Asphyxia (CCRN)

Asphyxia Definition
- Extreme decrease in oxygen concentration
- Increased carbon dioxide concentration
- Leads to loss of consciousness or death

Traumatic Causes
- Suicide: Drowning & Hanging
- Choking: internal FBO or external
- Compressive/restraint: Healthcare, Police, Children
- Electrocution
- Auto-erotic
- Perinatal
- Drug overdose
- Co-sleeping/overlay

Physiologic Causes
- Aspiration: EtOH/Drugs/PNA
- Angioedema: anaphylaxis
- Laryngeal Edema
- Isocapneic Hypoxia
- Cerebral Hypoxia
- Disease Processes
  - End stage COPD
  - Pulmonary Fibrosis
  - Obstructive Sleep Apnea
  - Pickwickian

Test Plan

<table>
<thead>
<tr>
<th>CCRN</th>
<th>PCCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>8% (8 questions)</td>
<td>5% (5 questions)</td>
</tr>
<tr>
<td>Asphyxia</td>
<td>Infectious disease</td>
</tr>
<tr>
<td>Shock states</td>
<td>Shock states</td>
</tr>
<tr>
<td>SIRS</td>
<td>SIRS</td>
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<tr>
<td>Multisystem trauma</td>
<td></td>
</tr>
<tr>
<td>Toxic exposure</td>
<td></td>
</tr>
</tbody>
</table>
Chemical/Toxic Inhalation Causes

- CO2
- Propane
- Helium
- Argon
- Nitrogen
- Other:
  - Altitude/Vacuum (mining accidents)
  - Burns

Asphyxia Clinical Presentation

- Early
  - Tachypnea
  - Tachycardia
  - Normo/Hypertensive
  - SNS: Fight or Flight

- Late
  - Confusion/Lethargy/Unresponsive
  - Insufficient Breathing
  - Hypotension
  - Bradycardia
  - Coma/Death

Asphyxia Treatment

- Identify the Cause
- Neutralize the cause if possible
- Establish Duration
- ABC’s
- Supportive Care
- Prevention/Monitoring for indirect injury

Shock States

<table>
<thead>
<tr>
<th>Shock States (CCRN and PCCN)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hypovolemic</th>
<th>Cardiogenic</th>
<th>Early Septic</th>
<th>Late Septic</th>
<th>Anaphylactic</th>
<th>Neurogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Normal or Low</td>
<td>Normal or Low</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Normal to Low</td>
<td>Normal to Low</td>
<td>Normal to Low</td>
<td>Low</td>
<td>Normal to Low</td>
<td>Normal to Low</td>
</tr>
<tr>
<td>Cardiac Output</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Normal to Low</td>
<td>Normal to Low</td>
</tr>
<tr>
<td>CVP/PAP/WP</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High but may be Normal or Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>SVR/PVR</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>SVO2</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Hemodynamics of Shock

<table>
<thead>
<tr>
<th>Shock Type</th>
<th>PCWP (preload)</th>
<th>Cardiac Output</th>
<th>SVR (afterload)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemic shock</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>IV fluids</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>Inotropes Revascularization</td>
</tr>
<tr>
<td>Distributive shock (septic, neurogenic)</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
<td>Pressors IV fluids</td>
</tr>
</tbody>
</table>

PCWP = pulmonary capillary wedge pressure  SVR = systemic vascular resistance
Shock States

<table>
<thead>
<tr>
<th>Measure</th>
<th>Hypovolemic</th>
<th>Cardiogenic</th>
<th>Obstructive</th>
<th>Distributive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Painful chest</td>
<td>Decreased</td>
<td>Increased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Fever with chills</td>
<td>Increased</td>
<td>Decreased</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Cardiac index</td>
<td>Increased</td>
<td>Decreased</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Oxygen delivery</td>
<td>Increased</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Increased</td>
</tr>
<tr>
<td>Oxygen consumption</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Increased</td>
<td>Decreased</td>
</tr>
</tbody>
</table>

