Isolated Injuries, Bites and Stings and Emergency and Critical Care Medicine Potpourri

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Learning Objectives

Upon completion of this session the learner will be able to...

• Recognize and manage isolated injuries including burns, fractures and wounds
• Plan sedation and analgesia for pediatric procedures
• Plan the management of bites, stings and envenomations
• Plan the evaluation of a patient with fever without localizing signs
• Recognize and plan the management of selected life-threatening medical conditions
Isolated Injuries
Burns

Every year, ~450,000 Burns Receive Medical Treatment
Prevention**

- Smoke detectors and fire extinguishers
- Fire drills, “stop, drop and roll” and safety ladders
- Avoid smoking indoors
- Keep matches and lighters away from children
- Water heater below 120F
- Avoid all fireworks
- Don’t leave food cooking unattended
- Flammables, locked up, away from heat sources
- Don’t use damaged electrical cords, overload electrical circuits or run electrical cords under carpets or furniture
- Avoid space heaters
Burns—Assessment

• Treatment/prognosis based on depth and size
• Partial-thickness vs. superficial most important
  – Superficial burns (first degree)—don’t count toward burn size
    – Generally sunburn or flash burns
    – Only damage epidermis
    – Redness and pain**
Burns—Assessment—Depth

• Partial-thickness burns (second degree)
  – Frequently caused by scalds
  – Superficial partial-thickness
    • Epidermis and superficial dermis involved
    • Thin walled, fluid filled blisters**
• Partial-thickness burns (second degree)
  – Deep partial-thickness
    • Extend into reticular dermis
    • Thick walled blisters, commonly ruptured**
Burns—Assessment—Depth

• Full-thickness burns
  • Third degree
    – Destroy epidermis and dermis
    – White or leathery appearance**
    – Anesthetic**
  – Fourth degree
    • Also involves underlying fascia, muscle or bone**
Burns—Assessment—Size

• Total body surface area
  – **Non**-superficial burn size
    • Lund-Browder chart—most accurate
      – Modifications for children
        » Larger heads and smaller lower extremities
    • Rule of 9’s only useful age ≥16 years
    • Patient’s palmar surface
      – Including fingers: 1%
      – Excluding fingers: ~0.5%
Minor Burns in Children

- Isolated burn without other injuries
- 10% or less TBSA
- 2% or less full-thickness

- Must not include
  - Hands
  - Face (including eyes or ears)
  - Feet
  - Perineum

- Cannot cross joints or be circumferential
Minor Burns—Treatment**

- Removal of clothing, debris, jewelry
- Cool (cool or room temperature tap water, or cool saline soaked gauze)
  - Limits tissue damage
  - Pain relief
- Clean with soap and water
- Debridement
  - Sloughed or necrotic skin
Minor Burns—Treatment**

• Pain management
• Dressing
  – Partial and full-thickness
    • Topical antibiotic, followed by non-adherent gauze, then dry gauze, then elastic gauze roll
• Prevention of infection
  – Deeper burns high risk
  – Topical antibiotics for any non-superficial burns
    • Antibiotic choice varies by area and expert
    • Silver sulfadiazine (some data suggests may increase rate of infection), combination antibiotic ointments, chlorhexidine
  – Tetanus vaccine if not up-to-date
Moderate/Severe Burns— Management**

• Initiate stabilization as for any trauma patient
• Oxygen (fire related burns)
• Anticipate airway involvement and difficult airway:
  – Stridor
  – Hoarseness
  – Tachypnea or respiratory distress
  – Drooling or dysphagia
  – Soot in mouth
  – Facial burns
  – Singed nasal hair
• Intubate early before edema affects anatomy**
Moderate and Severe Burn—Management**

• Obtain IV access, two if severe burns
  – Through unburned skin if able
• Fluid resuscitation—improves outcomes
  – Parkland (4 ml/kg/%TBSA + 24 hour maintenance)
  – Galveston (5000 ml/m² of TBSA + 2000 ml/m²)
    • Lactated ringer with 5% dextrose for children
      – Half given over first 8 hours, remainder over next 16 hours
• Pain control
• Tetanus if not up-to-date
Moderate and Severe Burns—Nutritional Management**

• Maximize nutritional support—ideally enteral
  – Hypermetabolic response
  – Maintain lean body mass
  – Assist and improve wound healing

