Neonatal and Pediatric Sepsis
When the Bugs Bite!

Kathie Dunn, RN MSN
Objectives

- Define SIRS, Sepsis and Septic Shock
- Identify the signs and symptoms of sepsis
- Apply the Pediatric Assessment Triangle to identify infant or child with sepsis or septic shock
- Identify hemodynamic and laboratory data meeting septic shock criteria for infants and children
- Define appropriate goal-directed management of the septic Pediatric/Neonatal patient
Sepsis: a leading cause of childhood death worldwide

In the US:

- Children’s Hospital data 2004-2012
  - ~637,000 Pediatric patients with sepsis
  - Prevalence of sepsis increased but so did survival
  - Higher mortality: < 1 yr of age, underlying CV condition, multi-organ dysfunction

- $20 billion annual cost in 2011 (all age groups)
  - http://www.sccm.org/Research/Quality/Pages/Sepsis-Definitions.aspx
Systemic Inflammatory Response Syndrome

Defined by two parameters out of range, one of which must be WBC’s or Temp

- Heart rate: age dependent
- Respiratory rate: age dependent
- **Temperature**: (36-38°C)
  - Hypothermia may be more ominous
- **WBC’s**: age dependent
- Bandemia > 10%
- Glucose > 140mg/dl
- Mental status changes
- Lactate > 1 mmol/L
Sepsis - life threatening organ dysfunction caused by dysregulated host response to infection

(Sepsis-3)
Septic Shock

Septic Shock
Profound circulatory, cellular and metabolic abnormalities associated with greater risk of mortality than sepsis alone

(Sepsis-3)
SHOCK

Oxygen ➔ Glucose/energy ➔ C.O.
Rapid restoration of circulation, tissue perfusion and oxygen delivery = most important concept in the acute management of septic shock
Identify state of decreased perfusion/patient at risk for sepsis

O2, IV/IO access, labs & cultures

**Initial Resuscitation:**
- Rapid fluid bolus 20 ml/kg and reassess
- Repeat fluid boluses up to 60 ml/kg for persistent shock, unless rales or hepatomegaly
- Correct hypoglycemia and hypocalcemia
- Begin antibiotics

**Fluid Refractory Shock:** Start inotrope IV/IO, secure airway
- **Cold Shock:** Dopamine or Epinephrine
- **Warm Shock:** Norepinephrine

**Catecholamine Resistant Shock:**
Begin hydrocortisone if at risk for absolute adrenal insufficiency

TRANSFER to higher level of care
Identify state of decreased perfusion/patient at risk for sepsis

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TRANSFER to higher level of care
Triage & Initial Assessment
# Pediatric Sepsis Screening Tool

![Pediatric Sepsis Screening Tool](image)

**Pediatric Assessment of Sepsis Evaluation (PASSE) Tool**

**Organ system and variable**

<table>
<thead>
<tr>
<th>Points assigned</th>
<th>0</th>
<th>1</th>
<th>10</th>
<th>20</th>
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<tr>
<td><strong>Neurologic</strong></td>
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<tr>
<td>Glasgow coma score</td>
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<td>Both fixed</td>
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<tr>
<td>Cardiovacular</td>
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<td></td>
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<tr>
<td>Heart rate, beats/min</td>
<td>&lt; 12 years</td>
<td>≤ 195</td>
<td>&gt; 195</td>
<td></td>
</tr>
<tr>
<td>and or</td>
<td>150</td>
<td>&gt; 150</td>
<td></td>
<td></td>
</tr>
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<td>Hypertension, mm Hg</td>
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<td>55-95</td>
<td>55</td>
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</tr>
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<td>85</td>
<td>35-75</td>
<td>35</td>
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<td>Renal failure, mmol/L (mg/dL)</td>
<td>&gt; 1.5</td>
<td>1.5-3.5</td>
<td>3.5</td>
<td></td>
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<tr>
<td>and or</td>
<td>5.5</td>
<td>2.5-5.5</td>
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<tr>
<td>Lactate, mmol/L</td>
<td>&gt; 4</td>
<td>1.5-4</td>
<td>4</td>
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<tr>
<td>and or</td>
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<td>0.5-1.5</td>
<td>1.5</td>
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<tr>
<td>Laboratory parameters</td>
<td></td>
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<tr>
<td>Leukocytes, × 10^9/L</td>
<td>&gt; 12</td>
<td>4-12</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>and or</td>
<td>&lt; 4</td>
<td>0-4</td>
<td>0.5</td>
<td></td>
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<tr>
<td>Platelet count, × 10^9/L</td>
<td>&gt; 100</td>
<td>100-300</td>
<td>300</td>
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<tr>
<td>and or</td>
<td>&lt; 100</td>
<td>0-100</td>
<td>0</td>
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<tr>
<td>Coagulation parameters</td>
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<td></td>
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<tr>
<td>Prothrombin time, % of standard (international normalized ratio)</td>
<td>&gt; 60 (1.4)</td>
<td>≤ 60 (1.4)</td>
<td>60</td>
<td></td>
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</tbody>
</table>