SIRS (CCRN and PCCN)
Systemic Inflammatory Response System

SIRS Definition
- Widespread inflammation
- Due to a variety of severe clinical insults
  - Pancreatitis
  - Ischemia and/ or reperfusion
  - Multiple trauma and tissue injury
  - Hemorrhagic shock
  - Immune-mediated organ injury
- Secondary diagnosis of the activation of the complement pathway, cytokine production, and endothelium activating chemical mediators

Manifested by two or more
- Hyper/ Hypothermia (Temperature > 38 or < 36) (Temperature >100.4 or <96.8)
- Tachycardia: HR> 90 beats/minute
- Hyperpnea: RR> 20 breaths/minute or PaC02 < 32 mm Hg or mechanical ventilation
- WBC > 12, 000 or < 4,000 OR 10% mature neutrophils

Sepsis Definition
- SIRS resulting from infection (bacterial, viral, fungal, or parasitic)
- Known or suspected clinical infection with two or more of the SIRS criteria
- Bacterial infection of the blood
- Can be a secondary complication to injury & illness
- Associated with generalized inflammatory response leading to abnormal clotting and bleeding in the presence of infection

Infection
- 140,000 cases of gram negative sepsis annually
- Mortality is still 40-60% with timely therapy
- Mortality is 90-95% with delayed or ineffective treatment
Gram-Negative

- 25% of all cases
- E. coli
- Klebsiella
- Pseudomonas
- Serratia
- Haemophilius
- Enterobacter

Gram-Positive

- 50% of cases
- Staph aureus
- Staph epi
- Strep pneumoniae
- Clostridia
- Pneumococcus

Viral and Fungi

- Viral
  - HIV
  - Herpes
- Fungi: (10% of cases)
  - Candida

Most Common Sources

- Exogenous
  - Hospitals & Staff
- Endogenous
  - Skin
  - GI Tract
  - Lungs
  - GU Tract

Sepsis Signs & Symptoms

- Chills
- Alteration in temperature
- Tachypnea
- Change in mental status
- Nausea/ Vomiting
- Diarrhea
- Tachycardia
- Low Blood Pressure
- Altered WBC, Bandemia
- Thrombocytopenia
- Decreased perfusion: mottling, poor capillary refill
- Increased blood sugar
- Petechiae/ Purpura

Severe Sepsis Defined

- Sepsis with either hypotension or systemic manifestations of hypoperfusion

OR

- Sepsis + dysfunction of at least one organ
Signs & Symptoms…Early
- Acute alteration in Mental Status
- Confusion
- Tachypnea
- Tachycardia
- Oliguria
- Warm extremities with bounding pulses

Signs & Symptoms…Late
- Lactic acidosis > 4
- Oliguria <1/2ml/kg/hr, Anuria, Elevated Creatinine
- Acute alterations in Mental Status/Confusion/Psychosis
- Chills
- Tachypnea: PaO2 < 70 mmHg, SaO2 < 90%, PaO2/FiO2 <300

Signs & Symptoms…Late (con’t)
- Tachycardia: SPB < 90 mmHg, decreased CVP & PAOP
- Altered WBCs, elevated immature neutrophils, decreased platelet count, increased PT/PTT, increased D-Dimer, decreased protein C, increased FDP/FSP
- Increased LFTs, jaundice, hypoglycemia, decreased albumin
- Cool extremities, mottling, poor capillary refill, petechiae

Septic Shock Defined
- Sepsis induced state
- Hypotension despite adequate fluid resuscitation
- With physiologic evidence of abnormal perfusion may include, but are not limited to…
  ◦ Lactic acidosis, oliguria, mental status changes, hypotension and reduced perfusion to vital organs

Septic Shock Treatment
- Early goal directed therapy in first 6 hours
- Early resuscitation
  - Decreases mortality by maximizing preload, afterload, & contractility to balance O2 delivery with demand
- Follow sepsis pathways and protocols
- All treatments should include basic nursing care, pain management, nutrition, and emotional support of the patient and family

