Multisystem Problems

- Sepsis $\rightarrow$ Multiple Organ Dysfunction Syndrome (MODS)
- Multisystem Trauma
- Toxic Ingestions and Exposure

Definitions

- **Sepsis**: Systemic inflammatory response to infection
- **Bacteremia**: Presence of viable bacteria in blood
- **Systemic Inflammatory Response Syndrome (SIRS)**: Systemic response to a chemical insult (infection, pancreatitis, ischemia, trauma, or hemorrhagic shock)

Multisystem Problems

- Over 750,000 cases each year in USA
- Mortality rate approximately 25%
- Leading cause of death in non-cardiac ICU’s
- Systemic response to infection
**Sepsis:** presence of infection with systemic manifestations of infection
Diagnostic criteria: fever (>38.3°C) or hypothermia (<36°C), HR > 90 bpm, tachypnea, altered mental status, edema, hypergycemia

**Severe Sepsis:** sepsis associated with organ dysfunction, hypoperfusion or hypotension

**Septic Shock:**
- shock resulting from massive vasodilation caused by mediator release of the inflammatory process in response to overwhelming infection
- sepsis with hypotension despite adequate fluid resuscitation combined with perfusion abnormalities

**Multiple Organ Dysfunction Syndrome (MODS):** presence of altered organ function in an acutely ill patient such that homeostasis cannot be maintained without intervention

**Risk Factors**
- Extremes of age
- Nutritional state (obese, malnourished)
- Malignancy
- Splenectomy
- Immunosuppressive therapies (corticosteroids, antibiotics)
- Chronic illness (DM, liver disease, HF, CAD, RF)

**Sources of Infection/Sepsis**
- Lung (gastric aspiration)
- GI tract (NPO, GI ischemia → translocation of bacteria)
- GU system
- Wounds, multiple trauma, burns
- Invasive lines/procedures
- Ischemic/necrotic tissue
Microorganisms

- Gram negative: E. coli, shigella, salmonella, klebsiella, serratia, pseudomonas, enterobacter
- Gram positive: streptococcus, C. difficile, S. aureus
- Viruses, fungi, protozoa

Clinical Presentation: Early, Hyperdynamic (looks like infection)

- Fever
- Tachypnea, hypoxemia (respiratory alkalosis)
- Tachycardia (HR > 90 bpm)
- Hypotension (SBP < 90 mmHg)
- Warm, dry skin, ↓ SVR
  - ↑ CI, ↑ CO
  - SVO2 > 70%
  - ↓ CVP, ↓ PAOP, ↓ PAP
  - Irritable, confused
  - Hyperglycemia, ↓ platelets, ↑ PT/aPTT
Clinical Presentation: Late, Hypodynamic (looks like shock)

- Tachycardia, hypotension
- ↓↑ RR
- Cool, pale skin, SVR variable
- Metabolic acidosis
- Anuria
- Hypothermia
- ↓ CO/CI, ↓ SVO2
- ↑ PT/PTT, ↑ creatinine/BUN, hypoglycemia
- ↓ platelets, ↓ protein C,
  Lethargy or coma

Management

- Airway, oxygen
- Maintain tissue perfusion (volume with crystalloids) to keep CVP 8-12 mm Hg, MAP > 65 mm Hg, urine output > 0.5 mL/kg/hr
- Vasopressors (norepinephrine, epinephrine, dopamine vasopressin)
- Identify (culture) and treat source of infection with IV antibiotics within 1 hour of recognition of severe sepsis
- Monitor arterial lactate levels

Which of the following mechanisms contributes to hypotension in sepsis?

- A. Elevated afterload
- B. Increased cardiac contractility
- C. Peripheral vasodilation
- D. Decreased vascular permeability

Management

- Maximize oxygen delivery (mechanical ventilation)
- Minimize oxygen consumption (sedation, NMB)
- Inotropes (dobutamine)
- Corticosteroids (hydrocortisone)
- Provide nutrition
- Renal replacement therapy
- Glucose control
- DVT and stress ulcer prophylaxis
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Multiple Organ Dysfunction Syndrome (MODS)

• Clinical events (infection, inflammation, hypoperfusion and ↓ oxygen delivery) lead to cellular events
• Primary MODS: direct organ injury
• Secondary MODS: Consequence of infection or trauma that leads to systemic inflammatory response and organ dysfunction elsewhere

Etiology

• Trauma, burns, crush injuries
• Abscesses, ischemic or necrotic tissue
• Infection
• Shock, cardiac arrest

Clinical Presentation

• ARDS
• Myocardial depression
• Abdominal distension, ileus, diarrhea, intolerance to tube feedings
• GI bleeding, hepatomegaly, ↑ liver enzymes and ammonia
• Acalculus cholecystitis
• DIC (↑ FSP, D-dimer > 2 mg/L)
Clinical Presentation