• Children are higher risk
  – Greater baseline basal metabolic requirement
  – More limited energy reserves
  – Less willing to cooperate if in pain or anxious
Burns—Infections**

- High risk
  - Lack of primary protective barrier to microorganisms (skin)
- Wound colonization, wound infection, invasive infection, cellulitis, necrotizing infection/fasciitis
- Most common pathogens
  - MSSA, MRSA, *Pseudomonas aeruginosa*, *Enterococcus*, fungi
Low Voltage Electric Burns

- Tends to be young children
- Touching an extension cord lacking insulation
  - Sucking an extension cord socket or biting an electrical cord
- Generally small but deep burns
- High risk for scarring**
- Oral burns are most frequently to the lips
  - May get significant bleeding from the labial artery when eschar separates 1-2 weeks after injury**
High Voltage Electrical Burns

• Electricity takes direct path
• Entry and exit wounds
  • In extremities—sign of deeper tissue destruction
  • Skin findings do NOT predict internal injuries
• Electrical energy converted to thermal
• May develop tissue necrosis, compartment syndrome and rhabdomyolysis**
• Frequently also have blunt trauma
Burn Centers

- Refer any moderate or severe burns (>10% TBSA)**
- Any full thickness burns
- Electrical burns
- Chemical burns
- Burns involving hands, feet, face, genitalia, perineum or major joints
- Inhalation injury
Common Pediatric Fractures and Orthopedic Injuries
Supracondylar Fracture

• Most common pediatric elbow fracture
• High risk for neurovascular compromise**
• Fall onto outstretched arm with elbow in hyperextension
• Brachial artery passes anterior to the distal humerus
• Median, radial and ulnar nerves also at risk
Greenstick Fractures**

- Incomplete long bone fracture—unstable fracture
- Often forearm, fall on outstretched hand, +/- obvious deformity
- Complete fracture of the cortex (tension side, convex side of the angulation) and plastic deformity of the cortex of the concave side
Subluxation of the Radial Head

• “Nursemaid’s elbow”
• Most common elbow injury in children
• Generally 1-4 years, peaks at 2-3 years. Can happen in infants, uncommon after 5 years.
• Axial traction on pronated forearm, elbow in extension—annular ligament slips over the head of the radius and is trapped in the radiohumeral joint
• “Pull injury” history only in ~50% of cases
Subluxation of the Radial Head

- Arm held close to body, elbow either fully extended or only slightly flexed and pronated**
- Generally no distress until manipulation (any supination of the forearm). NO tenderness to palpation. NO swelling.
- Imaging *not* indicated
  - Consider if concern for fracture
  - X-ray are generally normal but may demonstrate displacement of the radiocapitellar line
Reduction of Radial Head Subluxation**

- Immediate pain relief
- Usually will move the arm within 5-10 minutes
- May feel a click or pop when reduces
- For both methods, hold arm at the elbow, apply pressure on radial head, using the other hand:
  
  **Hyperpronation**
  - Hyperpronate the forearm

  **Supination/flexion**
  - Apply gentle traction, fully supinate and then fully flex the elbow
Clavicle Fracture

• Common fracture caused by either indirect or direct trauma to the shoulder
• Pain usually well localized, worsened with movement of the arm
  – Exam may show a bulge or little deformity
Clavicle Fracture—Management**

- Most heal well without surgical intervention
- Immobilization—sling (more comfortable) or figure of eight bandage (better use of hand)
- Refer to orthopedics:
  - Completely displaced (more than one bone width)
  - Commination
  - Shortening
Acromioclavicular (AC) Separation

• Fall or direct blow to the superior or lateral aspect of the shoulder with arm adducted
• Tenderness directly over AC joint**
• Passive cross-body adduction compresses the AC joint. Pain=AC joint injury**
Acromioclavicular (AC) Separation

- X-rays of both AC joints
  - Widening of AC joint alone is sprain or subluxation
  - Increase coracoclavicular distance of 25-50% compared to other side if coracoclavicular ligament is torn
Wounds
Wound cleansing**

- Poor cleansing increases risks of infection and cosmetically poor scar
- Adequate cleansing is painful!
  - Analgesia before cleansing
  - Hand hygiene for practitioner
Wound cleansing**