Septic Shock Initial Resuscitation
- Begin resuscitation immediately in patients with hypotension or elevated serum lactate >4 mmol/L
- Do not delay ICU admission…
- Resuscitation goals:
  ◦ CVP: 8–12 mmHg
  ◦ Mean arterial pressure: 65 mmHg
  ◦ Urine output 0.5 mL/kg/hr
  ◦ Central venous (superior vena cava) oxygen saturation 70% or mixed venous 65%
- If venous oxygen saturation target is not achieved
  ◦ Consider further fluid
  ◦ Transfuse packed red blood cells if required to hematocrit of >30% and/or
  ◦ Start Dobutamine infusion, maximum 20 mg/kg/min
**Sepsis Diagnosis**

- Obtain appropriate cultures before starting antibiotics (provided this does not significantly delay antimicrobial administration)
- Obtain two or more BCs
- One or more BCs should be percutaneous
- One BC from each vascular access device in place >48 hrs
- Culture other sites as clinically indicated
- Perform imaging studies promptly to confirm and sample any source of infection (if safe to do so)

**Antibiotic Therapy**

- Begin IV antibiotics as early as possible within the first hour of recognizing severe sepsis and septic shock
- Broad-spectrum: one or more agents active against likely bacterial/fungal pathogens and with good penetration into presumed source

**Antibiotic Therapy (con’t)**

- Reassess antimicrobial regimen daily to optimize efficacy, prevent resistance, avoid toxicity, and minimize costs
  - Consider combination therapy in *Pseudomonas* infections
  - Consider combination empiric therapy in neutropenic patients
  - Combination therapy < 3–5 days and de-escalation following susceptibilities
  - Duration of therapy typically limited to 7–10 days; longer if response is slow or there are undraining foci of infection or immunologic deficiencies
  - Stop antimicrobial therapy if cause is found to be noninfectious

**Source Identification & Control**

- Establish site of infection within first 6 hours
- Evaluate for focus of infection (e.g. abscess drainage, tissue debridement)
- Implement measures as soon as possible following successful initial resuscitation (exception: infected pancreatic necrosis, where surgical intervention is best delayed)
- Choose measure with maximum efficacy and minimal physiologic upset
- Remove intravascular access devices if potentially infected

**Fluid Therapy**

- Fluid-resuscitate using crystalloids or colloids
  - Target CVP of 8 mmHg
    - 12 mm Hg if mechanically ventilated
- Use a fluid challenge technique
  - Give fluid challenges of 1000 mL of crystalloids or 300–500 mL of colloids over 30 minutes
- More rapid and larger volumes may be required
- Rate of fluid administration should be reduced if cardiac filling pressures increase

**Vasopressors**

- Maintain MAP >65 mmHg
- Initial choice: Norepinephrine and Dopamine centrally administered
  - Epinephrine, Phenylephrine, or Vasopressin should not be administered as initial choice
  - Vasopressin 0.03 units/min may be subsequently added to norepinephrine
  - Use Epinephrine as the first alternative agent when blood pressure is poorly responsive to Norepinephrine or Dopamine
### Vasopressors (con't)
- Do not use low-dose Dopamine for renal protection
- In patients requiring vasopressors, insert an arterial catheter as soon as practical
- Inotropic therapy
  - Use Dobutamine in patients with myocardial dysfunction as supported by elevated cardiac filling pressures and low cardiac output
  - Do not increase cardiac index to predetermined supranormal levels

### Steroids
- Consider IV hydrocortisone when hypotension responds poorly to adequate fluid resuscitation and vasopressors
  - ACTH stimulation test is not recommended
  - Hydrocortisone is preferred to dexamethasone
  - Fludrocortisone (50 mcg orally once a day) may be included if an alternative to hydrocortisone is being used that lacks significant mineralocorticoid activity
  - Fludrocortisone if optional if hydrocortisone is used
  - Steroid therapy may be weaned once vasopressors are no longer required
- Hydrocortisone dose should be <300 mg/day IV
- Do not use corticosteroids to treat sepsis in the absence of shock unless the patient’s endocrine or corticosteroid history warrants it

