thoracic trauma?
    a. Chest tube insertion
    b. Thoracotomy
    c. VATS (video-assisted thoracoscopic surgery)
    d. Pericardiocentesis

10. Three days post motor vehicle crash, a patient was started on a regular diet. The nurse noticed the patient's chest tube drainage changed from serous-sanguineous to milky white. The physician orders for the fluid to be sent for triglyceride and chylomicron levels. The nurse suspects the patient may have:
    a. Thoracic duct injury with chylothorax
    b. Pulmonary contusion with empyema
    c. Retained hemothorax with interstitial bleeding
    d. Persistent air leak with pneumatocele

Chapter 9 - Thoracic Trauma Answer Key

1. a
2. b
3. c
4. d
5. a
6. a
7. b
8. a
9. a
10. a

Chapter 10 - Abdominal Injuries Test Questions

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

Chapter 10 - Abdominal Injuries Answer Key

1. b
2. a
3. b
4. b
5. d
6. c
7. d
8. a
9. a

Chapter 11 – Genitourinary Injuries Test Questions

1. A urine specimen is ordered on a patient diagnosed with bilateral pubic rami fractures. When preparing to catheterize the patient, the trauma nurse observes blood at the urinary meatus. The nurse's next steps are to:

    a. Stop the insertion and notify the trauma surgeon
    b. Insert the catheter and obtain the urine sample
    c. Cleanse the meatus thoroughly and insert the catheter
    d. Place the patient on a bedpan and obtain a mid-stream sample

2. A 20 year old male has suffered a gunshot wound to the upper left flank and abdomen. Your assessment reveals gross hematuria and an expanding palpable flank mass. He is complaining of flank pain and tenderness. HR 140, BP 80/40, RR 35. The trauma nurse should anticipate the following diagnosis:
    a. Minor renal trauma
    b. Major renal trauma
    c. Grade III splenic laceration
    d. Grade III liver laceration

3. A 67 year old unrestrained male driver arrives in the ED after a head-on MVC. He is unresponsive, has a flail chest, obvious abdominal trauma and a pelvic fx. He is going directly to the OR due to his BP being 70 by palpation. His rectal exam reveals a high riding boggy prostrate. The trauma nurse knows that they should:

    a. Proceed with foley catheter insertion prior to taking to surgery
    b. Rule out a urethral injury before foley catheter insertion.
    c. Put a condom catheter on the patient and send him to the OR.
    d. Tell surgical nurse to insert foley prior to prep and draping.

4. A 3 year old female is brought in to the ED by her mother. She says the child has been listless, complains of abdominal pain and has been complaining about having to go to the bathroom since she got up this AM. Child was reportedly fine yesterday. BP 40/80, P 100, RR 14, T 101.F. Has a firm, protruding, tense abdomen which is painful to touch. Bruising is noted on the abdomen and flank. Genitalia is swollen as well. Mother says child fell yesterday when playing outside. The trauma nurse knows to:

    a. Prepare for abdominal CT Scan
    b. Initiate a trauma work-up (start IVs, make NPO, send labs, do not attempt to insert a foley or straight cath the patient until the extent of injuries are known
    c. Contact Social Work and let them know that there is suspected abuse case
    d. All of the above.

5. A 34 year old male sustained a Grade II renal injury from a MVC. He has been managed non-operatively for over a week now. He was transferred 3 days ago from the step-down unit to the surgical floor. Nursing assessment and intervention priorities include all of the following except:

    a. Frequent monitoring of vital signs and hematocrit
    b. Reassessment of abdomen
    c. Bed rest with a gradual increase in activity and diet
    d. Pain control
    e. NPO

6. A 33 year old female who boxes for fun on the weekends has sustained blunt trauma to the left kidney during a boxing match. Her chief complaint is flank tenderness and she has developed a bruise. Her urinalysis reveals microscopic hematuria. All of her other laboratory data are within normal limits. The trauma nurse suspects:

    a. Pulled muscles in the flank area
    b. Fractured iliac bone
    c. Retroperitoneal hematoma
    d. All of the above

7. A 45 year old male who has sustained multiple injuries (liver, spleen, kidney and small bowel) along with a pelvic fracture from a MVC has begun to display signs and symptoms of acute renal failure. The trauma nurse suspects the oliguric phase which is reflected by which of the following?

   a. Obstruction of the tubules by cellular debris, tubular casts or tissue swelling
   b. A decrease in glomerular filtration rate
   c. Large daily urinary output
   d. Gradual improvement of renal function

8. Administering an IVP is considered the goal standard diagnostic test for detecting hematuria.

   a. True
   b. False

9. A significant factor contributing to the etiology of acute renal failure is:
   a. Profound hypotension
   b. Profound hypertension
   c. Traumatic brain injury
   d. LeForte II fracture