- Wound periphery cleansing
  - Remove visible contamination and dried blood
  - Avoid “tattooing”
  - Povidone-iodine
    - Effective against bacteria, fungi and viruses
  - Chlorhexidine
    - Toxic to wound tissue

- Irrigation
  - Syringe and splash shield
  - Saline traditionally but may consider tap water
Tetanus prophylaxis**

• Clean and minor wounds in vaccinated patient
  – Give vaccine if last dose ≥10 years ago

• All other wounds
  – Give vaccine if last dose given ≥5 years ago (give Tdap if ≥11 years)

• If un- or under-vaccinated (<3 doses)
  – Give vaccine and human tetanus immune globulin**
Laceration Repair

• Clean wounds up to 18 hours, 24 hours for face
• Goals of repair
  – Control bleeding
  – Reduce likelihood of infection
    • Be sure to look for and remove foreign bodies**
  – Minimize cosmetic appearance
    • Vermillion border **
  – Maximize function
    • Tendon injuries in hand—partial tears can be missed**
Puncture wounds—Management**

- Majority from nails but also glass, wood etc.
- X-ray if concern for foreign body
- Tetanus prophylaxis if needed
- Foreign body removal—key for infection risks
- Clean the wound
- No data to recommend antibiotic prophylaxis except possibly high risk patients
  - May actually promote growth of gram-negative bacteria
Puncture Wounds—Complications**

• High risk of infection:
  – Deep wounds
  – Retained foreign body
  – Puncture wound to forefoot
  – Wearing shoes at time of injury

• Most often cellulitis
  – *Staphylococcus aureus* and *beta-hemolytic streptococci*

• Treat with first generation cephalosporin or
  trimethoprim/sulfamethoxazole if MRSA concern

• Osteomyelitis occurs in 0.6-1.8% of children with puncture wounds
  – *Pseudomonas aeruginosa* if through the sole of a shoe
Analgesia, Anxiolysis and Sedation
Performing Pediatric Procedures

• Think about what you need!
  – Pain control alone?
  – Anxiolysis?
  – Pain control and anxiolysis?
  – A completely still child?
• You’ll be more successful and safer if your patient is cooperative, still and has pain and anxiety controlled.
Non-pharmacologic Pain Control**

- Distraction—adapt to developmental level
- Imagery (older children)
- Preparation/Education
- Video games, television
- Breathing (bubbles can help with younger kids)

- Desensitization
- Parent training/coaching
- Books (“I spy”), songs/music
- Squeeze balls (older children)
- Non-nutritive sucking (infants)
- Distracting conversation
Analgesia**

• Relief of pain without intentionally producing sedated state
  – Sedation may be a side effect of analgesia medications
Analgesia Options**

- Oral sucrose solution (neonates and older infants)
- Acetaminophen and NSAIDs (IV or oral)—mild pain
- Local and regional anesthesia
  - Topical (LMX, LET, EMLA)
  - Lidocaine
  - Nerve blocks
Analgesia Options**

• Opioids (oral, IV, IN, transdermally)
  – Moderate or severe pain
  – Serious side effects
    • Sedation (sometimes a benefit)
    • Respiratory depression
    • Rigid chest (rare) from fentanyl
    • Hypotension (more common with morphine)
Anxiolysis

• Minimal sedation (anxiolysis)
  – Responds normally to verbal commands
  – Cognitive function and coordination may be impaired
  – No change in ventilatory or cardiovascular function

• Use alone only for non-painful procedures**

• Combined with topical anesthesia, can often avoid sedation in short procedures**
Benzodiazepines

• Midazolam (oral, sublingual, intranasal, rectal)
  – Anxiolytic and amnestic
  – Short lasting
  – Side effects of any benzodiazepine include respiratory depression and apnea**
    • Reverse with flumazenil (except in patients with seizure history or chronic use)
Goals of Sedation**

