Multisystem Trauma

Objectives

- Describe the pathophysiology and clinical manifestations of multisystem trauma complications.
- Describe the risk factors and criteria for the multisystem trauma patient.
- Describe the nursing management of the patient recovering from multisystem trauma.
- Describe the collaboration with the interdisciplinary teams caring for the multisystem trauma patient.

Multisystem Trauma Facts

- Leading cause of death among children and adults below the age of 45
- 4th leading cause of death for all ages
- Accounts for approximately 170,000 deaths each year and over 400 deaths per day
- Affects mostly the young and the old
- Kills more Americans than stroke and AIDS combined
- Leading cause of disability
- Costs: 100 billion dollars to U.S. society annually
- Research dollars only 4% of U.S. federal research dollars
- Most traumas are preventable!

Who Is a Trauma Patient?

Evidence-Based Categories:

- Physiologic Criteria
- Patient/Environmental Criteria
- Mechanism of Injury Criteria
- Anatomic Criteria

Umm.edu

mc.vanderbilt.edu

Physiologic Criteria

- Systolic blood pressure <90mm HG
- Respiratory rate 10 or >29 per minute
- Glasgow Coma Scale score <14

Glasgow Coma Score		
Eye Opening (E)	**Verbal Response (V)**	**Motor Response (M)**
4=Spontaneous 3=To voice 2=To pain 1=None	5=Normal conversation 4=Disoriented conversation 3=Words, but not coherent 2=No words.....only sounds 1=None	6=Normal 5=Localizes to pain 4=Withdraws to pain 3=Decorticate posture 2=Decerebrate 1=None
		Total = E+V+M

Anatomic Criteria

- Penetrating injuries to the head, neck, torso or proximal extremities
- 2 or more obvious femur or humerus fractures
- Amputation above the waist or ankle
- Crushed, de-gloved or mangled extremities
- Open or depressed skull fracture
- Unstable chest wall (flail chest)
- Paralysis
- Pelvic fracture

Mechanism of Injury Criteria

Blunt Trauma:

- Falls (most frequent injury)
- Motor vehicle collisions:
  - Frontal=head on (65% of crashes)
  - Lateral=T-bone
  - Rear end
  - Rotational=spins
  - Rollovers
- Motorcycle or ATV collisions
- Auto vs. pedestrian
- Struck by or against object

Caraccidentbest.blog.spot.com

Mechanism of Injury Criteria

- Penetrating trauma (firearms, stabbing)
- Inhalation of noxious gases & poisoning
- Burns/blast injuries
- Near drowning
- Suffocation
- Bites & Stings
- Crush injury

www.americantrainingresource.com

Patient/Environmental Criteria

- Age >55 years (considered geriatric)
- Pregnancy >20 weeks
- Significant co-morbid medical conditions
- Burns (according to American Burn Association criteria)
- Time sensitive extremity injuries (amputations)
- Globe rupture)
- EMS provider judgement

Who Is a Level 1 Trauma Patient?

- Confirmed systolic blood pressure less than 90mm Hg
- Respiratory compromise, obstruction and/or intubation (rate <10 or >29 breaths / minute)
- Receiving blood to maintain vital signs
- Emergency physician's discretion
- Glasgow Coma Scale (GCS) score ≤8 with mechanism attributed to trauma
- Gunshot wound to the abdomen, neck or chest

American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes

www.facs.org

Who Is a Level 2 Trauma Patient?

- GCS <14 when associated with trauma
- Respiratory rate <10 or >29 breaths / minute when associated with trauma
- Penetrating wounds (other than gunshot wounds) to the head, neck, torso, extremities proximal to the elbow and knee
- Flail chest
- Pelvic fractures
- Two or more long bone fractures
- Limb paralysis and/or spinal cord injury
- Amputation proximal to the wrist and/or ankle
- Burns

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High Risk For Trauma

www.familysolutionsteenhelp.wordpress.com

www.sigridmcnab.com

www.horizonfamilysolutions.com

www.payh.org

High Risk For Trauma

- Gender – 2 out of 3 major trauma patients are male
- Age – Teen and young adult years
- Behaviors – Choices greatly affect injury risk.
- Environment – No lifestyle is completely risk-free. High-risk patients have high risk jobs, live with, or associate with dangerous people, abuse alcohol and other drugs, or make weapons a major part of their life.

Types of Energy

- Mechanical
- Gravitational
- Thermal
- Chemical
- Electrical
- Radiant

www.cei.int

The majority of traumatic injuries are the result of mechanical or gravitational forces.

Three Concepts of Energy

"In the trauma patient *energy* is the pathogen".

1. Potential = Energy stored within an object, not in motion but capable of becoming active related to position or condition (rather than motion).
2. Kinetic = Energy of motion. Work of a moving object.
3. Work = Force of energy. Acting over a distance. Kinetic energy of motion will change by the amount of work (force) done.

"Energy can be neither created nor destroyed, but can only be converted or transformed". The force goes somewhere!

KINEMATICS

Kinematics – The process of predicting potential injuries based on analysis of the forces involved.

Four factors effecting injury potential:

- The nature and amount of force
- Various patient characteristics
- Characteristics of the wounding agent
- Tissue characteristics

Effect of Speed

- An increase of 40% in speed produces almost 100% increase in force.
- "The odds of being killed or severely injured in a crash **DOUBLE** for every 10mph traveled over 50mph."
- For every second of falling, speed accelerates by about 20 mph.
- It's not the speed but the **STOP** that kills.

"Modern vehicles are designed to crumple, absorbing energy before it reaches occupants"

Multisystem Trauma

Serious injury to more than one body system.

- Traumatic injury occurs when the body's tissues are exposed to energy levels beyond their tolerance.
- The location of injuries will depend on the POINTS of CONTACT

Multisystem Trauma

Top 3 "Dead-at-the-scene" Injuries:

- Massive head trauma
- High spinal cord injury
- Aortic rupture

Trauma.org

Mechanism Of Injury

Motor Vehicle Crash

In every motor vehicle crash "3" types of collisions can occur:

1. Collision of vehicle against some type of object.
2. Collision of passenger against interior of vehicle.
3. Collision of passenger's internal organs against the solid structures of the body.

Other Collision Types

Auto vs. Pedestrian / Bicyclist:

- The speed of the vehicle upon impact.
- Distance and height patient was thrown.
- Was patient wearing a helmet?
- Was patient pulled/pinned under vehicle?

Auto vs. Motorcycle:

- Was patient wearing a helmet, protective clothing, boots?
- The speed of both the vehicle and motorcycle upon impact. (3)

Falls

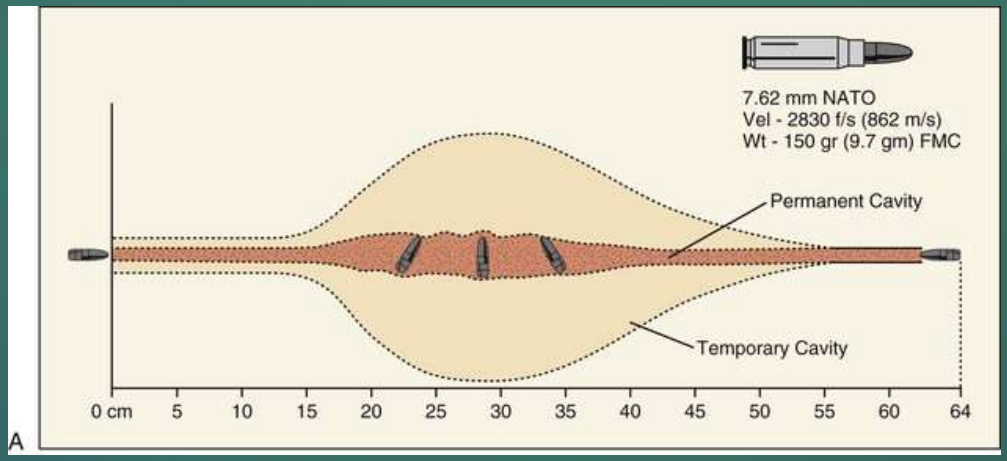
Factors Predicting Fall Injuries:

- Fall height (velocity) – more than 15 feet or 3 x the patient's height is considered significant.
- Landing surface (deceleration distance)
- Point of impact on the body – where the energy was initially applied

Penetrating Trauma

Penetrating Trauma:

- The size of the **permanent cavity** is a result of the size and shape of the bullet / missile (mass)
- The size of the **temporary cavity** is the result of the bullet blast wave (a function of the bullet's speed/velocity)



www.pocketdenistry.com

Damage can occur to tissues not directly in the path of the missile.