**Important Vital Signs**

- **Age:** (years)
  - Heart rate (per minute): 110-160
  - Respiratory rate (per minute): 30-40
  - Systolic blood pressure: 70-90

**Normal Values of Vital Signs**

- **Age (years):**
  - <1: 160-110
  - 1-2: 100-150
  - 2-5: 95-140
  - 5-12: 80-120
  - Over 12: 60-100

**Decision Tree**

- Start at top and work down to the right.
- Yes/No questions leading to next step.
- Yes = proceed to next step.
- No = terminate.

**Normal Values of Vital Signs**

- **Normal values of vital signs**
  - **Age (years):**
    - Heart rate (per minute): 110-160
    - Respiratory rate (per minute): 30-40
    - Systolic blood pressure: 70-90
  - **<1:** 160-110
  - **1-2:** 100-150
  - **2-5:** 95-140
  - **5-12:** 80-120
  - **Over 12:** 60-100

**Note:**

- **Hypothermia:** If the patient is hypoventilated, record the estimated core temperature before sedation. Assess the patient only with known or suspected acute central nervous system disease. For pulmonary reactions, nonreactive pupils must be ≥ 8 mm; do not assess after endogenous pupillary dilation.
- **Platelet count:** The use of mask ventilation is not considered to be mechanical ventilation.

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**13**
Identify state of decreased perfusion/patient at risk for sepsis

O2, IV/IO access, labs & cultures

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Catecholamine Resistant Shock:
Begin hydrocortisone if at risk for absolute adrenal insufficiency

TRANSFER to higher level of care
Intraosseous

<table>
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<th>Lab</th>
<th>Reliable?</th>
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<td>Glucose</td>
<td>+</td>
</tr>
<tr>
<td>Hgb</td>
<td>+</td>
</tr>
<tr>
<td>Hct</td>
<td>+</td>
</tr>
<tr>
<td>WBC</td>
<td>-</td>
</tr>
<tr>
<td>Plt</td>
<td>-</td>
</tr>
<tr>
<td>pH</td>
<td>+</td>
</tr>
<tr>
<td>pCO2</td>
<td>+</td>
</tr>
<tr>
<td>BUN/Cr</td>
<td>+</td>
</tr>
<tr>
<td>Na</td>
<td>+</td>
</tr>
<tr>
<td>K</td>
<td>-</td>
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</table>

PMID: 1928886 & 20807043
Labs

- ABG or VBG
- CBC with diff, BMP
- Lactate
- Glucose
- Ca++ (ionized calcium is most valuable)
- Cultures: Identify causative organism/ site source ASAP
Identify state of decreased perfusion/patient at risk for sepsis

O2, IV/IO access, labs & cultures

Initial Resuscitation:
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Initial Resuscitation:
- Warm Shock: Norepinephrine

Catecholamine Resistant Shock:
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TRANSFER to higher level of care
Fluid Bolus Technique

Most Effective techniques for rapid fluid bolus
REASSESSMENT

- Lung sounds
- Cap Refill
- Liver margin
- Mental Status
- Pulse
- Urine output
Therapeutic Endpoints