• Protect patient’s safety and welfare
• Minimize discomfort and pain
• Minimize anxiety, psychological trauma
• Control movement/behavior to facilitate performance of procedure
• Return patient to state of safe discharge
Sedation States
<table>
<thead>
<tr>
<th></th>
<th>Moderate**</th>
<th>Deep**</th>
<th>General Anesthesia**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of consciousness</strong></td>
<td>Depressed</td>
<td>Depressed</td>
<td>Loss of consciousness</td>
</tr>
<tr>
<td><strong>Level of arousal</strong></td>
<td>Responds purposefully to verbal commands</td>
<td>Not easily aroused Responds purposefully only after repeated or painful stimulation</td>
<td>Unable to arouse</td>
</tr>
<tr>
<td><strong>Maintenance of Airway</strong></td>
<td>Patent</td>
<td>May require assistance</td>
<td>Requires assistance</td>
</tr>
<tr>
<td><strong>Ventilation</strong></td>
<td>Spontaneous</td>
<td>May require assistance</td>
<td>May require positive pressure ventilation</td>
</tr>
<tr>
<td><strong>Cardiovascular Function</strong></td>
<td>Unchanged</td>
<td>Maintained</td>
<td>May be impaired</td>
</tr>
</tbody>
</table>
Sedation States

• Continuum—not exact science
• Providers should have the capability of managing one level deeper than the target depth
Pre-sedation for Moderate Sedation

• Is the patient a candidate?
  – ASA classes I and II (normal healthy patient or with only mild systemic disease)
  – No evidence of a difficult airway
    • History—personal or FH of adverse reactions to sedation
    • Exam—Vitals and focused airway exam
    • Higher risk if <3 months, special needs, airway abnormalities, obstructive concerns, current URI or symptomatic asthma
Pre-sedation for Moderate Sedation

• NPO status
  – Elective (clears, 2 h; breast milk 4 h, formula/milk or light meal 6 h)
  – Emergent—must weigh risks and benefits

• Informed consent
Pre-Sedation Setup—Moderate Sedation **

• SOAP ME mnemonic
  – Suction
  – Oxygen
  – Airway equipment (bag-mask, adjuncts)
  – Pharmaceuticals (for procedure and reversals)
  – Monitoring Equipment
  – Emergency cart (code medications, defibrillator)
Monitoring—Moderate Sedation

During procedure
- Practitioner
- Support Personnel
- Continuous pulse oximetry
- Continuous heart rate
- Capnography recommended
- Intermittent respiratory rate
- Intermittent blood pressure

After procedure
- Until fully alert
  - Continuous pulse oximetry and heart rate monitoring
- Discharge
  - Adequate and stable cardiovascular function and airway patency
  - Intact protective reflexes, easily arousable
  - Able to talk and sit (if developmentally appropriate)
  - Adequate hydration
Nitrous Oxide

- Anesthetic gas
- Mild analgesia, sedation, amnesia and anxiolysis**
- Maintain protective airway reflexes, spontaneous respirations and hemodynamic stability**
- Quick onset and recovery but must tolerate the mask
  - Contraindicated
    - Trapped gas within body cavities, pregnancy
  - Adverse effects
    - No major cardiopulmonary events reported
    - Vomiting
Ketamine

• Dissociative agent
• Single most used agent for painful procedures in children in emergency departments**
• Analgesia, sedation and amnesia**
• Maintain protective airway reflexes, spontaneous respirations and hemodynamic stability**
Ketamine

- Contraindications
  - Absolute:
    - <3 months, schizophrenia (caution with other forms of psychosis)
  - Relative:
    - Posterior pharynx stimulation (major procedures), history of airway instability, tracheal surgery or tracheal stenosis, active pulmonary infection or disease (including URI and asthma), cardiac disease, increased ICP, increased intraocular pressure, porphyria and thyroid disease

- Adverse reactions
  - Laryngospasm, respiratory depression, emesis, recovery reactions
Bites, Stings and Envenomations

>51,000 reports to poison control in 2015.
Dog and Cat Bites—Management**

- Pressure for bleeding wounds
- Clean surface
- Irrigate wound with copious amounts of saline
- Punctures generally aren’t closed (cat bites especially) unless highly cosmetic
- Do NOT glue bite wounds

- High risk for infection—*Pasteurella, Staph aureus, streptococci, anaerobes, and others*
  - Prophylaxis for deep punctures, any wound closure, near hands, face or joints
  - Amoxicillin-clavulanate; Penicillin allergic: Extended-spectrum cephalosporin or trimethoprim/sulfa and clindamycin
Rabies Prophylaxis**

• Urgency, not emergency
• Contact local health department for advice
• Report animal bites to local animal control

• High risk animals—treat unless available for testing
  – Bats, raccoons, foxes, skunks, coyotes and groundhogs