### Recombinant Human Activated Protein C
- Consider Xigris if **APEX** present:
  - Antibiotic
  - vasoPressor…consider
  - Evaluating for…
    - Xigris
- Adult patients with severe sepsis and low risk of death (typically one organ failure) should not receive rhAPC
- Must monitor patient for BLEEDING

### Recombinant Human Activated Protein C
- Consider if there are no contraindications:
  - Active internal bleeding
  - Recent (within 3 months) hemorrhagic stroke
  - Recent (within 2 months) intracranial/intraspinal surgery, or severe head trauma
  - Trauma with risk of life-threatening bleeding
  - Presence of an epidural catheter
  - Intracranial neoplasm/mass lesion/evidence of cerebral herniation

### Blood Product Administration
- Give RBCs when hemoglobin <7.0 g/dL (<70 g/L) to target a hemoglobin of 7.0–9.0 g/dL
- A higher hemoglobin level may be required in special circumstances (e.g., myocardial ischemia, severe hypoxemia, acute hemorrhage, cyanotic heart disease, or lactic acidosis)
  - Do not use erythropoietin to treat sepsis-related anemia
  - Do not use FFP to correct clotting abnormalities unless there is bleeding or planned invasive procedures

### Blood Product Administration
- Do not use antithrombin therapy
  - Administer platelets when counts are <5,000/mm^3 regardless of bleeding
  - Counts are 5,000–30,000/mm^3 and there is significant bleeding risk
  - Higher platelet counts (>50,000/mm^3) are required for surgery or invasive procedures
**Mechanical Ventilation**
- Target a tidal volume of 6 mL/kg (predicted) body weight in patients with ALI/ARDS
- Target an initial upper limit plateau pressure <30 cm H2O. Consider chest wall compliance when assessing plateau pressure
- Allow PaCO2 to increase above normal, if needed, to minimize plateau pressures and tidal volumes

**Mechanical Ventilation (con’t)**
- Set PEEP to avoid extensive lung collapse at end-expiration
  - Use prone position for ARDS patients requiring potentially injurious levels of FIO2 or plateau pressure, provided they are not put at risk from positional changes
  - Maintain in a semirecumbent position (head of the bed raised to 45°) unless contraindicated
  - Noninvasive ventilation may be considered in the minority of ALI/ARDS patients with mild to moderate hypoxemic respiratory failure

**Mechanical Ventilation (con’t)**
- Use a weaning protocol & SBT regularly
- SBT options include a low level of pressure support with continuous positive airway pressure 5 cm H2O or a T piece
- Before the SBT, patients should be:
  - Arousable
  - Hemodynamically stable
  - No new potentially serious conditions
  - Low ventilatory & end-expiratory pressure requirement
  - FIO2 levels that can be safely delivered with a face mask or nasal cannula

**Mechanical Ventilation (con’t)**
- Do not use a pulmonary artery catheter for the routine monitoring of patients with ALI/ARDS
- Use a conservative fluid strategy for patients with established ALI who do not have evidence of tissue hypoperfusion

**Sedation, Analgesia, Neuromuscular Blockade**
- Use sedation protocols with a sedation goal
- Provide daily interruption/lightening to produce awakening
- Re-titrate if necessary
- Avoid neuromuscular blockers
- Monitor depth of block with train-of-four when using continuous infusions

**Glucose Control**
- Use IV insulin to control hyperglycemia
- Keep blood glucose <150 mg/dL (8.3 mmol/L) using a validated protocol for insulin dose adjustment
- Provide glucose calorie source
- Monitor blood glucose values every 1–2 hrs (4 hrs when stable) when receiving IV insulin
- POC T may overestimate arterial blood or plasma glucose values
Other Considerations