Stab and Slash

Stab & Slash Injuries:

- Low velocity – no significant temporary cavity
- Damage limited to structures directly in the object's path
- Blade / object can be moved around inside victim, damaging structures away from insertion site
- Permanent cavity is the size / shape of stabbing instrument

Cutresistantclothing.wordpress.com

Impalement Injury

Impalement:

- A penetrating wound that doesn't involve an instrument designed to cut
- Low velocity impalement injuries push vital structures aside

Trauma.org

Crush Injuries

Crush injuries are associated with massive tissue destruction:

- Machinery
- Animal bites
- Structure collapse
- Pin-in motor vehicle crash
- Pedestrians ran over by vehicle

Idalilymail.co.uk

Blast Injury

Primary Injury: Due to the blast wave itself

Secondary Injury: Damage to the body as a result of flying debris (fragment penetration, blunt injury)

Tertiary Injury: Victim hurled by force of explosion

Public-domain-phases.com

Miscellaneous Blast Injuries:

- Burns – hot gases, fire
- Respiratory injury – inhaling toxic gases
- Crush injury – collapsed buildings(5)

Blast Injury

- **Primary Injuries**: Head (ear), lung & organ injuries from overpressure blast wave unique to high order explosives.
- **Secondary Injures:** Produced by flying debris or bomb fragments. Penetrating and blunt trauma, fractures and soft tissue damage.
- **Tertiary Injuries:** Results from being thrown by a blast wave. Head injuries including multiple fractures.
- **Quaternary Injuries:** All injuries not due to primary, secondary & tertiary mechanisms, such as burns, head injuries (brain) and exacerbation of pre-existing medical conditions. Injuries indirectly caused by the explosion.

Blast Injury Facts

- Organs that contain air or gas are most susceptible to pressure changes (middle ear, lungs, GI tract)
- Ear most sensitive to blast injury
  - Tympanic membrane injury or rupture and middle ear damage. Look for signs of tinnitus or hearing loss.
- Pulmonary blast injuries result from short range exposure to the detonation of explosive
  - Expansion of the alveoli from close proximity to high pressure explosions. Blast lung is characterized by the clinical triad of apnea, bradycardia, and hypotension. (CDC.gov)

Blast Injury

Blast lung produces a characteristic "butterfly" pattern on chest X-ray.

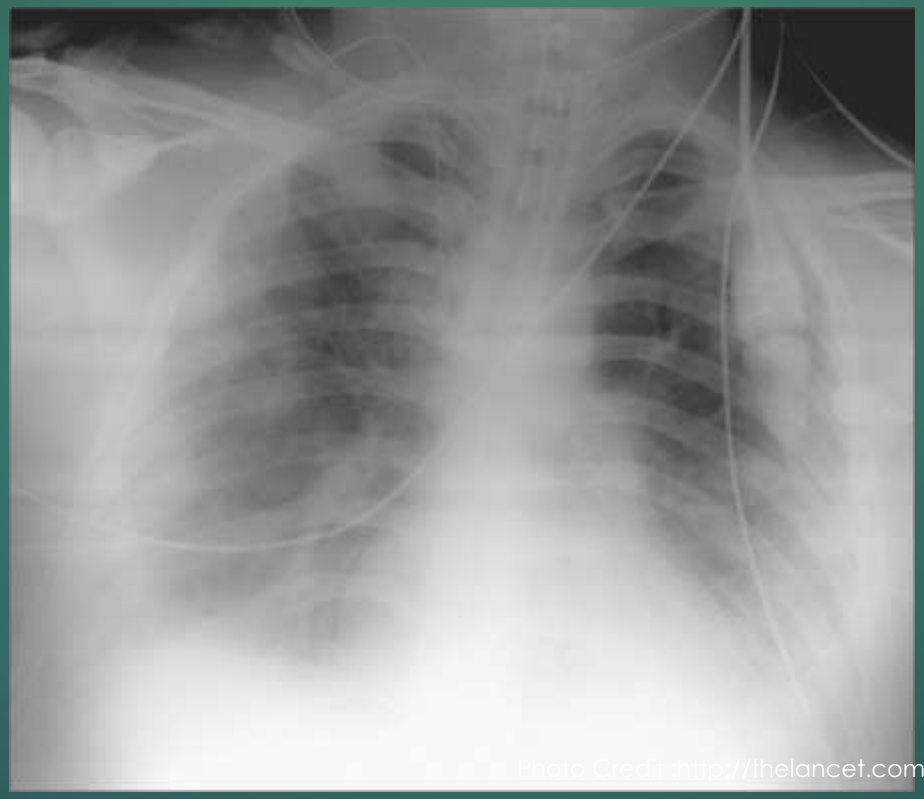


Photo Credit: http://thelancet.com

Pathophysiology of Injury

Tissue Characteristics

Solid Structures – crack in response to blunt force

- Bone
- Solid organs
  - spleen
  - Liver
  - Kidneys

Semi-Solid Structures – crack/shatter in response to blunt force

- *Brain*
- *Pancreas*

Tissue Characteristics

HOLLOW STRUCTURES – POP/ RUPTURE

Air-Filled:

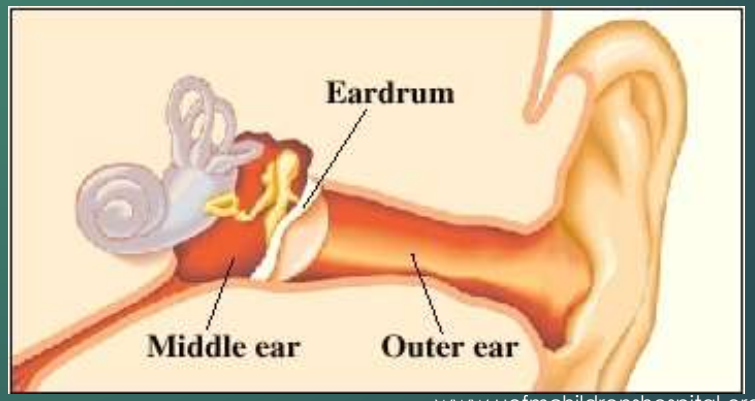
- Lungs
- Middle ear

Fluid-Filled:

- Bladder
- Globe
- Ear
- Heart
- Pregnant uterus/amniotic sac

Air and Fluid Filled:

- Stomach
- Intestines, large and small
- Abdominal cavity



www.uofmchildrenshospital.org

Tissue Characteristics

FIXED POINTS – TEAR

Vessels:

- Large (aorta, vascular attachment sites)
- Small (cause bruising)

Tubes:

- Urethra
- Trachea / bronchi

Ligaments and Tendons:

- Musculoskeletal system

Nerves:

- Macro – nerve roots
- Micro – diffuse axonal injury

Other Structures:

- Diaphragm
- Skin

Multisystem

Neurological
TBI
Spinal cord injury

Cardiac
Cardiac tamponade
Myocardial contusion

Orthopedic
Fractures

Pulmonary
Simple pneumothorax
Tension pneumothorax
Open pneumothorax
Severe flail chest
Massive hemothorax
Pulmonary contusion
Pulmonary laceration

Vascular
DVT, Fat embolism
Hypovolemia
Aortic disruption

GI
Hepatic injury
Shock liver
Pancreatic injury
Splenic injury

Renal
Acute renal failure

Neurological

Primary Injury

Traumatic brain injury (TBI) occurs during initial insult and results from initial displacement of physical brain structures.

Secondary Injury

An indirect result of the injury and processes initiated by the trauma. Occurs gradually in the hours and days following initial injury.

Spinal Cord Injury

Hyperflexion, hyperextension, axial loading, rotation, penetrating trauma.

Severe TBI has a mortality rate of approximately 30%.

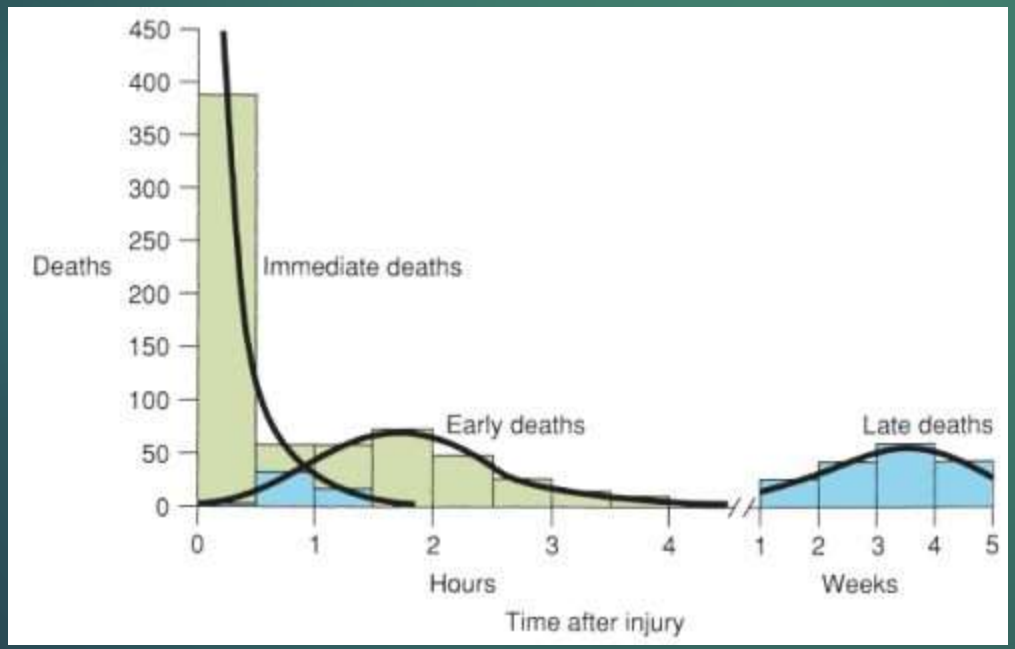
3 Peaks of Fatalities

1st Peak = 50% of death occur before care arrives

2nd Peak = 30% "Golden Hour" actually 1st few hours

3rd Peak = 20% occurs days or weeks post event (6)