• ATN, electrolyte imbalances, acid-base imbalances
• Restless, no interest in surroundings
• Insomnia, confusion, coma
• ↑ PT/PTT, ↑ or ↓ WBC
• Bleeding, ecchymosis

Management

• Prevention!
• Early identification
• Eliminate source of infection
• Maintain tissue perfusion/oxygenation
• Decrease oxygen consumption
• Nutritional support (tube feedings)

Multisystem Trauma

• Injury is leading cause of death in people from age 1 to 37 years
• 4th leading cause of death for all ages, following heart disease, cancer, and stroke
Mechanisms of Injury

• Blunt/nonpenetrating (MVC, falls)

• Penetrating (GSW, stab wounds, impalement, avulsion and degloving)

Physiological Response

• Stress response
  ↑ HR, ↑BP, vasoconstriction
  ↑ capillary permeability, hypovolemia

• Coagulopathy

• Decreased tissue perfusion with increased oxygen consumption

• Metabolic response: hyperglycemia, catabolism
Assessment

- Primary survey (A-B-C-D)
  - Performed in 1-2 minutes to identify life-threatening injuries
- History of the incident
- Secondary survey (E-F-G-H-I)

Primary Survey

- Airway
  - Open and patent
  - Maintain cervical spine immobilization
- Breathing
  - Presence and effectiveness
  - Decreased or absent breath sounds
  - Color
  - Presence of external bleeding

Impaired Airway

- Shallow, noisy breathing
- Cyanosis
- Inability to speak
- Trauma to face, neck, mouth
- Drooling
- Nasal flaring
- ↓ LOC

Primary Survey

- Circulation
  - Presence and quality of major pulses
  - LOC
  - Bleeding
  - Hypotension is a late sign!
- Disability
  - Gross neurological status - LOC
  - Pupil size, equality, reactivity to light
Management

• Open airway by chin lift or jaw thrust
• Suction
• Intubation
• Cricothyrotomy

Impaired Breathing

• RR < 10 or > 29 breaths/min
• Absent, unequal breath sounds
• Blunt chest injury/ open chest wound
• Pallor, cyanosis
• Labored breathing
• Tracheal shift
• Paradoxic chest wall motion
**Tension Pneumothorax**
- Distended neck veins
- Hyperresonance on affected side
- Absent/decreased breath sounds on the affected side
- Tracheal shift toward unaffected side
- Hypotension
- Tachypnea

**Hemothorax**
- Flat neck veins
- Dullness to percussion
- Absent breath sounds on the affected side
- Tracheal shift toward unaffected side
- Hypotension

**Cardiac Tamponade**
- Blood/ fluid in pericardial space compromises cardiac filling and cardiac output
- ↑ HR, ↑ CVP, ↑ PAOP
- Beck’s triad: ↓ BP, distended neck veins, muffled heart sounds
- ↓ CO, ↓ CI, ↓ SVO2
Management

• Oxygen
• Intubation
• Needle thoracostomy
• Chest tube
• HOB elevation 30 to 45 degrees

Impaired Circulation (Hypovolemia)

• Weak, thready pulse
• Cool, damp skin
• BP < 90 mm Hg
• Bleeding
• ↓ LOC
• Delayed capillary refill
• Oliguria

Management

• Manual pressure over bleeding site
• Fluid resuscitation (blood or crystalloids)
• Warm IV fluids to prevent hypothermia
• Short, large bore peripheral IV’s or trauma catheters
• Administer volume rapidly (volume infuser, pressure bag)

Impaired Neurological Status

• Glasgow Coma Scale < 11
• Agitation
• Motor deficits
• Primary injury: direct injury to brain tissue
• Secondary injury: occurs over hours or days as a result of biochemical changes, ↑ ICP, seizures, hypotension, hypoxia, hypercapnia, hyperthermia, and/or sodium imbalance
Management

- Maintain and protect airway, breathing, and circulation
- Intubation
- Control for increased ICP (head in neutral position, normothermia, volume resuscitation, adequate oxygenation)
- Protect patient from self harm

History of the Incident

- "Index of suspicion"
- Accident data base
  Type of accident (MVC, driver, passenger)
  Events (type of weapon, ejection, speed of vehicle)
  Blunt or penetrating
  Extrication (how long?)