- **Renal replacement**
  - Intermittent hemodialysis and CVVH are considered equivalent
  - CVVH offers easier management in hemodynamically unstable patients

- **Bicarbonate therapy**
  - Do not use bicarbonate therapy for the purpose of improving hemodynamics or reducing vasopressor requirements when treating hypoperfusion induced lactic acidemia with pH >7.15

Deep Vein Thrombosis Prophylaxis

- Use either low-dose UFH or LMWH, unless contraindicated
- Use a mechanical prophylactic device, such as compression stockings or an intermittent compression device, when heparin is contraindicated
- Use a combination of pharmacologic and mechanical therapy for patients who are at very high risk for deep vein thrombosis
- In patients at very high risk, LMWH should be used rather than UFH

Other Considerations

- **Stress ulcer prophylaxis**
  - Provide stress ulcer prophylaxis using H2 blocker or proton pump inhibitor
  - Benefits of prevention of upper gastrointestinal bleed must be weighed against the potential for development of ventilator-acquired pneumonia

  - **Consideration for limitation of support**
    - Discuss advance care planning with patients and families
    - Describe likely outcomes and set realistic expectations

Deep Vein Thrombosis Prophylaxis

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Multisystem Organ Dysfunction Syndrome (MODS): Defined

- Presence of altered organ function in an acutely ill patient such that homeostasis cannot be maintained without intervention
- Primary MODS is the direct result of a well-defined insult in which organ dysfunction occurs early and can be directly attributable to the insult itself
- Secondary MODS develops as a consequence of a host response and is identified within the context of SIRS
- Clinical factors associated with progression to MODS:
  - Inadequate initial resuscitation
  - Persistent infection
  - Systemic inflammation in the absence of infection

Organ Failure… Central Nervous System

- Lethargy
- Fever
- Hepatic encephalopathy
- GCS <15 or decreased by 1 point
- “Brain Failure” (confusion, agitation, psychosis)

Organ Failure… Cardiovascular

- **Hyperdynamic**
  - ↓ PAOP/ Wedge
  - ↓ SVR/PVR
  - ↓ CVP/RAP
  - ↓ LVSWI
  - ↑O2 Consumption /delivery
  - ↑ C.O./C.I.
  - Tachycardia
  - Hypotension

- **Hypodynamic**
  - ↑ SVR/PVR
  - ↑ CVP/RAP
  - ↑ LVSWI
  - ↓ O2 Consumption /delivery
  - ↓ C.O./C.I.
Organ Failure...Pulmonary

- ARDS/ ALI
  - Bilateral infiltrates on x-ray
  - Wedge <18 mmHg
  - Unexplained hypoxemia...
    - PaO2/FiO2 <175-250 mmHg
  - ABG deterioration from baseline
  - Tachypnea
  - Dyspnea
  - Pulmonary HTN

Organ Failure...Gastrointestinal

- Paralytic ileus
- Intolerance of GI feeding for > 5 days
- GI bleeding
- Stress ulcers
- Decrease bowel sounds
- Abdominal distension

Organ Failure...Renal

- Oliguria <0.5ml/kg/hr
- Serum creatinine up to 2-3 mg/dL (normal renal function)
  - Urine Na <40 mmol/L (normal renal function)
  - Serum creatinine up by 2.0 mg/dL (chronic renal failure patients)

Organ Failure...Hepatobiliary

- LFTs elevated to twice baseline
- Bilirubin above 2.0 mg/dL
- PT twice normal time
- Decreased albumin
- Jaundice
- Increased ammonia

Organ Failure...Coagulation Hematologic

- Decrease in platelets by 25%
- Thrombocytopenia
- Bleeding
- Elevated PT/PTT to 125% of normal