Head injuries make up 50% of all trauma deaths



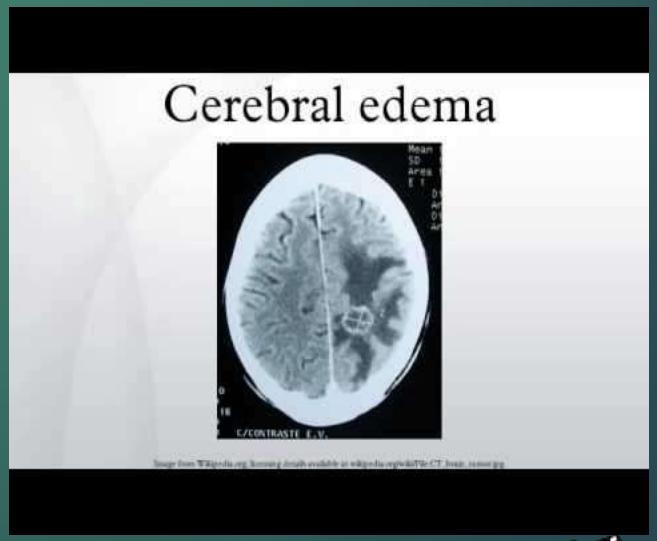
Hospitalization focuses on the 3rd peak; the days and sometimes weeks after the initial event. During this time these trauma patients are in dependent on hospital care.

Injury Detail and Care

TBI – Primary Injury

Traumatic brain injury (TBI) occurs during initial insult and results from initial displacement of physical brain structures.

- Axonal shearing – axons of neuron stretched and torn
- Cerebral contusion
- Subarachnoid / epidural / intracerebral hemorrhage
- Skull fractures (open / depressed)
- Subdural hematoma
- Concussion – most common



www.utube.com

TBI – Secondary Injury

An indirect result from the complications of the injury:

- Cerebral edema
- Impaired metabolism
- Altered cerebral blood flow
- Free radical formation
- Excitotoxicity

Causes:

- Cerebral hypoxia
- Hypercapnia
- Ischemia – insufficient blood flow to brain

TBI

- Survivors of severe and moderately severe head injuries are likely to be left with some degree of disability.
- The goal of treatment is not only full recovery from the primary injury but the prevention of secondary neurologic injury.
- Secondary brain injury is damage that occurs as a result of the body's response to the initial brain injury.

Spinal Cord Injury

The extent of injury is defined by the American Spinal Injury Association Impairment Scale (modified from the Frankel classification), using the following categories:

- **A = Complete**: No sensory or motor function is preserved in sacral segments S4 – S5.
- **B = Incomplete**: Sensory, but not motor, function is preserved below the neurologic level and extends through sacral segments S4 – S5.
- **C = Incomplete**: Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade <3.
- **D = Incomplete**: Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade that is ≥3.
- **E = Normal**: Sensory and motor functions are normal.

Chin, 2015

Spinal Cord Injury

- **Airway management** – The cervical spine must be maintained in neutral alignment at all times; clearing of oral secretions and/or debris is essential to maintaining airway patency and preventing aspiration.
- **Hypotension** – Hypotension may be hemorrhagic and/or neurogenic (loss of autonomic function) in acute spinal cord injury; a diligent search for occult sources of hemorrhage must be made.
- **Neurogenic shock** – Judicious fluid replacement with isotonic crystalloid solution of about of 2 L is the initial treatment of choice; maintain adequate oxygenation and perfusion of the injured spinal cord; supplemental oxygenation and/or mechanical ventilation may be required. (Chin et al, 2015)

Basilar Skull Fracture

- Located at the base of the cranium
- Assess for CSF drainage from the nose or ears
- Ecchymosis over mastoid (Battle's sign)
- Hemotympanum (blood in middle ear)
- Raccoon eyes
- Complications:
  - Infection and cranial nerve injury

www.pharmacology2000.com

Orthopedic Rib Fractures

Rib fractures can cause organ injuries:

- Bones penetrate the lungs (mid-upper ribs)
- Bones penetrate the great vessels, liver, spleen (lower ribs)

Note: Thoracic cage fractures can interfere with the **MECHANICAL** process of breathing

Note: Posterior rib fractures involve great force. Look for associated T-spine fractures

Pelvic Fractures

Stable Pelvic Fracture – one of the two pelvic rings is intact

Minimize bleeding with pelvic fractures:

- Stabilize the fracture
- Pelvic splints
- Sheet and towel clips
- Commercial devices
- Surgery

T-Pod Pelvic Splint

www.emsworld.com

Most life threatening complication of pelvic fracture is hemorrhage.

Femur Fractures

Femur Fracture Facts:

- Mid-shaft / middle is most common fracture location
- Hemorrhage is most life-threatening complication
- Traction splinting is initial intervention

Once stabilized initiate R.I.C.E. (Rest, Ice, Compression, Elevation)

Monitor for ongoing swelling and Compartment syndrome

Simple Pneumothorax

Simple Pneumothorax:

- Partially or completely deflated lung
- Air enters and leaves pleural cavity at the same rate

Treatment: Chest tube insertion

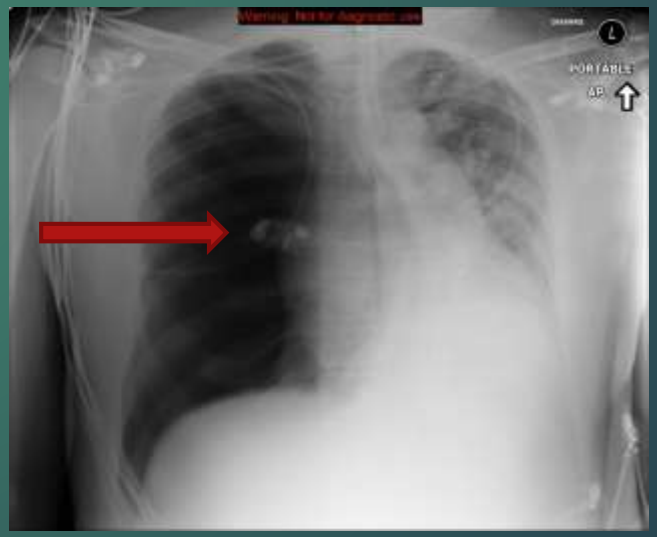
- Analgesia
- Site – 5th Intercostal space, mid-axillary line
- Seal the incision site
- Chest tube drainage device, monitor collection/output

Tension Pneumothorax

Tension Pneumothorax:

- Air enters pleural cavity but doesn't leave at same rate
- Causes accumulation of air under pressure
- Trapped air volume is **VERY** large
- Effects ventilation and cardiac output

Shift across mediastinum causes respiratory and circulatory problems, signs of shock and can lead to death.