- Baseline mentation
- Capillary refill < 2 seconds
- Normal pulse quality with no peripheral/central differential
- Warm extremities
- Urine output at least 1ml/kg/hr
- Decreasing serum lactate and resolving base deficit

- BLOOD PRESSURE IS NOT A RELIABLE END POINT!
Considerations

• Communicate!
• Activate additional Resources
• Labs
  - POC testing if possible
  - Priority status
• Expedite Rx
• Initiate transfer process early
Neonatal Considerations
CDC Immunization Schedule

2014 Recommended Immunizations for Children from Birth Through 6 Years Old

- HepB
- RV
- DTaP
- Hib
- PCV
- IPV

- HepB
- RV
- DTaP
- Hib
- PCV
- IPV

- DTaP
- Hib
- PCV
- IPV

- Influenza (Yearly)*
- MMR
- Varicella

- HepA®
Neonatal Sepsis (0-30 days of life)

- **Early onset** usually presents within 24-48 hours of birth
  - But can present within first week of life
- **Late onset** presents from one week to 3 months of life
  (most often occurs within one month of life)

**Risk factors**
- Maternal Group B strep (+)
- Preterm delivery/ LBW
- Rupture of membranes >18°
- Chorioamnionitis - infection of placenta/ amniotic fluid
- Prolonged hospitalization with invasive lines/ tubes
- Congenital anomalies
- Depression at birth
NEONATE
Early Onset - vertical transmission

- Group B streptococcus
- Escherichia coli
- Listeria monocytogenes
- Enterococcus
- Herpes

- Treatment: Ampicillin and Gentamicin, Acyclovir
NEONATE
Late Onset- horizontal transmission

- Group B strep
- Coagulase negative staphylococcus
- Community acquired

- Treatment: Cefotaxime and ampicillin
  *Ceftriaxone- displaces bilirubin and may cause hyperbilirubinemia
Neonates are not ‘little’ Pedi Patients……

- The neonate has Mom’s immunities (IgG only) for first 30 days of life
- Breast milk is IgA rich (as well as containing others) so baby receives extra immunities if breast fed
- Sepsis occurrence is inversely related to the patients age in Pediatrics.....meaning.....the youngest are the most susceptible
- Seizures in infant often vague: lip smacking, cycling of extremities, ‘tremors’, eye fluttering, blank staring, clonus, ‘stretching’
Transfer to Higher Level of Care
Determinants of cardiac function and oxygen delivery to tissues
Oxygen is the ‘doorman’ of the cell- a requisite to aerobic metabolism

Lactic acid production= acidosis

↑Lactate a reliable “marker”

Consider Hgb as a contributor to ↓ O2 delivery

Consider circulation

Badness of Anaerobic Metabolism
Patient Presentation

• EARLY Signs of trouble
  - Minimal tachycardia (sustained, not situational)
  - Minimal widened pulse pressure
  - Minimal tachypnea
  - Minimally delayed capillary refill

• Fever usually presenting complaint
• Feeding- children do not starve themselves- use this like a vital sign!
• Wet diapers- U.O. is a great end organ perfusion indicator
• Rash- purpura/ petechial non-blanching are BAD
• Hydration- oral mucosa/ tenting of skin (abdomen)
• Mentation- interacting with environment?
HISTORY

- Perinatal history if < 3 months old
  - GBS status- did Mom receive antibiotics before delivery?
  - Complications- did baby go home with Mom?
  - Medications- did baby get any medications in hospital/ go home on medications?