• Domestic animals
  – If ill, euthanize and test
  – If stray—treat if not found within 48 hours (12 hours if head/neck exposure)

• Human rabies immune globulin
  – Infiltrated in the area around and in the wound, remainder IM

• Rabies vaccine
  – Four doses: day of exposure, days 3, 7 and 14
Dog and Cat Bites—Prevention**

- Don’t leave young children alone around animals
- Have all pets immunized against rabies
- Teach children animal safety:
  - Always ask before petting
  - Don’t bother dogs that are eating or sleeping
  - Never take a toy away or play tug of war
  - Don’t feed treats with your fingers
  - Don’t tease animals
  - Stand still if approached or chased by a strange dog, face the dog, don’t make eye contact and back away
  - If a dog attacks, put something between you and the dog
Human Bites

- Common in toddler age
  - Intercanine distance <3 cm
- Self-inflicted (paronychia)
- On hands (teens/adults), small wounds over metacarpophalangeal joints—likely bites
  - Very high risk—proximity to joint capsule and deep tendon spaces
- Higher risk of infection than animal bites
  - Streptococci, S. aureus, Eikenella, Fusobacterium, Peptostreptococcus, Prevotella, Porphyromonas
  - Average 4 isolates/wound
- Empiric treatment with amoxicillin-clavulanate**
# Spider Bites

- Rare occurrence, most spiders can’t penetrate human skin and the venom has little effect on mammalian tissue
- Only two types of spiders in the US are a risk

<table>
<thead>
<tr>
<th>Widow spiders (Black and Brown in Southern US)</th>
<th>Recluse spiders</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Muscle pain (local for mild reaction, generalized for moderate/severe)</td>
<td>• Worsening pain at site</td>
</tr>
<tr>
<td>• May have nausea, vomiting</td>
<td>• May develop necrotic center</td>
</tr>
<tr>
<td>• Headache</td>
<td>• May get malaise, nausea, vomiting, fever, myalgias</td>
</tr>
<tr>
<td>• Tachycardia, hypertension</td>
<td>• Rarely, hemolysis, jaundice, renal failure, shock</td>
</tr>
</tbody>
</table>
## Widow Spider Bites—Management**

<table>
<thead>
<tr>
<th>Mild envenomation</th>
<th>Moderate/severe envenomation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Most patients</td>
<td>• Wound care and tetanus prophylaxis</td>
</tr>
<tr>
<td>• Wound care</td>
<td>• Opioids, parenteral, for pain</td>
</tr>
<tr>
<td>• Tetanus prophylaxis if needed</td>
<td>• Benzodiazepines, parenteral, for muscle spasms</td>
</tr>
<tr>
<td>• Oral analgesia</td>
<td>• Antiemetics</td>
</tr>
<tr>
<td></td>
<td>• Consider antivenom if requiring large amounts of pain medications—call a toxicologist</td>
</tr>
</tbody>
</table>
Recluse Spider Bites—Management**

- Local wound care, antihistamines for pruritus
- Pain medication as needed (NSAIDs or opioids)
- Tetanus prophylaxis if needed
- Monitor for development of secondary infection
Snake Bites

• Pit vipers (rattlesnakes, water moccasins/cottonmouths and copperheads)—most common venomous snakes in US

• Bites from coral snakes and imported exotic snakes are much less common
Pit Viper Bite

- Local tissue damage
- Coagulopathy
- Increased vascular permeability, tachycardia, tachypnea, hypotension
- Neurotoxicity (altered mental status, seizures)
- Nausea, vomiting, diarrhea, weakness, lightheadedness, diaphoresis or chills
Snake Bite—Management**

• First Aid
  – Remove patient from snakes territory
  – Keep warm and calm
  – Immobilize injured body part and remove jewelry
  – Clean the wound
  – Attempt to identify the snake
  – Transport to nearest medical facility
Snake Bite—Management**

- ~25% “dry bite”—local irritation—observe 8-12 hours
- Labs for coagulopathy and rhabdomyolysis
- Monitor local tissue injury (leading edge, q15-30 min)
- Antivenom—Crotalidae Polyvalent Immune Fab
  - Coagulopathy, hypotension, systemic bleeding or other systemic effects or progression of local tissue injury
- IV crystalloid
- Cleanse the wound
- Tetanus prophylaxis
Scorpion Stings