Radiopaedia.org

Tension Pneumothorax

Assessment:

- Dyspnea, tachypnea, hypoxemia, agitation, tachycardia, hypotension (signs of shock)
- Unilateral or absent breath sounds
- Chest asymmetry
- JVD
- Deviated trachea (late sign)
- Chest tympany (drum like sound)

Treatment:

- Needle decompression
- Chest tube insertion

www.littcase.com

Open Pneumothorax

Open Pneumothorax:

- Abnormal connection between pleural cavity and the atmosphere
- Pleural space has lost negative pressure
- Causing inability to ventilate the lungs

Treatment:

- Seal the hole with occlusive dressing (Xeroform or Vaseline gauze) taped on 3 sides
- Chest tube

Severe Flail Chest

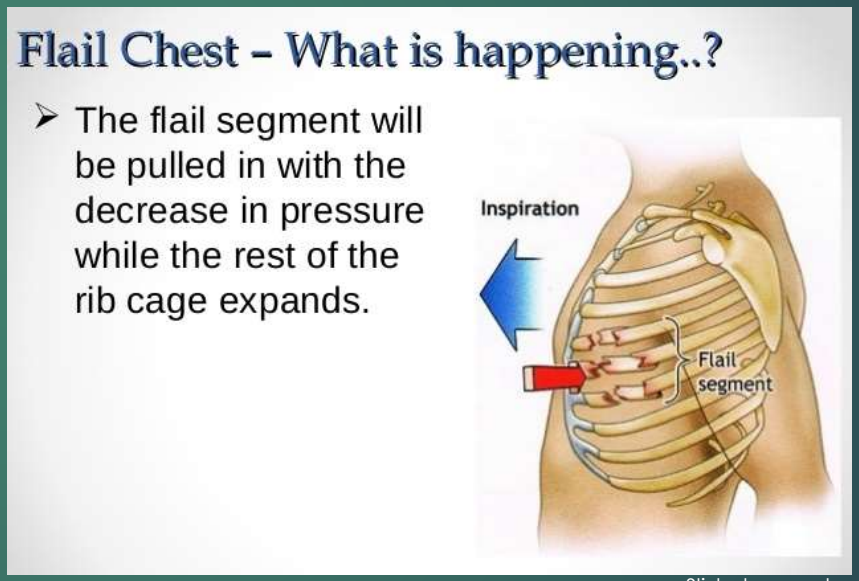
Segmental separation of the chest wall causing inability to breath and ventilate the lungs

Assessment:

- Dyspnea and tachypnea
- Paradoxical movement
- Decreased breath sounds

Treatment:

- Intubation/oxygenation
- Pain control
- Breathing exercise



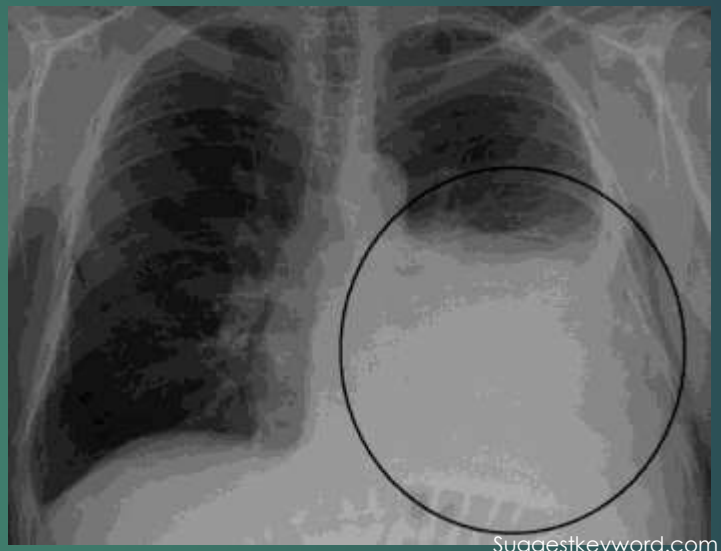
Slideshare.net

Massive Hemothorax

Hemothorax:

Blood in the pleural space

- Systemic/pulmonary vessel disruption
- >1500cc blood loss



Assessment:

- Flat vs. distended neck veins
- Shock with no breath sounds and/or percussion dullness

Treatment:

- Chest tube insertion (low, blood follows gravity)
- Size – large

How Much is Too Much?

What's considered too much drainage from a chest tube?

- 1,000 – 1,500 ml initially
- More than 150 – 200 ml per hour
- If the amount of bleeding **INCREASES** call the physician

Treatment:

- Normothermia
- Coagulopathy management
- Volume replacement
- Surgical intervention

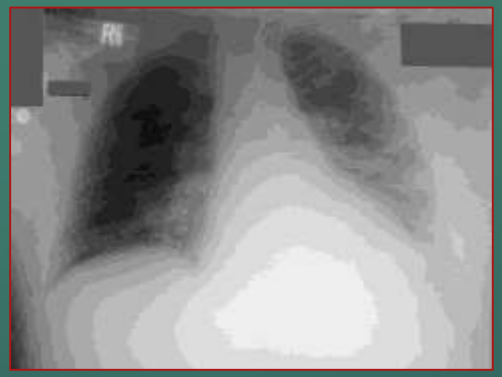
EXTENSIVE CHEST TUBE BLOOD LOSS REQUIRES SURGICAL EXPLORATION

Pulmonary Contusion

Pulmonary Contusion: A big boggy bruise on the lung

- Difficult for oxygen to diffuse from alveoli to capillaries
- Blossoms over time (48 – 72 hours post injury)
- Can lead to acute respiratory distress syndrome (ARDS)
- May lead to impaired gas exchange
- Monitor $Pa0_2$ / FiO_2 ratio

Signs and Symptoms:
Respiratory insufficiency
Cough and hemoptysis
Tachypnea and hypoxia



Pulmonary Contusion on Admission

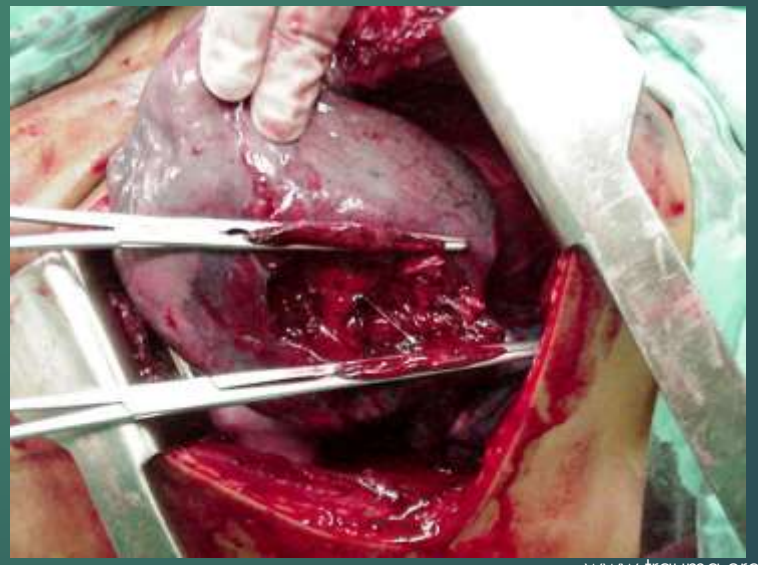
Pulmonary Contusion at 24 Hours

Pulmonary Laceration

Pulmonary Laceration:

- Tear in lung parenchyma
- Associated with significant hemorrhage
- May require emergent surgical repair

Signs and symptoms:
Frank hemoptysis



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Subcutaneous Emphysema

Trapped air in the subcutaneous layer of the skin:

- Travels along fascial planes between the muscles
- Mostly harmless, cosmetic
- Air is reabsorbed over time

"Rice-Krispy" feeling on palpation

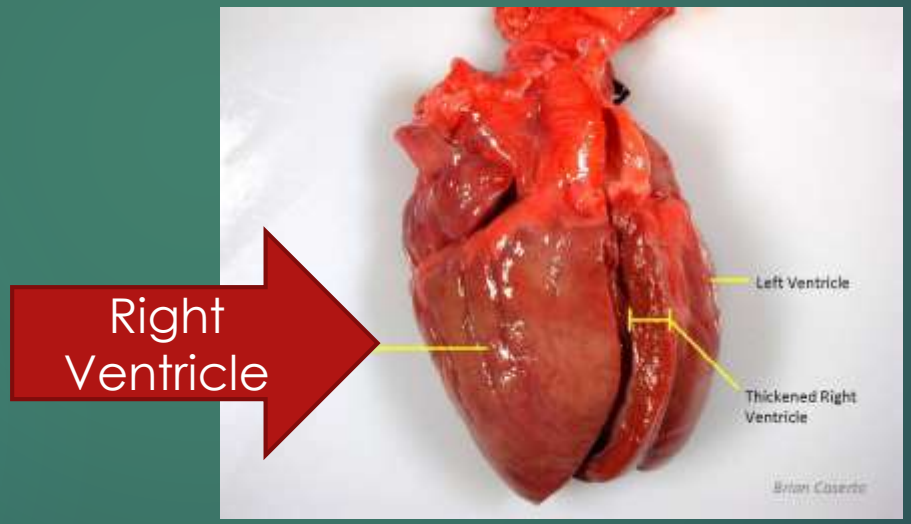
www.trauma.org

Cardiac Injury

Which of the 4 chambers is most commonly affected by Cardiac trauma? **The right ventricle**

Assessment findings that suggest cardiac injury:

- Muffled heart sounds
- Jugular vein distention
- Hypotension
- Dysrhythmias
- Poor contractility
- Shock
- Death



Bedside imaging = Ultrasound, Echocardiogram, FAST exam

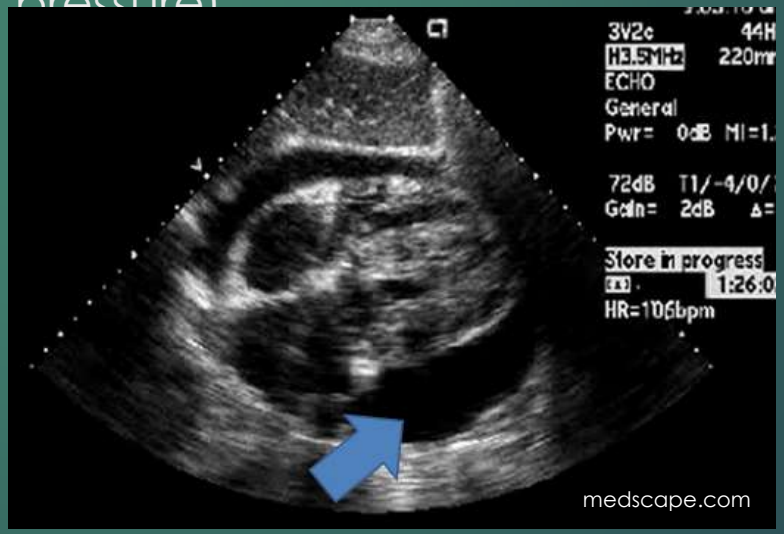
Cardiac Tamponade

Accumulation of pericardial fluid under pressure.