- Any chronic illness?
- Recent hospitalizations?
- Any ill contacts/ exposures/ recent travel?
- Go to daycare?
- Immunizations up to date?
- Breast or bottle fed?
- Allergies to medications?
RASH
LATE Signs of Trouble

• END ORGAN DYSFUNCTION
• Decreased level of consciousness
• Anuria
• Hypotension (even just one episode)
• DIC/ coagulopathy
• Hypothermia may be ominous
Labs

- ABG or VBG
- CBC with diff, BMP
- Lactate
- Glucose
- Ca++
- Cultures: Identify causative organism/ site source ASAP
Spoken of quite a bit in adult literature
Not a lot of data on children
Consensus that a goal of Hgb > 7 to 10 gm/dl is reasonable
Hgb is the protein in RBC’s responsible for delivering oxygen to tissues
CBC with Differential

- Neutrophils (40-60%) - attacks bacteria
- Lymphocytes (30-50%) - B and T cells, often elevated with viral infection
- Monocytes (4-6%) - some bacterial killing qualities (phagocytes)
- Eosinophils (1-3%) - elevated in patients with “worms, wheezes and funny diseases”
- Basophils (0.5-3%) - participates in immune response
- **Bands** (<5%) - Immature neutrophils....sign that the body is running low on strong fighters
## Relationship Of Lactate To Mortality In Sepsis

<table>
<thead>
<tr>
<th>Lactate</th>
<th>Mortality</th>
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<tbody>
<tr>
<td>2</td>
<td>15%</td>
</tr>
<tr>
<td>2-4</td>
<td>25%</td>
</tr>
<tr>
<td>&gt;4</td>
<td>38%</td>
</tr>
</tbody>
</table>

Polymerase Chain Reaction

PCR: Non-culture based diagnostic tool in finding DNA of causative organism
Initial Stabilization

- Respiratory distress or hypoxia: start with simple face mask or NC, escalate to HHFNC or CPAP if available.
- Rapid volume resuscitation.
- If intubation needed: ensure adequate volume resuscitation/preload to mitigate hypotension.
- Consider pneumothorax, pericardial tamponade, endocrine emergency in patients with refractory hypotension.
SHOCK

**WARM shock**
- Exaggerated host immune response
- ↑ cardiac output
- Widened pulse pressure
- Bounding pulses
- Peripheral vasodilation
- ↑ tissue O2 consumption
- Hypermetabolic state
- Warm extremities

**COLD shock**
- Shunting of blood to vital organs
- ↓ cardiac output
- Narrow pulse pressure
- Poor peripheral pulses
- Peripheral vasoconstriction
- Tissue hypoxia from shunting
- Metabolic acidosis (lactate)
- End organ failure
- Death
Hepatomegaly or Rales?
Pressors/Inotropes next step......

- **Alpha Receptors**
  - Vasoconstriction
  - No Chronotropy
  - Some Inotropy

- **Beta Receptors**
  - Vasodilation (b2)
  - (+) Chronotropy (b1)
  - (+) Inotropy (b1)
Pressor versus Inotrope

- Pressor (alpha and beta dependent upon agent/dose used)
  - Significant peripheral vasoconstrictive effects
  - Increase systemic blood pressure by increased peripheral vascular resistance (afterload) and enhanced myocardial contractility
  - Common agents: Dopamine, Epinephrine, Norepinephrine

- Inotrope (beta)
  - Enhances contractility
  - Does not have notable peripheral vasoconstrictive effects
  - Common agents: Dobutamine and Milrinone
**Dopamine**

**First-line vasopressor agent** (alpha & beta)
- Cold shock up to 10mcg/kg/min

- Releases endogenous norepinephrine stores
  - 5-10 mcg/kg/min more beta (increase HR and contractility)
  - 10-20 mcg/kg/min more alpha (arterial vasoconstriction)
    - If need alpha effects, switch to alpha agent
    - Dopa thought to interfere with prolactin = immunosuppression

- May be less effective in infants < 6 mo
  - Less robust norepinephrine stores
  - 10-20 mcg/kg/min may be seen more often in this age group
Epinephrine (alpha & beta receptors)
- Low dose is an alternative first-line vasopressor agent
- Agent of choice for dopamine-resistant cold shock
- Second line agent for warm shock
- 0.05 – 0.3 mcg/kg/min

Norepinephrine (alpha receptors)
- First-line vasopressor agent for warm shock
- Agent of choice for dopamine resistant warm shock
- 0.01 – 0.1 mcg/kg/min
  - (max dose 1-2 mcg/kg/min)
Dobutamine