Chapter 11 - Genitourinary Injuries Answer Key

1. a
2. b
3. b
4. d
5. e
6. c
7. a
8. b
9. a

Chapter 12 – Musculoskeletal Injuries Test Questions

1. Nursing responsibilities for caring for the patient with skeletal traction include all of the following:
    a. Early ambulation
    b. Insertion of inferior vena cava (IVC) Filter
    c. Nutrition consultation
    d. Incentive spirometry

2. Patients with pelvic and/or femur fractures are at significant risk for developing which common post-trauma complication?

    a. Herniation
    b. Rhabdomyolysis
    c. Deep vein thrombosis
    d. Necrotizing fasciitis

3. A major etiological factor associated with deep vein thrombosis is:

    a. Low platelets
    b. Venous stasis
    c. Increase in the number anticoagulation factors in the venous system
    d. Nerve damage

4. The accepted approximate threshold compartment pressure indicative of a fasciotomy is:

    a. 20 mm/Hg
    b. 30 mm/Hg
    c. 40 mm/Hg
    d. 50 mm/Hg

5. The most common locations for the development of compartment syndrome are:

    a. Shoulder and upper arm
    b. Upper arm and hands
    c. Lower leg
    d. Pelvis and hips

6. Which of the following conditions do not require immediate intervention in a patient with traumatic amputation?

    a. Reduced sensation in the affected extremity
    b. Hypothermia
    c. Metabolic acidosis
    d. Coagulopathies

7. During the resuscitative phase of musculoskeletal trauma, what is imperative to recognize early?

    a. Potential for ileus
    b. Patients at risk for neurologic and vascular compromise
    c. Problem with body image
    d. Patients at risk for post-traumatic stress syndrome

8. The most appropriate initial treatment for an open or compound tibia/fibula fracture is:

    a. Irrigation with betadine solution
    b. Splinting the extremity in the position found, above and below the joint while maintaining pedal pulses
    c. Application of a "Hare" traction splint or Sager traction device
    d. Reduction of the open fracture manually

9. Hemorrhagic shock is more commonly associated with which type of fracture?

    a. Distal tibia fracture
    b. Colle's fracture
    c. Humerus fracture
    d. Pelvic ring fracture

10. The two leading cellular components that result in acute tubular necrosis from rhabdomyolysis due to a crush injury are:

    a. Creatinine and BUN
    b. Hemoglobin and platelets
    c. Myoglobin and potassium
    d. Magnesium and potassium

Chapter 12 – Musculoskeletal Answer Key

1. b
2. c
3. b
4. b
5. c
6. a
7. b
8. b
9. d
10. c

Chapter 13 - Soft Tissue Injuries Test Questions

1. Skin is critical to survival because it provides what major function related to immunity?

    a. Retains body heat
    b. Secretes enzymes that digest protein, carbohydrates, and fats
    c. Prevents loss of proteins and assists with regulation of electrolytes and fluid
    d. Serves as a barrier to invasion by microorganisms and chemicals

2. Soft tissue anatomy is made up of:

    a. Skin, muscle, and nerves
    b. Skin, muscle, and bones
    c. Muscle, nerves, bones
    d. Skin, nerves and bones

3. Abrasion injuries:

    a. Involves only the epidermis
    b. Iinvolves only the dermis
    c. May involve both the epidermis and the dermis
    d. Never involves the epidermis or the dermis

4. Puncture wounds carry a heightened risk of infection primarily because:

    a. They result from a stretching or tearing away of the soft tissue
    b. They deliver bacteria or foreign inoculum deep into the body
    c. They cause widespread tissue destruction
    d. They are always closed by primary intention

5. During the history portion of the wound assessment, the time of injury is very important:

    a. To determine the amount of time before inoculum reaches critical proportion
    b. To validate the patient's account of the incident
    c. To determine the type of antibiotic administered
    d. To determine ischemia time

6. Local wound anesthesia is:

    a. Used for repair of digit lacerations
    b. Used for contaminated wounds
    c. Is infiltrated directly into the wound
    d. Injected through intact skin at wound edge

7. External hemorrhage is initially treated with:

    a. Direct pressure on the bleeding site
    b. Occlusion of the pulses distal to the bleeding site
    c. Application of a tourniquet
    d. Administration of blood products

8. What two host elements adversely influence tissue oxygenation and wound healing the most?

    a. Age and pain
    b. Perfusion and nutrition
    c. Pain and stress
    d. Smoking and anemia

9. The Reconstructive Ladder describes wound closure techniques. What is the simplest technique for wound closure?

    a. Local flap
    b. Skin graft
    c. Free flap
    d. Primary closure

10. The three major phases of wound healing are:

a. Infection, proliferation and remodeling
b. Bleeding, bruising and inflammation
c. Inflammation, proliferation and remodeling
d. Inflammation, infection and remodeling

Chapter 13 - Soft Tissue Injuries Answer Key

1. d
2. a
3. c
4. b
5. a
6. c
7. a
8. d
9. d
10. c