Outcome ranges from minimal effects to full blown circulatory collapse.

Signs and symptoms for Beck's triad:

- Hypotension (narrowing pulse pressure)
- Distant heart sounds
- Engorged neck veins



Treatment:

- Pericardiocentesis
- Thoracotomy

Reduced volume in cardiac chambers = low CO/obstructive shock

Cardiac Contusion

A bruise to the heart after an injury.

- Common mechanism of injury is blunt trauma to anterior chest wall
- **Most commonly affects the right ventricle**

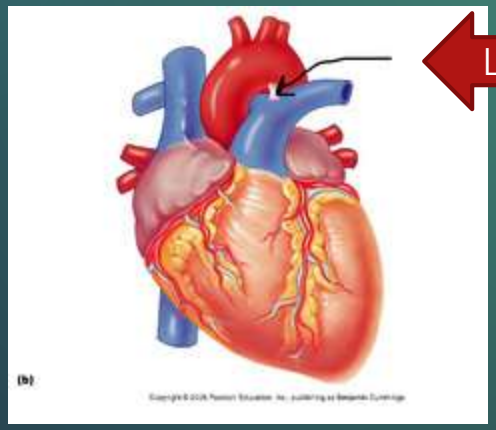
Diagnostics:

- Transthoracic Echo
- Transesophageal Echocardiogram
- ECG
- Cardiac markers

www.slideshare.net

Cardiac Trauma: Nursing Intervention

- Continuous cardiac monitor
- Monitor I & O
- **Compare Blood pressures on both sides**
  - If blood flow is occluded due to blunt cardiac trauma (possible aortic tear) the BP with left arm will drop. In Adults there should be **<12mm Hg** difference between arm pressures.



Ligament arteriosum

According to the American College of surgeons, 90% of blunt aortic injuries occur at the site of the Ligament Arteriosum (where the heart is affixed to the aorta)

Hepatic Injury

The liver is the second most commonly injured organ with blunt trauma.

Graded I through VI.

Clinical finding with hepatic injury:

- Right flank bruising
- RUQ pain/tenderness
- Abdominal distension/rigidity
- Hypotension, tachycardia
- Dropping hemoglobin and hematocrit levels
- Jaundice
- Elevated bilirubin and elevated liver function tests
- Altered coagulation factors

www.healingliverciirhosis.com

Hepatic Injury Grading

- **Grade I**
  - Hematoma: subcapsular, <10% surface area
  - Laceration: capsular tear, <1 cm depth
- **Grade II**
  - Hematoma: subcapsular, 10-50% surface area
  - Hematoma: intraparenchymal <10 cm diameter
  - Laceration: capsular tear, 1-3 cm depth, <10 cm length
- **Grade III**
  - Hematoma: subcapsular, >50% surface area, or ruptured with active bleeding
  - Hematoma: intraparenchymal >10 cm diameter
  - Laceration: capsular tear, >3 cm depth

Hepatic Injury Grading

- **Grade IV**
  - Hematoma: ruptured intraparenchymal with active bleeding
  - Laceration: parenchymal disruption involving 25-75% hepatic lobe or involves 1-3 couinaud segments (within one lobe)
- **Grade V**
  - Laceration: parenchymal disruption involving >75% of hepatic lobe or involves >3 Couinaud segments (within one lobe)
- **Grade VI**
  - Vascular: hepatic avulsion

Shock Liver

Liver shock - Ischemic hepatitis:

Acute liver injury caused by insufficient blood.

Flow and insufficient oxygen delivery to liver secondary to shock or hypotension.

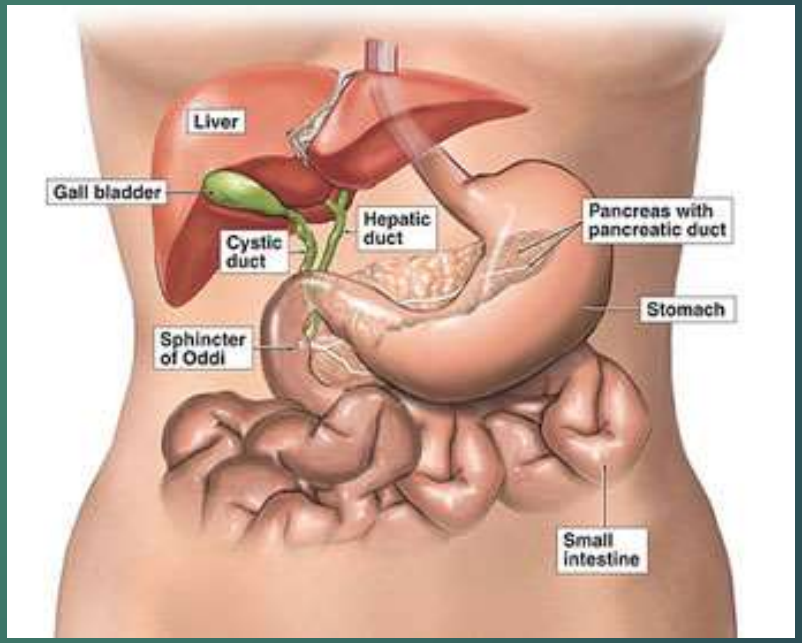
Most common causes:

- Hemorrhagic shock
- Septic shock
- Acute respiratory failure/MSOF
- Metabolic disorders
- Myocardial dysfunction
- Viral hepatitis
- Multiple blood transfusions
- Parenteral nutrition
- Immunosuppression
- Increased intra-abdominal pressures
- Drugs

Pancreatic Injury

Pancreas- a non-blood filled retroperitoneal organ:

- Commonly injured by compression against the spine
- Secondly injured by a direct blow to the epigastrium
- Injury identified by CT
- Serial lipase and amylase levels



www.NHS.UK.com

Splenic Injury

Most Commonly Injured:

- Minimal elasticity
- Highly vascular

Clinical Findings:

- Left flank bruising
- LUQ pain
- Abdominal distension/rigid
- Hypotension/tachycardia
- Kehr's sign(referred pain to left shoulder)
- Drop in hematocrit/hemoglobin

Management - Non-Invasive:

- Serial abdominal exams
- Serial hematocrit/hemoglobin
- Repeat CT/ultrasound

Management - Invasive:

- Splenectomy
- Splenorrhaphy (spleen repair)
- Angioembolization (minimally invasive repair)

Splenic Injury - Grading

- **Grade 1**
  - Subcapsular hematoma <10% of surface area
  - Capsular laceration <1 cm of depth
- **Grade II**
  - Subcapsular hematoma 10 – 50% of surface area
  - Intraparenchymal hematoma <5 cm in water
- **Grade III**
  - Subcapsular hematoma >50% of surface area or expanding
  - Intraparenchymal hematoma >5 cm or expanding
  - Laceration >3 cm depth or involving trabecular vessels
- **Grade IV**
  - Laceration involving segmental or hilar vessels with major devascularization (>25% of spleen)
- **Grade V**
  - Shattered spleen
  - Hilar vascular injury with devascularized spleen

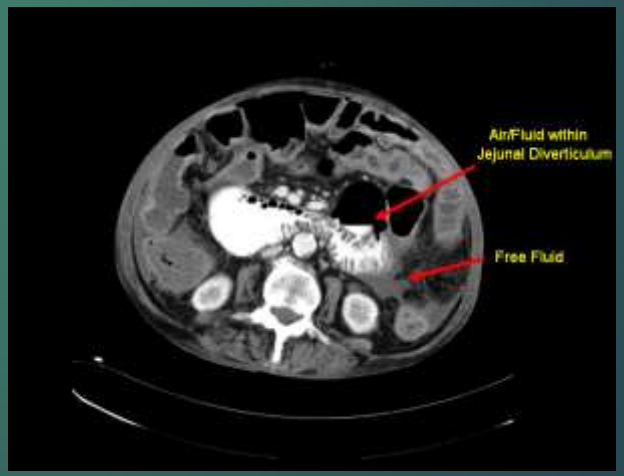
Small Bowel Injury

Small Bowel:

- Most commonly injured organ from penetrating trauma, (located in all 4 quadrants)
- Penetrating injury typically requires surgery
- Hollow structure pops with blunt trauma

Assess for:

- Signs of infection: fever, leukocytosis
- Rebound tenderness
- Free air under diaphragm on CT



www.medicalcasereports.com

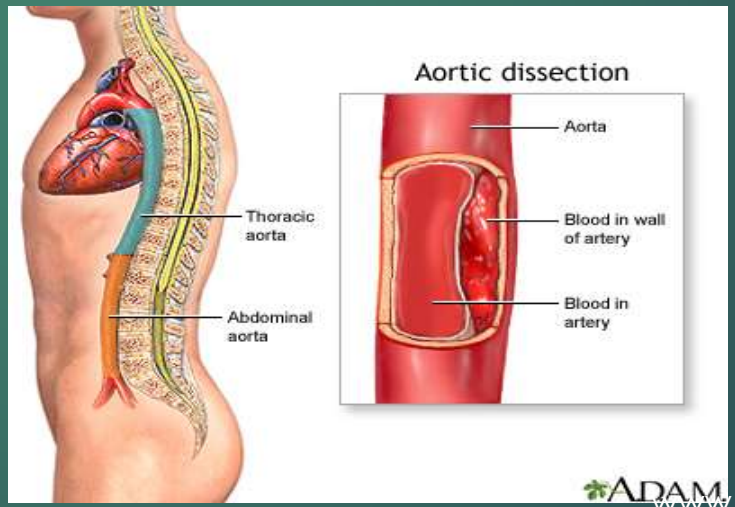
Aortic Disruption

Four Common Sites of Dissection:

- Left subclavian artery(ligamentum arteriosum)
- Ascending aorta
- Lower thoracic aorta above diaphragm
- Innominate artery at aortic arch

Signs and Symptoms:

- Weak femoral pulses
- Dysphagia
- Dyspnea
- Hoarseness
- Pain



www.nlm.nih.gov

Vascular Complications

- **Aortic dissection or tear** = widened mediastinum on X-ray
- **Hypovolemia**: Lack of circulating blood volume resulting in body's oxygen need not being met.
- **Deep vein thrombosis (Fat Embolism)**: Usually associated with long bone, pelvis and multiple fractures

Which of the thoracic great vessels is most commonly injured?

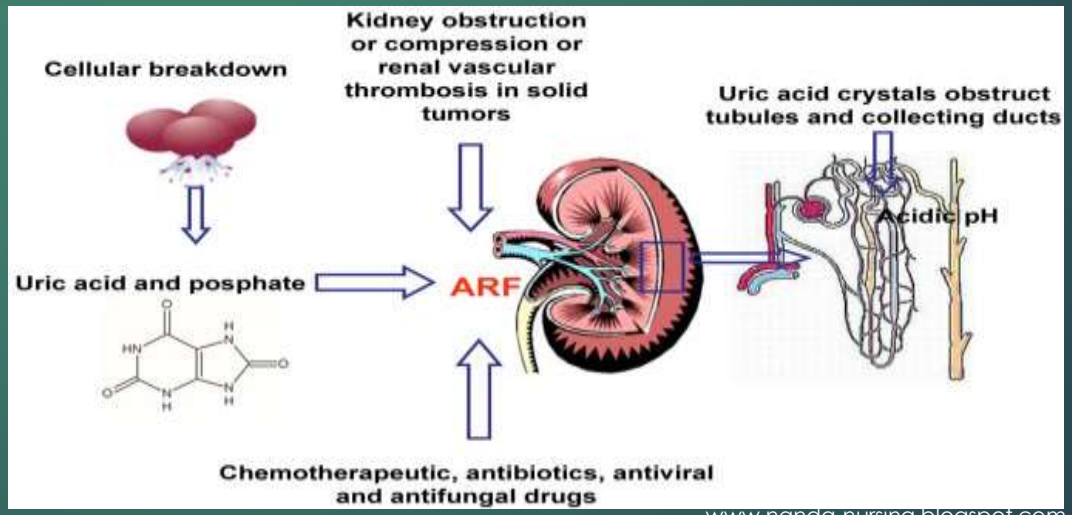
Penetrating Trauma = any vessel in the path of the missile

Blunt Trauma = descending aorta at the ligamentum arteriosum

Acute Renal Failure

Risk factors:

- Hypovolemia
- Rhabdomyolysis – complication of crush injuries
- Radiographic contrast exposure
- Nephrotoxic medications



www.nanda-nursing.blogspot.com

Massive Hemorrhage

- Assess for signs of shock
- Identify the source
- Stop the internal/external bleeding

BODY CAVITY	ml blood loss
Hemothorax	500-3000
Peritoneum	500-5000
Pelvis	750-5000

FRACTURE SITE	ml blood loss
Femur	500-3000
Humerus	500-1500
Tib/Fib	250-2000
Ankle	250-1000

Other Considerations

Pharmacology

Pain control:

- Fentanyl infusion or IV push
- Dilaudid IV push or PCA
- NSAIDS – if not contraindicated

Infection control:

- Initial broad spectrum antibiotics
- Agent specific antibiotics

Sedation:

- Versed
- Propofol infusion

Pulmonary:

- Duo-nebulizer / Combivent if intubated
- Corticosteroids
- Inhaled Epoprostenol (ARDS)

Antianxiety:

- Ativan
- Xanax

Neuromuscular blockade:

- Rocuronium
- Vecuronium

Patients who substantially drop their B/P with narcotics may need volume replacement.

Procedures and Plan

- Radiology:
  - CT scan, X-rays, Ultrasound, MRI
- Labs:
  - ABG, CBC, CMP, PT, PTT, INR, lactic acid, TOX screen
    Urine analysis
- EKG
- Cardiac echo
- MRI
- Possible surgery

Procedures

Pericardiocentesis/Thoracotomy

Indication:

- Cardiac Tamponade

Chest tube placement

Indication:

- Tension pneumothorax
- Open pneumothorax
- Hemothorax

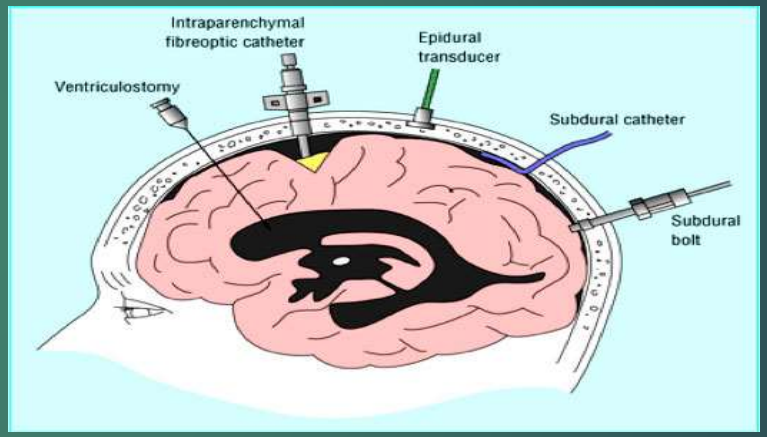
www.foramen.com

Procedures

Intracranial pressure monitor placement

Indication:

- Severe head injury with risk of cerebral edema



www.uichildrens.org

Ventriculostomy placement

Indication:

- Severe head injury with risk of
- cerebral edema and excess CSF production

Trauma Concepts

- **ABCDE** approach evaluation and treatment
- Treat greatest threat to life first
- Definitive diagnosis not immediately important
- Time is of the essence
- Do no further harm

A – E APPROACH

- **A**irway with c-spine protection
  - Ensure patent airway, and assess patients ability to maintain
- **B**reathing/ventilation/oxygenation
  - Is the patient breathing adequately? Do they need assistance or supplemental oxygen?
- **C**irculation: Stop the bleeding/restore volume
  - Is a pulse present? Blood pressure? Volume replacement fluid vs. blood.
- **D**isability / neurological status
  - Quick neuro exam alert, voice, pain, unresponsive (AVPU) / Glasgow Coma Scale (GCS), check pupils
- **E**xpose/environment/body temperature
  - Remove clothes to examine all surfaces, warm patient, prevent hypothermia

Medical Care

Survival for the critically injured multisystem trauma patient is time dependent.