Dobutamine (beta 1-agonist)

- Pure inotropic agent (squeeze)
- Increases cardiac contractility
- Vasodilator so can lower blood pressure - BEWARE
- A typical dose begin with 5 mcg/kg/min IV and is gradually increased to ~20 mcg/kg/min IV gtt
- May be used with normal BP/ poor perfusion
Milrinone

Milrinone (phosphodiesterase inhibitors)

- Increase in intracellular cyclic adenosine monophosphate (cAMP), which raises intracellular calcium levels, improving cardiac inotropy as well as peripheral vasodilation
- May be used with normal BP/ poor perfusion
- Inotrope + decreases afterload (BEWARE- may cause hypotension)

- Loading Dose – 50mcg/kg IV over 60 mins
  - Many omit a loading dose due to concern of hypotension

- Maintenance IV – 0.5 – 1.0 mcg/kg/min
**Adrenal Insufficiency**

**Steroids are recommended for catecholamine-refractory shock**

- 25-30% of children with septic shock have adrenal insufficiency
- Associated with catecholamine-resistant shock
  - Hydrocortisone – weight based dose:
    - 1-2 mg/kg IVP q 6 hr

*No longer recommending cortisol stim test*
Clinical Endpoints:
- Capillary refill < 2 seconds
- Normal pulse quality with no peripheral/central differential
- Warm extremities
- Urine output at least 1ml/kg/hr
- Improved mentation
- SCVO2 > 70%

Laboratory Endpoints:
- Decreasing lactate
- Hgb 7-10 gm/dl
Continued Care

- **Mechanical ventilation**- avoid ALI by avoiding large lung volumes and minimizing plateau pressures
  - Hypercapnea may be tolerated as long as patient is oxygenating
  - Consider positioning- prone? Semi-recumbent with HOB ↑ 45° thought to diminish vent acquired pneumonias
  - Want PaO2/ FiO2 > 300

- **Sedation/analgesia/paralytics**- patients allowed to ‘lighten’ daily have less # days intubated/ ventilated
  - Propofol not recommended

- **Glycemic control**- Infants at higher risk for hypoglycemia due to ↓ glycogen stores
  - Both hypo and hyperglycemia should be avoided
Continued Care

- **Bicarbonate** - no evidence to support use in treating acidosis

- **DVT/ Stress ulcer prophylaxis**
  - No data to support heparin use in Pedi/ Neonate
  - Stress ulcers thought to occur similarly to adults so H2 blockers commonly used

- **IVIG** - adjunct therapy in PICU
Think Transport Early On

- Transport to appropriate facility for initial stabilization
- Consider EDAP (Emergency Department Approved for Pediatrics)
- Consider HEMS
- Consider pediatric team
- Consider additional personnel
Conclusion

EARLY goal directed treatment associated with improved outcomes
CONTINUOUS REASSESSMENT IS ESSENTIAL

- Treatment should not be delayed while considering differential diagnosis
  Evolving “Superbugs” cause legitimate concern but this does not supersede the need for early response and treatment of the septic patient
- Differential diagnosis considerations
  viral infections, cardiac diseases, endocrine, genitourinary, metabolic, hematologic, and gastrointestinal disorders, neurologic disease and intentional trauma/physical abuse .......
Questions???
References


Arch Pathol Lab Med. 2010 Sep;134(9):1253-60. doi: 10.1043/2009-0381-OA.1


Singer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3)
Pediatric DKA
Diabetic Ketoacidosis
In Review
Kathie Dunn RN MSN
Objectives

• provide the definition of DKA
• identify frequency and common presentation
• discuss risk factors and pathophysiology considerations
• offer diagnostic considerations
• review current management strategy
Diabetic Ketoacidosis

• Three inclusive criteria:
  - Hyperglycemia
  - Acidosis
  - Ketosis
Cause

- Body lacks insulin hormone utilized to process glucose for energy
- Body breaks down fat instead which leads to ketone accumulation = toxic
- Liver produces more glucose but cells can’t use it without insulin
- Vicious cycle leading to acidotic/dehydrated state
Remember...