  DIC:
  - <Platelets: <100,000/mm2
  - >PTT: >60-90 seconds
  - >PT: >15 seconds
  - < Fibrinogen: <200mg/100ml
  - >FDP/FSP elevated: >10mg/ml but<100
  - >D-Dimer elevated: <2mg/L abn>2mg/L
  - <Antithrombin III (nml 80-120%, abn <70%)
Extent of Injury
- Determined by
  - The type of energy applied
  - How quickly the energy is applied
  - To what part of the body the energy is applied
  - Mechanical energy can cause damage to:
    - Epithelial tissue: Skin, trachea, mucous membranes
    - Connective tissue: Cartilage, bone, joint structures
    - Muscle tissue: Cardiac, skeletal, blood vessels
    - Nerve tissue: Neurons and supporting cells
- Mass vs. Velocity
  - Double the Mass = Double the Energy
  - Double the Velocity = Quadruple the Energy

Descriptors of Injury
- Blunt
  - An injury produced by the wounding forces of compression and change of speed (shearing), which may disrupt tissue
  - Direct compression or pressure on a structure
  - The most common type of force
  - MVC's and Falls

Descriptors of Injury
- Penetrating
  - An injury that causes lacerations, cuts, puncture, piercing, and amputation…any interruption in skin and integrity (avulsion/degloving)
  - Firearms, knives, and other items can cause penetration injuries
  - Most important to leave penetration device in place until surgical removal!!

Descriptors of Injury
- Acceleration
  - An injury event that occurs when the victim is slow moving or stationary and in acted upon by increasing amounts of energy and velocity.
  - Example: A slow moving car struck from behind by a fast moving car.

Descriptors of Injury
- Deceleration
  - Force that stops or decreases the velocity of a moving victim.
  - Motor vehicle collision:
    - The vehicle strikes an object
    - The occupant collides with the inside of the car
    - The internal organs collide inside the body
    - Tensile stress (tissue cells are separated i.e. splenic capsule)
    - Compressive stress (tissue and structures pressed together i.e. comminuted bone fracture)
    - Shearing stress (stress results from a tangential force i.e. ligamentum arteriosum & ligament of Treitz)

Descriptors of Injury
- Direct: Initial injury/point of impact, injury resulting from a dynamic energy load
  - Examples: Brain contusion or concussion, Long bone fracture, Shattered pelvis, Asphyxia from drowning, Electrical burn

- Indirect: secondary injury that is a result of direct injury
  - Examples: cerebral edema, ischemia & bleeding, Fat Emboli, Retroperitoneal bleed, ARDS , Renal failure from Myoglobinuria, Sepsis…
Class 1 Hemorrhage
- 15% loss (up to 750ml)
  - Pulse: less than 100
  - BP: normal
  - Pulse Pressure: Normal or increased
  - LOC: Slightly anxious
  - RR: 14-20
  - U.O: >30ml/hr
- Treatment: Crystalloids

Class 2 Hemorrhage
- 15-30% loss (750ml - 1500ml)
  - Pulse: >100
  - BP: normal
  - Pulse Pressure: decreased
  - LOC: Mildly anxious
  - RR: 20-30
  - U.O: 20-30 ml/hr
- Treatment: Crystalloids & Blood Products

Class 3 Hemorrhage
- 30-40% loss (1500ml - 2000ml)
  - Pulse: >120
  - BP: decreased
  - Pulse Pressure: decreased
  - LOC: Anxious, Confused
  - RR: 30-40
  - U.O: 5-15 ml/hr
- Treatment: Blood Products

Class 4 Hemorrhage
- >40% loss (> 2000ml)
  - Pulse: >140
  - BP: decreased
  - Pulse Pressure: decreased
  - LOC: Confused, Lethargic
  - RR: >35
  - U.O: Minimal
- Treatment: Blood Products, Surgery