- Complete an organized assessment
- Assess diagnostic and lab results
- Conduct injury specific procedures
- Surgery if indicated
- Palliative care if indicated

Complications:

- Dangerous mechanism of injury
- ALOC
- Threats to airway, breathing and/or circulation

Pre-Critical Care

Pre-hospital:

- Scene size up
- Primary survey- aims to identify and treat immediately life-threatening injuries
- History taking- (using AMPLE acronym)
  A = allergies **M** = meds **P** = past medical, surgical, social history **L** = last meal **E** = events leading to injury

Emergency Department: Rapid head to toe exam (primary survey) full body scan

- Secondary survey – post correction and stabilization of immediately life-threatening injury

Patient's Response to Injury

Understanding the body's response to injury involves:

- Recognizing problems
- Identifying their etiology
- Evaluating deficits
- Intervening appropriately

Anticipate Developing Problems

Mechanism of Injury	Signs and Symptoms	Complication
Chest wall blunt force/penetrating trauma from MVC/MCC, pedestrian vs car	• Chest pain • Shortness of breath • Asymmetrical chest wall movement	• Cardiac/pulmonary contusion • Pneumo/hemothorax • Rib fractures
General blunt force/penetrating trauma from MVC/MCC, pedestrian vs car	• Trauma to neck, chest, abdomen, groin • Injury to head causing LOC • ALOC, confusion • Changes in speech	• Tear/damage to large vessels leading to internal/external bleeding • SDH, brain contusions • ICH • Increased ICP

Anticipate Developing Problems

Mechanism of Injury	Signs and Symptoms	Complication
Blunt or penetrating trauma to neck	• Noisy or labored breathing • Swelling of neck or face	• Significant bleeding or foreign bodies in upper/lower airway causing obstruction • Airway compromise
Any significant blunt force/penetrating trauma, significant falls	• Severe back/neck pain • Difficulty moving extremities • Loss of sensation	• Injury to bones of spinal column • Injury to spinal cord

Nursing Care

- Initial assessment

  Primary survey & Secondary survey
- Ensure stabilization
- Complete cleaning- skin, hair, wounds

TRAUMA assessment is a HANDS-ON activity, not something accomplished from across the room.

Some injuries are not seen on initial exam, and may not be evident for several hours or days after the initial event. It's our job in the post-resuscitation and recovery phase to identify these delayed and sometimes subtle injuries.

Tissue Oxygen Consumption

Effect of patient conditions on tissue oxygen:

Fever (each 1 degree C)	10%
Agitation	18%
Skeletal injury	10-30%
Increased WOB	40%
Chest trauma	60%
Multi System Organ Dysfunction	20-80%
Sepsis	80-100%
Shivering	50-100%
Head injury (sedated)	89%
Head injury (non-sedated)	138%

Shivering needs to be avoided. If not controlled the patient's metabolic rate will increases and so will their oxygen demand.

Tissue Oxygen Consumption

Effect of nursing interventions on tissue oxygenation:

Dressing change	10-25%
Nursing assessment	12%
12 lead ECG	16%
Visitors	22%
Bath	23%
Chest radiograph	22-25%
ET suctioning	27%
Linen change (occupied bed)	22%
Turning	31%
Weight on sling scale	36%

Tissue Oxygen Consumption

Interventions that decrease tissue oxygen consumption:

Hypothermia (each 1 degree C)	10%
IV pain medication push	9-21%
IV pain medication infusion	21%
Anesthesia	25%
Anesthesia in burn patient	50%
Neuromuscular blockage	Blocks shivering & agitation

Nursing Care

Diligent nursing care leads to early detection and complication prevention of the following problems:

- Infection
- ARDS
- DVT/Embolisms
- Renal failure
- SIRS/MODS
- DIC
- Compartment syndrome

Critical Care Considerations

- Neurologic injury
- Acute respiratory failure
- Cardiac injury
- Vascular stability
- Sepsis
- Organ failure
- Pain – physical/psychological
- Nutrition
- Early mobilization
- Damage control sequelae

Neurologic Injury

Frequent neurological examinations

- Assess for disability
- Altered mental status
- Assess for unseen injury ex. Inner cranial bleeding/swelling
- Subtle behavior changes/cognitive changes
- Depression (loss of independence/earning power)
- Sensory/Motor deficits

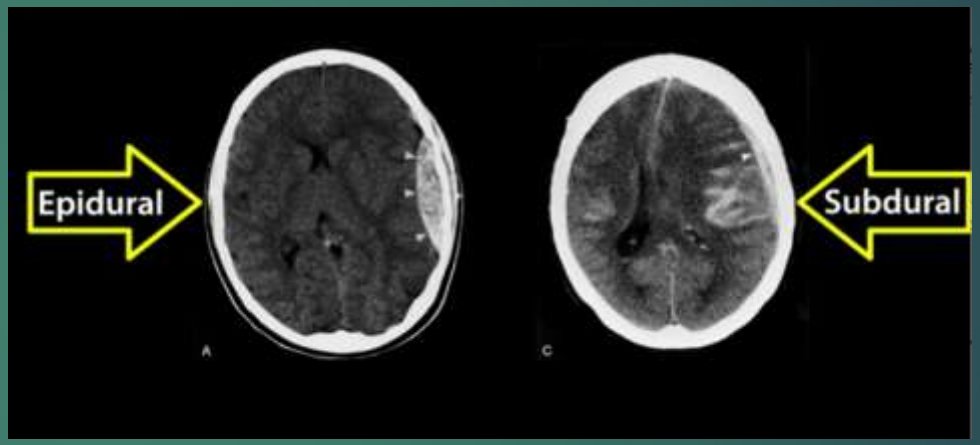
Neurologic injuries and head trauma are the most common causes of death in the trauma population.

Neurologic Injury

Nursing interventions

Optimal positioning:

- Head of bed elevated
- Neutral head alignment



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Stimuli reduction:

- Calming, quiet environment
- Gentle handling
- Analgesia, sedation, paralysis
- Cautious suctioning

Acute Respiratory Failure

Assess for airway patency and ensure adequate oxygenation and ventilation

Note:

- Respiratory rate and quality
- Chest movement rise and fall symmetrical?
- Lung sounds- diminished air entry, obstructed breathing
- Sign of foreign body, blood or vomit
- Oxygen saturation
- Tracheal location-midline shift?
- Crepitus

"Look, Feel, Palpate and Listen"

Acute Respiratory Failure

ACUTE RESPIRATORY FAILURE – Due to neck and throat injuries:

- Areas of serious and deadly injury
- Airway compromise may result
- Swelling may prevent adequate blood flow to brain
- Penetrating injury may result in air embolism
- Crushing injury may cause
- cartilage of upper airway/larynx to fracture

www.medpagetoday.com

Tissue Oxygenation

Physiologic Process	Parameter	Clinical Assessment	Interventions
Pulmonary Ventilation	PaCO2 ETCO2	Respiratory status PH	Positioning Suctioning Assisted ventilation Drug therapy
Diffusion	P/F ratio	PaO2, SpO2, SaO2	Supplemental O2 Mechanical Ventilation PEEP/CPAP Drug Therapy
Hemoglobin Availability	CaO2	Hemoglobin level	Hemostasis Normothermia Volume replacement Transfusion
Cardiac Output	DO2	CO/CI, BP, Pulse quality, perfusion	Rate control Volume manipulation Obstruction removal Contractile Support
Tissue O2 Utilization	VO2	SvO2/ScvO2, lactate, PH, base deficit	Increase O2 delivery Reduce O2 demand Sepsis interventions Drug therapy

ARDS Severity

Category	Mortality	P/F Ratio*
Mild	27%	200-300
Moderate	32%	100-200
Severe	45%	<100

*** P/F ratio Equation: PaO2/FiO2 x 100**

Example: PaO2 of 80 and is on 70% FiO2
80/70 x 100 = 114

Vascular Stability

Circulation:

- Look- note skin color
- Listen-B/P (hypotension is a late sign)
  -LOC (change in speech)
- Feel-pulse, perfusion

Interventions:

- Assess disability
- IVF
- Control hemorrhage
- Maintain MAP>65

www.osceskills.com

Mean Arterial Pressure = the perfusion pressure that organs and tissue actually receive