- Children respond to treatment much differently than adults
- **Goal of treatment is to give patient mechanisms to “correct” their own imbalance**
Diagnosis often with illness

• According to the American Diabetes Association, about 30% of pediatric patients are diagnosed with Type I diabetes after an episode of DKA

• Infection, dehydration, increased metabolic requirements can be precursors
Serum Osmolarity

- \((2 \times \text{Na}) + (\text{BUN} / 2.8) + (\text{glucose} / 18)\)
- Normal = 285-300 mmol/L

- Need to correct reported Na before calculate
- Add lab NA to: \((\text{glucose} - 200) / 100 \times 1.6\)
Try it... assume DKA confirmed

- Patients labs....
  - $560 - 200/100 \times 1.6 = 5.8$
  - $132 + 5.8 = 137.8$
  - The corrected serum sodium is 138
- **Serum Osm?**
  - $(2 \times 138) + (\text{BUN}/2.8) + (\text{gluc}/18) = 321$
  - Serum osm is 321 mmol/L (high is dry)

<p>| | | |</p>
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<td>BUN</td>
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<tr>
<td>Gluc</td>
<td>560</td>
<td>high</td>
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</table>
Why do we care?

- Water moves from area of higher concentration to lower concentration (will move to where it is high and dry)
- Watch mentation!
Intracerebral Insults

- Cerebral edema is the most common and dreaded in the pediatric population.
- Hemorrhage/infarcts also seen but rare.
- Account for 31% DKA associated diabetic deaths.
- Account for 20% of all diabetic deaths (not in DKA).
- No empiric data points to definitive cause.
Mentation

• For worsening mentation: often need to gauge treatment at increasing serum osmolarity

• Mannitol vs 3%NS
  - Mannitol is osmotic diuretic, may worsen electrolyte imbalance as prevents re-absorption
  - Hypertonic saline is osmotic, not diuretic
Treatment

• Judicious isotonic fluid replacement to support perfusion
• NS has osm of 308 which is hypotonic for this pt
• Insulin to “stop madness”
• Goal- glucose drop ~80mg/dl per hour
• Replete electrolytes
Potassium

- Remember: potassium is its highest at the worst state of acidosis
- Even if serum potassium is “normal”, the total body potassium is depleted
- Serum potassium will drop as acidosis is corrected
- Insulin will exacerbate drop
Case Study: DKA

- Previously healthy 8yo, 25Kg
- N/V/D “flu-like” symptoms x 1 week
- More lethargic over past 2 days
- POV/ parents to ED: GCS 14, T 100.3ax HR sinus 130’s, 112/72, RR 28, 98%, pupils brisk 4mm to 2mm bilat, lungs clear
- Pulses +2/4, rapid & deep respirations
<table>
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<tr>
<th>NA</th>
<th>K</th>
<th>Cl</th>
<th>Co2</th>
<th>BUN</th>
<th>Cr</th>
<th>Gluc</th>
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<td>3.2</td>
<td>96</td>
<td>7</td>
<td>39</td>
<td>1.0</td>
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</table>

What is the corrected serum sodium?
What is the calculated serum osm?
Serum PO4???
Labs

VBG: 6.8/ 9/ 62/ 6.5 with BE -27

* every 10 torr change PCo2 yields 0.08 change in pH
* every 10 torr change HCo3 yields 0.15 change in pH

We Do NOT give NaHCO3!
(unless electrical conduction disturbances)
<table>
<thead>
<tr>
<th>WBC</th>
<th>Neuts</th>
<th>Lymph</th>
<th>Monos</th>
<th>Eosino</th>
<th>Bands</th>
<th>Platelets</th>
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<tr>
<td>12.1</td>
<td>80%</td>
<td>9%</td>
<td>3%</td>
<td>0%</td>
<td>8%</td>
<td>428</td>
</tr>
</tbody>
</table>

Hct 43  Hgb 14

Differential is ominous.....
ED Treatment

• Pt given 60ml/Kg NS
• Insulin regular started at 0.1units/kg/hr
• Zofran 2.5mg IVP
• Called for transport
Awaiting TT.....