• Common in southwestern US
• Venom contains neurotoxins
• Mild/moderate
  – Pain and paresthesia

• Severe—more common in children <5 years
  – Pain and paresthesias
  – Tachycardia, hypertension
  – Increased secretions
  – Opisthotonos with muscle twitching, fasciculations
  – Roving eye movements, nystagmus
Scorpion Stings—Management**

<table>
<thead>
<tr>
<th>Mild/moderate</th>
<th>Severe</th>
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<tbody>
<tr>
<td>• The majority of stings</td>
<td>• Airway management</td>
</tr>
<tr>
<td>• Oral pain medications (NSAIDs)</td>
<td>(suction secretions, consider intubation)</td>
</tr>
<tr>
<td>• Wound care</td>
<td>• IV fentanyl</td>
</tr>
<tr>
<td>• Tetanus prophylaxis</td>
<td>• IV benzodiazepines</td>
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- Oral pain medications (NSAIDs)
- Wound care
- Tetanus prophylaxis
- Airway management (suction secretions, consider intubation)
- IV fentanyl
- IV benzodiazepines
- Antivenom
Jellyfish Stings

• Immediate pain
• Linear, urticarial lesions afterward
• Severe reactions rare
  – respiratory distress, cardiac arrest
• Treatment**
  – Remove the tentacles as soon as possible
    • Bathe with saltwater. Apply vinegar to inhibit nematocyst firing
  – Hot water immersion up to 20 minutes for blue bottle and non-tropical jellyfish
  – Antivenom exists for some jellyfish for severe reactions
Emergency medicine and critical care potpourri
# Fever—Diagnosis**

**Fever**
- Generally defined as >38.0°C
  - Sometimes defined as >38.3°C or 38.5°C)
- Hyperthermia from fever
  - *No evidence* for tissue damage (brain injury/death) until sustained temperatures between **41-42°C** (41.7°C or 107°F based on enzyme physiology)

**Methods to measure**
- Digital
- Rectal (birth-3 years)
- Oral (4 years and older)
- Axillary is unreliable
- Temporal artery (≥3 months)
- Tympanic (≥6 months)
Fever—Management**

- Recognize that fever itself is unlikely to be harmful
- Beneficial in fighting infection
- Treat fever only to improve child’s comfort

- Acetaminophen
  - Risks from chronic overdose
- Ibuprofen
  - Risk of nephrotoxicity with dehydration
  - Avoid <6 months (pharmacokinetic and renal function differences)
- Alternating or combined
  - Increased efficacy in lowering temperature (no data on improving comfort)
  - Safety concerns
Fever—≤28 days**

- Majority viral illness
- Highest risk group for serious bacterial infection (SBI) – 9-19%
  - UTI most common; bacteremia and meningitis less common
- May be well appearing with SBI
Fever—29-90 days**

• Majority viral illness
• Still high risk group for SBI – 7-11%
  – UTI most common; bacteremia and meningitis much less common
• May be well appearing with SBI
Low Risk (may be managed off antibiotics/outpatient)
Fever—≤28 days**

• No “low risk criteria”
  – Full evaluation even if apparent source
    • Urine, blood, CSF (most criteria), chest x-ray if respiratory symptoms, stool if diarrhea
  – Admission
  – As likely to have SBI if RSV+ than if RSV-
  – Consider HSV (0.3% of febrile neonates)
Rochester Criteria

• Age ≤60 d, ≥38.0°C

• History:
  – Full term ≥37 weeks
  – No antibiotics
  – No prior hospitalization
  – No chronic or underlying illness

• Well appearing

• No evidence of skin, soft tissue, bone, joint or ear infection

• Laboratory values:
  – WBC 5,000-15,000/mm³
  – Absolute bands ≤1500/mm³
  – Urine, ≤10 WBC/hpf
  – Stool (if diarrhea) ≤5 WBC/hpf
Boston Criteria

- Age 28-89 d, ≥38.0°C
- History:
  - No recent immunizations
  - No recent antibiotics
  - Not dehydrated
- Well appearing
- No evidence of soft tissue, bone, joint or ear infection

- Laboratory values:
  - CSF <10/mm³
  - WBC <20,000/mm³
  - UA <10 WBC/hpf
  - CXR without infiltrate (if obtained)
Milwaukee Criteria