Rules of Resuscitation
- Two large bore catheters or central line
- Warm fluids for massive resuscitation to maintain body temp...Level I Rapid Infuser
- Monitor and expect edema ...protect airway, watch for pulmonary edema
- Maintain adequate Hgb/Hct
  - Sat >94%, Hgb >7 g/dl, PaO2 > 60 mm Hg

Rules of Resuscitation
- For every unit of PRBCs, you anticipate Hct increasing by 3 pts.
- Repeat CBC should be done 2-3 hours AFTER last unit transfused
- For every four units of PRBCs, give one amp of Ca Glucanate
- For every unit of PRBCs, you should anticipate administering FFP for Factor V-VII
- Replacement of blood loss/resuscitation: PRBC:Plasma:Platelets/ 1:1:1
Osmolality of Solutions

- **Isotonic**
  - Expand intravascular compartment
  - *Do Not give LR to pts with hepatic compromise*
- **Hypotonic**
  - Cellular hydration…fluid moves into cells
  - *Do Not give to neuro, burn, trauma, malnourished or liver diseased pts.*
- **Hypertonic**
  - Cellular “shrinking” fluid move into intravascular space
  - *Watch for CHF, fluid overload, fluid shifts*

Endpoints…
When Enough is Enough

- Hemodynamic Parameters WNL
- MAP >65
- U.O > 0.5ml/kg/hr
- Lactate level WNL <2
- Cleared Base Deficit +/- 2
- pH 7.35-7.45 Compensated
- SvO2 65-75%
- pAO2 35-45 on mixed venous gas

Toxic Exposure (CCRN)

Burns & Chemical Exposure

- Severity of chemical exposure injuries depends on
  - Strength or concentration of chemical
  - Length of contact with skin
  - Quantity of chemical
  - Extent of tissue penetration
  - Mode of action of chemical

Burns & Chemical Exposure

- Cellular dehydration, denaturation (discoloring), Oxidation (tissue degeneration), Chemical coagulation of protein, and Protoplasmic poisoning can be caused by:
  - Desiccants (strong acids): sulfuric, muriatic, and hydrofluoric acid
  - Alkalis: Lime, ammonia, caustics
  - Corrosives: Phenol, Lye, white phosphorus
  - Oxidizing Agents: Chromic Acid, Potassium permanganate
  - Vescivants: chemical warfare agents
  - Protoplasmic Poisons: hydrochloric acid, tannic acid, formic acid

Burns & Chemical Exposure

- *Systemic response to injury = 20% of TBSA*
- SIRS and release of mediators
- Release of vasoactive substances
- Possible bacterial translocation
- Release of stress hormones
Sequelae of Response

1. Mediator release increases vascular permeability causing fluid shifts to the intracellular and interstitial spaces (edema)
2. Decreased intravascular volume = hypovolemic shock
3. Anaerobic metabolism
4. Hypermetabolism

Physiologic Changes
- SIRS, MS changes, Tachycardia, ARDS, ileus, Myoglobinuria

Treatment Burns/Chemicals

- Safety of staff in removal of offending chemical and clothing
- Flush chemicals from skin for 15 minutes with saline, 30 minutes for eyes
- Do not rub skin, blot with sterile towel
- ABC’s
- Maintain patient’s body temperature (Poikilothermia)

Treatment Burns/Chemicals

- EARLY fluid resuscitation:…..
- Parkland Formula
- 4 ml/kg/TBSA burn (second and third degree) of Lactated Ringer’s solution over the first 24 hours.
- Half of the fluid should be administered over the first 8 hours post burn
- Remaining half should be administered over the next 16 hours.
- The volume of fluid given is based on the time elapsed since the burn.