• 99.2ax, HR 128, 108/77, 99%
• Confused with sluggish pupils 3mm bilat
• NS infusing at 100ml/hr
• Glucose is 218mg/dl by fingerstick
• It has been almost one hour since pt arrived to ED
PICU Consult

- Requests D10NS to replace NS at 100ml/hr
- Add 10meq KPhos + 10meq KAcet/L IVF
- Continue insulin gtt at 0.1unit/kg/hr
- Check glucose every 15 minutes
- Give mannitol, hypertonic saline or glucose if serum glucose continues to drop with worsened mentation
Any questions?

• Intubation?
• Antibiotics/ blood cultures?
• Check Po4?
• Why KPhos and KAacetate?
• Antipyretics?
Food for thought...

• Intubation? Their brains are smarter than ours and we can’t seem to mimic same cascade effect with mechanical ventilation as pt does with autoregulation. Consider BiPap.
• Antibiotics/ blood cultures? Yes
• Check Po4? Often forgotten but we lose a lot of phosphorous in polyuria state
• Kphos/Kacetate? To replete potassium & phos and acetate is a hydrogen ion acceptor
• Antipyretics? Great thought to cover in case he spikes. Fever increases metabolic requirements.
TT arrives

- Awaiting IVF from Pharmacy
- TT only has D5NS and D50 to treat pt whose mentation is worsening
- Pt starts to exhibit flattened T waves
- What is happening?
Treatment

• Pt needs to have osm increased
• Potassium levels dropping with insulin
• Call PICU and notify/ consult
• Orders rec’d to hang D5NS at 125ml/hr and d’c insulin
• Pt glucose at this time 238mg/dl and pupils now asymmetrical 5mm/3mm sluggish bilat
Treatment

• D5NS up and insulin dc’d
• Glucose administered at 1 gm/kg
• Pt more responsive, remains tachypneic with stable VS, FS 299mg/dl
• What else could we give to increase serum osm if mentation worsens again?
Hypertonic Solutions

- 3% NS = 900 mOsm/L
- Mannitol = 1100 mOsm/L
- D50 = 2500 mOsm/L
- D10W = 500 mOsm/L

- 8.4% NaHco3 = 2000 mOsm/L
Key Points

- Judicious NS bolus - only to support perfusion, rehydrated over 48 hrs
- Insulin gtt 0.05 - 0.1unit/kg/hour, no bolus, 'stop the madness'
- Glucose drop < 100mg/dl per hour
- IVF titrated by glucose results: NS, D5NS, D10NS with electrolytes
- Electrolyte replacement (K+ and Po4-)
- Prepare for worst case: 3%NS, mannitol (last resort glucose)
Remember

“It is not enough to do your best, you must prepare to be the best”
Dr. McDonald
Questions?
Case Study

Pediatric Sepsis
6 week old baby girl

- Parents called 9-1-1 for respiratory distress and now they think the baby is not breathing
- Parents instructed to give breaths while EMS en route
- Time of call is at shift change O’clock in the AM and your relief is late
What are you thinking?
On scene - Pedi Assessment Triangle

- Baby now breathing with shallow, non-noisy respirations 12 breaths/min
- Brachial pulse 170 beats/ min
- Color pale/ mottled/ cap refill 4 seconds
- Spo2 is 86% on room air
- Baby does not open eyes spontaneously, no cry with noxious stim, floppy tone
Now what?
Sick or not sick?
A,B,C’s

- You and your partner are rock stars
- Your partner assists the baby’s respirations with BVM and oxygen while you attempt IV
- IV successful, baby still has no cry but now color has improved
- Blood sugar check with IV placement = 26mg/dl
- Weight estimated at 5Kg
What do you do now?
Quick exam

- Fontanel is sunken
- Pulses barely palpable peripherally
- No murmur evident
- Breath sounds clear and equal
- Abdomen is soft/round with positive bowel sounds
- No external signs of trauma
- Lacy rash (blanching) noted to trunk and legs
Base contact