History of the Incident

- Health history
  Smoking, chest pain, surgeries
  A: allergies
  M: medications
  P: past illness
  L: last meal (type, quantity, time)
  E: events preceding the injury
- Physical exam

Secondary Survey

- Expose
  Remove patient's clothing to perform a thorough physical exam
  Maintain spine alignment
  Keep patient warm
Secondary Survey

• Full set of vital signs/Five interventions/ Facilitate family presence
  HR, RR, BP, temperature
  Five interventions: Foley, NG tube, pulse oximetry, cardiac monitor, blood and urine for lab studies
  Update family, facilitate visitation

Secondary Survey

• Give comfort measures
  • Pain relief
• History/head to toe assessment
  • Mechanism of injury
  • Injuries sustained
• Vital signs
  • Treatment
• Inspect posterior surfaces

Vital Signs

• Heart rate (HR)
  ↑ HR following trauma
  ↓ HR/irregular HR in blunt chest trauma
• Respiratory rate (RR)
  ↑ RR following trauma
  Absence of ↑ RR suggests CNS injury or substance abuse

Vital Signs

• Blood pressure
  Ideal is systolic > 90 mmHg
  Older adults less able to tolerate volume deficits
  ETOH intoxication may lead to ↑BP or ↓BP
Inspection

• Abrasions, ecchymoses, swelling, skin lacerations may indicate deeper injuries
• Otorrhea (CSF from ears), rhinorrhea (CSF from nose), and blood from nose or ears may indicate basilar skull fracture
• Blood at urinary meatus may indicate lower urinary tract injury or pelvic fracture
• Protruding bone fragments or viscera
• Deformity of extremities
• Entry or exit wounds

Auscultation

• Heart and lung sounds
• GI tract for hypoactivity or hyperactivity

Palpation

• Skull depression
• Facial deformity
• Deformity of thorax; subcutaneous emphysema
• Abdominal guarding
• Deformities/tenderness of extremities and spine
• Absence of peripheral pulses

Diagnostic Tests

• CBC, blood type and crossmatch
• Serum electrolytes, BUN, creatinine, coagulation studies, lactate
• Arterial blood gases
• Urine and blood toxicology
• Urinalysis
Diagnostic Tests

- Ultrasound of four abdominal compartments to detect abdominal injury and cardiac tamponade
- X-rays (chest, spine, extremities)
- CT scan
- 12 lead ECG
- Echocardiography
- Angiography
- Diagnostic peritoneal lavage

Complications

- Hypothermia
- Infection
- Altered tissue perfusion from DVT or emboli
- Catabolism
- Pain
- Post-traumatic stress

Toxic Ingestions and Exposure

- Accidental or intentional overdose
- Accidental overdose of illegal drugs
- Ingestion/absorption of a poison

Pathophysiology

- Dependent on:
  - Drug ingested
  - Amount ingested
  - Time from ingestion to treatment
  - Preexisting condition of patient
Physiologic Response

- Local toxicity (effects occur at site of first contact)
- Systemic toxicity (effects occur after absorption and distribution of substance)
- CNS involved most frequently followed by CV, blood, liver, kidney, lung, and skin

Etiology

- Cleaning substances most frequent accidental exposure
- Analgesics have largest number of deaths
- Recreational drug use dependent on the community. Most common: cocaine, heroin, methamphetamine, inhalants
- Designer drugs (created): analogues of phenylethylamine, fentanyl, meperidine

Management - History

- Name of poison
- Route and amount of exposure
- Current symptoms
- Age of victim
- Time and length of exposure
- General health history

Management: Stabilization

- Airway, oxygenation, ventilation
- Cardiac monitor
- IV access
- Blood, urine, gastric contents for toxicology screening
- Serum electrolytes, coagulation studies, ABG’s, chest x-ray, 12 lead ECG, pregnancy test
Prevent Absorption

- Emesis – rarely used in hospital setting
- Gastric lavage
- Adsorbent therapy
- Bowel irrigation

Gastric Lavage

- Use if patient arrives within 1 hr of ingestion
- Intubate first if patient has ↓ LOC and diminished gag reflex
- Contraindications: caustics ingested, seizures, GI bleeding
- Ewald tube (32-40 French)
- Left side-lying position
- 150-200 mL warm tap water (up to total of 5-10 liters) instilled and aspirated

Adsorbent Therapy

- Activated charcoal (1g/Kg) after gastric lavage
- Adsorbing drugs adhere to surface of activated charcoal (adhesion of liquid or gas to the surface of a solid) decreasing absorption of drug
- Effective with theophylline, Tegretol, and phenobarbital

Bowel Irrigation

- Used in large ingestions not adsorbed with activated charcoal; “body packers” and “body stuffers”
- GoLYTELY 1-2 liters/hr for 4-6 hrs or until patient having clear stools
Facilitate Drug Removal

- IV fluids
- Loop or osmotic diuretics
- Urinary alkalinization (sodium bicarb for ASA and tricyclic antidepressants)
- Hemodialysis (lithium, amphetamines, ethylene glycol)

Management

- Monitor hepatic function
- Maintain renal function
- IV fluids
- Monitor for myoglobinuria

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lopathy. What physiologic process contributes to the patient’s progressive response to this toxic ingestion?

A. Clearance
B. Absorption
C. Distribution
D. Adsorption
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