Treatment Burns/Chemicals

- Early nutrition (3,500-7,000kcal/day) with electrolyte replacement
- Surgical Intervention/ Wound care
- Pain Management
- Renal protection (1ml/kg/hr u.o.)
- PT/OT
- Emotional Support
- Psychosocial Considerations

Toxic Ingestions

- Toxicant: poison
- Absorption: extent and rate of substance movement from outside the body to intravascular compartment; depends on route and bioavailability
- Distribution: way in which substances disseminate throughout the body, affected by pH, tissue perfusion, protein binding, lipid solubility
- Clearance: body’s ability to eliminate substance over time; accelerated by chelation, binding to activated charcoal, hemodialysis, hemoperfusion

Physiological Response: CNS most commonly affected, CV system, blood & spleen, liver, kidneys, lungs, skin…all are affected depending on effect of specific toxicant

Toxic Ingestions

- Most Common Lethal Ingestions
  - Analgesics
  - Sedatives/ hypnotics/ psychotics
  - Antidepressants/Cardiovascular Meds
  - Stimulants/ street drugs
  - EtOH
  - Chemicals
  - Anticonvulsants
  - Gases/ Fumes
  - Antihistamines/ Asthma Meds
  - Muscle relaxants
Signs & Symptoms of Selected Toxins

- Acetaminophen: N/V, low BP, diaphoresis, pallor, hepatotoxicity
- Sedatives: Low HR, low Temp, low BP, low RR, HA, Nystagmus, depressed DTR
- Beta-Blockers: Bradycardia, heart blocks, RBBB, Low BP, heart failure, Cardiogenic shock, Arrest, low RR, seizures, decreased LOC, Hyper or hypoglycemia
- Cocaine: High HR, dysrrhythmias, M.I., hyper/hypotension & RR, pallor, cyanosis, Hyperexcitability, high temp, diaphoresis, N/V, Confusion, delirium, seizures, Respiratory arrest, coma

- Ethanol: affective alterations, alcohol odor on breath, hypoglycemia, seizures, metabolic acidosis
- Ethylene Glycol: “drunk” with odor of alcohol, N/V, seizures, coma, nystagmus, metabolic acidosis with anion gap, ARF, pulmonary edema, HF
- Salicylates: decreased LOC, high temp, high RR (respiratory alkalosis), tinnitus, diaphoresis, thirst, metabolic acidosis with anion gap, low BP, deafness

Toxic Ingestions - Treatment

- ABC’s
- Call Poison Control!!!
- 100ml of 50g dextrose in water
- Thiamine 100mg IV to prevent Wernicke-Korsakoff Syndrome
- Naloxone 2mg IV for narcotics
- Provide Antidote…

- Do not give routine doses of flumazenil, analeptics, or physostigmine
- Noncaustic agents - orogastric lavage
- Caustic agents - dilute with milk or water
- Emetics
- Activated Charcoal: 1G/kg…sometimes given with cathartic like Magnesium citrate
**Toxic Ingestions - Treatment**

- Whole Bowel Irrigation
  - Polyethylene glycol and electrolytes, 2 L/hr until clear…good for sustained release meds, paint chips, cocaine, heroin (smuggling)
- Hemodialysis/ Hemoperfusion/ Hemofiltration
- Surgical intervention for body stuffing and packing (drug mules)
- Hemodynamic and physiological support

**Salicylate Toxicity**

- Metabolic acidosis
- Respiratory alkalosis
- Urine alkalinization increases salicylate elimination
  - IV sodium bicarbonate infusion
- Potassium replacement – monitor levels
- Hemodialysis for severe cases

**Beta-Blocker Toxicity**

- Hypotension, bradycardia
- Hypoglycemia
  - Decrease glucose formation in liver
  - Enhance hypoglycemic action of insulin
- Give glucagon to increase myocardial contractility, heart rate, and AV conduction – non-beta mechanism
- Dose 3-10mg IV bolus
- Infusion of 2-5mg/hr

**Excited Delirium Syndrome**

- Extreme hypermetabolic state
- Related to illicit stimulant use
- Mehtamphetamine, cocaine, PCP
- Bizarre, aggressive behavior
- Paranoid, panic, violence
- Rhabdomyolysis - consequence
- 33% experience acute renal failure
- Serial CPK monitoring to identify rhabdomyolysis