- Transport to closest facility (10 minutes away)
- Give glucose: 0.5gm/Kg
  D25=2ml/Kg or
  D10= 5ml/Kg
- Recheck BS in 15 minutes
- Give NS fluid bolus 20ml/Kg rapidly
- Continue to support respirations with BVM
En route

- Glucose given, NS bolus almost complete
- Baby continues to require BVM support to maintain rate at 20 breaths/ min and SpO2 now 97%
- Repeat glucose 47mg/ dl
- HR now 120’s and temp is 34°C axillary
- Unable to obtain BP, cap refill now 3 seconds, liver edge above costal margin
- Mom has accompanied transport as front seat passenger
What next?

- What is reassuring?
- Non-reassuring?
- Considerations?
What questions can you ask Mom to help you navigate course?
PMH/ HPI

- Full term baby with some of that ‘green stuff’ in her lungs at birth which required her to stay in the hospital for a week after birth
- Had CPAP with oxygen need for 5 days then home at 8 days of life
- Bottle fed but hasn’t fed well in past couple days, last fed 2 hours ago ~ half an ounce only
- Siblings (four of them) have had runny noses and one spiked a fever 3 days ago
- Baby has been more sleepy over past 2 days and last wet diaper was yesterday
- Wet stools started yesterday, no emesis
- No immunizations to date
Risk factors

How many risk factors does this baby have?
In ED

- What details would you like highlighted in this baby’s prodrome and subsequent care?

- What equipment do you have ready for this baby?
Expectations

- Airway - intubate or not to intubate?
- Breathing - grunting/flaring/retractions?
- NS bolus repeated?
- Glucose repeated?
- Steroids?
Transfer to warmer....

- Baby has peculiar lip smacking and cycling of legs
- Apnea
- HR 90 beats/min
- Skin mottled and cold
- SpO2 is 84%
- Mom is screaming at you to do something!
What do you do now? (MD is in the bathroom)
Options for help?
What are your priorities?
Help arrives……..

- RT setting up for intubation while EMS continues great BVM with SpO2 99%
- You check a glucose and it is 22mg/dl
- Temp is 33.2 rectal, HR 90’s, unable to obtain BP and baby has no respiratory effort
- Colleague obtaining Ativan from pyxis but waiting for someone to co-sign
- IV infusing well with NS still hanging
- Mom fainted at bedside but before she did, she warned you all that Dad is a lawyer
Is the code cart at the bedside yet?
Orders received

- IVF 40ml/Kg NS in
- D10W 5ml/Kg in
- Ativan 0.1mg/kg given
- Hydrocortisone 1mg/Kg given
- Labs - CBC with diff, chem 21, lactate, blood culture and ABG sent
- Actively warming patient to euthermia
- Broad spectrum antibiotics infusing
  - Consider late onset GBS?
- Baby intubated by ED resident (its July)
Now- seizures stopped

- HR 160’s, BP 68/37, with some respiratory effort intubated, T 36 rectal
- Chest barely moving, (+) intercostal retractions, (+) nasal flaring
- Now opening eyes and moving all 4 extremities
- Glucose check = 98mg/dl
- Liver edge still above costal margin
- Color improved pale/pink
- Wet diaper
Labs come back….  

- **ABG:** 7.0/73/15/191 with BE of -17  
- Lytes ok, glucose 87mg/dl  
- Lactate 11  
- **CBC:**  
  - WBC 2,000  
  - Neuts 82%  
  - Lymphs 4%  
  - Monos 1%  
  - Bands 13%
If these are the vent settings, how would you change them?

- #3.5 cuffed OETT 11cm at lipline
- Pressure control of 10
- Peep of 4
- SIMV of 12
- Pressure support zero
- FiO2 1.0 (100%)
Anything else?

- Consider more volume?
- Maintenance IVF with glucose?
- Careful not to ‘over warm’?
- Analgesia/ sedation?
- Emotional support for Mom and Dad
- CONTINUOUS reassessment
Blood cultures came back positive for strep

But, your quick actions and teamwork saved her

She got better

AND parents are delighted with your services 😊
Questions, comments, concerns?