Sepsis

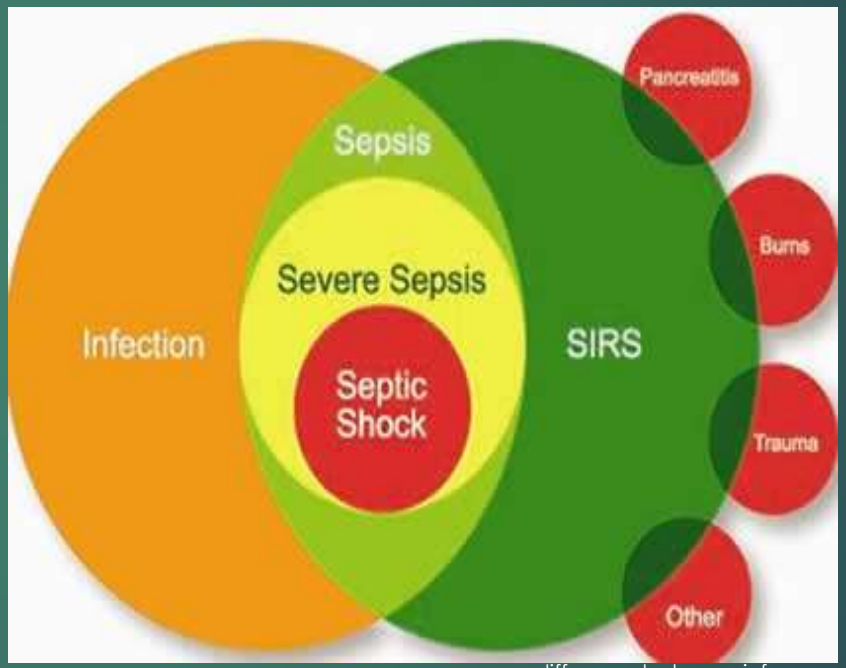
Sepsis: Complication and inflammatory response to infection

Treatment goals:

- Early detection
- Tissue oxygenation
- Source control

Diagnostic studies:

- Elevated WBC
- Elevated lactate
- Elevated procalcitonin
- Positive blood cultures
- C-reactive protein



www.differencebetween.info.com

Organ Failure

Failure to identify and correct critical deficits in tissue oxygenation leads to death of the organism.

Number of Failed Systems	Mortality
1	30%
2	60%
3	85%
4	100%

Cell death → Tissue death → Organ Death → Organ System Death → Organism Death

Vital organs in the abdomen require a high amount of blood flow.

Pain

Physical pain relief:

- Allows patient to better tolerate treatments
- Enhances the healing process
- Decreases work of breathing

www.medicaljane.com

Psychological pain relief:

- Decreases stress and anxiety
- Assists patient's that may have concerns regarding alteration in body image

Nutrition

Nutritional demands are increased in the trauma patient due to alterations in metabolism.

- Decreased body mass
- Increased O2 consumption
- Increased CO2 production
- Delayed wound healing
- Weakened immune system

Treatment:

- Provide high protein to replace muscle loss
- Monitor and replace electrolytes
- Feed the gut when possible to improve immunity and to prevent translocation of GI bacteria

Early Mobilization

Early mobilization after a traumatic injury can prevent detrimental complications

- DVT
- Pneumonia
- Contractures
- Muscle wasting
- Depression
- Delirium

www.Anatomy-physiotherapy.com

Damage Control Sequelae

Prevent and manage complications:

- New onset hypoxemia, hypercapnia, acidosis
- Cardiac arrhythmias
- Barotrauma from positive pressure ventilation
- DVT and pulmonary emboli
- GI distention, ileus or bleeding
- Infection
- Aspiration pneumonia

www.shop.advancecare.com

Case Study

PATIENT SCENARIO:

- R.S., a 60yo female motorist struck on driver side by truck driver. Lap belt in place without airbag deployment. No head injury.
- Brought to ER by EMS. Alert at the scene. GCS 15
- Reports severe chest and abdominal pain

WHAT INJURIES WOULD YOU SUSPECT THIS PATIENT HAS SUSTAINED?

Case Study (Continued)

History:

- Obesity
- Hyperlipidemia
- Hypertension
- 1 pack a day smoker
- 2-3 cocktails nightly
- Married but legally separated from spouse

Home Meds:

- Lopressor 25mg PO bid
- Prozac 20mg daily

Case Study (Continued)

ER PHYSICAL EXAM:

- Neuro: A & O x4, anxious, PERRLA, cooperative
- CV: ST with frequent unifocal PVCs on monitor, chest pain
- Pulmonary: Diminished breath sounds on left
- GI: Absent bowel tones, severe abdominal pain
- GU: Foley catheter placed. Amber urine

VITAL SIGNS:
Blood pressure – 90/49 (MAP 62)
Heart rate – 135, Respirations – 31, shallow, rapid
Temperature – 35.8, Spo2 – 92%, 10L oxy-mask, Pain – 8/10

Case Study (Continued)

Diagnostic Imaging:

- 2 View chest x-ray: left hemo/pneumothorax
- Head CT: negative
- Chest CT: left hemo/pneumothorax
- Abdomen/pelvis CT: laceration of liver grade II, splenic rupture, pancreatic contusion, small bowel perforation
- Cardiac echocardiogram: myocardial contusion
- Renal Ultrasound: negative
- ABG – WNL

Case Study (Continued)

Abnormal laboratory results:

- WBC 13, HCT 24, Platelets 112
- AST 89, ALT 77
- Urinalysis- trace RBC, Blood Cultures: negative

ER Assessment Diagnosis:

- Left hemo/pneumothorax
- Cardiac contusion
- Grade II liver lac, splenic rupture, pancreatic contusion
- Small bowel perforation
- Hypotension

Case Study (Continued)

Treatment plan:

- Dilaudid 1mg IV for pain
- Versed 2mg IV for anxiety
- Left lateral chest tube x2 placement
- Transfusion of 2 units packed red blood cells, 6 pack platelets
- IV LR 2 liter bolus followed by continuous infusion at 150cc/hr
- Emergent surgery for exploratory laparotomy
- Family notified

Case Study (Continued)

Post Operative Diagnosis: Splenectomy, small bowel resection, liver laceration, pancreatic contusion, cardiac contusion

Treatment plan:

- Admit to ICU – condition critical
- IV hydration, IV antibiotics, electrolyte replacement protocol
- IV infusion of fentanyl for pain, nicotine patch daily
- IV infusion of versed for sedation
- Blood glucose monitoring q 6 hrs, NPO
- Chest tube to wall suction, daily PCXR
- Continue ventilator support
- Serial hematocrit, hemoglobin, platelet, PT, PTT, INR
- DVT and GI stress ulcer prophylaxis
- Code status: FULL CODE

Case Study (Continued)

POST OP DAY 1

Assessment:

- Sedated on ventilator
- Follows commands
- Severe anxiety and bilateral hand tremors noted when sedation lowered for neuro assessment
- Hematocrit, hemoglobin and platelets stable
- Sinus tachycardia with occasional PVC's on monitor

Treatment plan:

Initiate alcohol withdrawal protocol

Case Study (Continued)

POST OP DAY 2

Treatment plan:

- Extubate patient
- Swallow evaluation – if passed clear liquid diet, if failed feed tube placement in IR and initiate tube feeding
- Physical therapy evaluation
- Continue IV fluids and antibiotics
- Continue alcohol withdrawal protocol
- Continue electrolyte replacement protocol
- Dilaudid IV prn pain
- Albuterol / Ipratropium SVN, incentive spirometer use
- Continue chest tube to wall suction

Case Study (Continued)

Assessment:

- Pt successfully extubated, on 3L NC with O2 sat 95%
- Non-invasive CPAP at night
- Passed swallow evaluation
- Tolerating clear liquid diet
- Reports adequate pain control with Dilaudid IV
- Alcohol withdrawal symptoms controlled with protocol
- Dangled at bedside with physical therapy

Case Study (Continued)

POST OP DAY 4

Treatment plan:

- Transfer patient to step down unit with telemetry
- Soft cardiac diet
- Out of bed for meals and ambulate TID
- Chest tube to water seal
- Continue antibiotics
- Continue albuterol / ipratropium SVN, incentive spirometer use
- Daily PCXR, labs
- Encourage smoking cessation, advance directive completion with designated medical POA

Case Study (Continued)

Summary:

The patient made a full recovery and was eventually discharged home to resume daily activities. Because "Best Practice" protocols were followed the patient did not suffer any adverse complications.

www.quora.com

Evidence Based Practice

Nursing care makes a difference
You can help decrease or prevent the following

Infection prevention – Hand washing – Every patient every time

- **CLABSI** (Central Line Associated Blood Stream Infection)

  Hand washing, CHG Baths

- **CAUTI**(Catheter Acquired Urinary Tract Infection)

  Hand washing, CHG baths

- **VAP** (Ventilator Associated Pneumonia)

  Hand washing, oral care, HOB at 30 degrees, sedation vacations, vent bundle, PEP/Flutter valve, turn q 2 hours, incentive spirometry, influenza vaccine, pneumonia vaccine, early ambulation

- **DVT** (Deep Vein Thrombosis)

  Early ambulation, sequential compression devices (SCD)

Key Points

- **Anticipate and treat problems with a greater level of complexity than usual.**
- **Provide the best quality care possible.**
- **Respond above and beyond the call of duty.**
- **Ask yourself "Have we missed anything?"**

Trauma Yesterday and Today

Ems.museum.or

Nola.gov

Allentownpa.gov

www.taams.org

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