• Age 28-56 d, ≥38.0°C
• History
  – No criteria
• Well appearing
• Not dehydrated
• No evidence of soft tissue, bone, joint or ear infection

• Laboratory values:
  – CSF <10/mm³
  – WBC <15,000/mm³
  – UA < 5-10 WBC/hpf, no bacteria, negative LE/nitrite
  – CXR without infiltrate (if obtained)
Philadelphia Protocol

- Age 29-60 d, ≥38.2°C
- History
  - No criteria
- Well appearing
- Unremarkable examination

- Laboratory values:
  - CSF <8/mm³, negative gram stain
  - WBC <15,000/mm³
  - Band-neutrophil ratio <0.2
  - UA < 10 WBC/hpf, negative gram stain
  - CXR without infiltrate
  - Stool, no blood and few or no WBC
Pittsburgh Criteria

- Age ≤60 d, ≥38.0°C
- History
  - No prematurity (>35 6/7 weeks)
  - No chronic/underlying illness
  - No previous hospitalizations
  - No perinatal antibiotics (if <14 days old)
  - No antibiotic in last 7 days
  - No siblings with GBS disease
- Well appearing
- No focal infection (excluding AOM)

- Laboratory values:
  - CSF ≤ 5/mm³, negative gram stain
  - WBC 5,000-15,000/mm³
  - Absolute band count ≤1,500/mm³
  - Enhanced UA ≤9/mm³, negative gram stain
  - CXR without infiltrate if respiratory findings
  - Stool <5/hpf if diarrhea
How good are these criteria?

• NPV of 90-100%
• Rochester: 511 low risk, 5 SBI
  – 3 UTI, 2 bacteremia (*Yersinia enterocolitica* and *Neisseria meningitidis*)
• Boston: 503 low risk, 27 SBI
  – 9 bacteremia
  – 8 UTI
  – 10 bacterial gastroenteritis
• Milwaukee: 143 low risk, 1 SBI
  – *Moraxella catarrhalis* bacteremia
  – 1 non-low risk only by CSF with *E. coli* meningitis
• Philadelphia: 287 low risk, 0 SBI
• Pittsburgh: 127 low risk, 0 SBI
  – 1 non-low risk only by CSF had meningitis
Adherence to Guidelines

- 3066 infants, ≤3 months, ≥38.0°C, 1995-1998
  - Full evaluation: 45.7% <31 d; 35.8% 31-90 d (ill)
  - No culture 23.6%
  - Treated 61/63 infants with bacteremia/bacterial meningitis on initial visit
    - Missed GBS bacteremia and pneumococcal meningitis
Adherence to Protocols

- 1380 infants, 7-90 d of age, ≥38.0°C, 2010-2013
  - Full evaluation: 59% 7-28 d, 25% 29-60 d, 5% 61-90 d
    - 59% had at least one culture
  - No culture (24% 7-28 d, 28% 29-60d, 44% 61-90d)
    - Didn’t believe (63% 7-28 d, 19% 29-60 d, 8% 61-90 d)
    - URI/bronchiolitis (18% 7-28 d, 34% 29-60d, 45% 61-90 d)
    - Other diagnosis—AOM, pna (14% 7-28 d, 7% 229-60 d, 5% 61-90d)
    - Recent vaccination (22% 29-60 d; 24% 61-90 d)
Emergency Departments:

• 37,907 visits, <90 d with fever, 2011-2013
  – Full evaluation:
    • 72% ≤28 d
    • 47% 29-56 d
    • 11% 57-89 d
  – 81.8% had at least one culture
Epidemiology of SBI, 7-90 days

13.5% of 6232 previous healthy, full term infants had SBI
- 13.2% (n=823) UTI
- 2.1% (n=129) bacteremia (5.5% contaminated blood cultures)
- 0.3% (n=16) bacterial meningitis; (7 aged <29d, 3 aged >61d)

Pathogens
- *E. coli*
  - UTI (719); bacteremia (78); bacterial meningitis (7)
- *GBS*
  - Bacteremia (23); meningitis (6, 1 aged >29d)
- No cases of *Listeria*
- Viral co-infection
  - Bacteremia (6%); UTI (9%)
- Abnormal CXR
  - Bacteremia (17%); UTI (11%); Meningitis (15%)
Fever and Positive Test for Virus?

Infants <60 days of age with fever of >38°C

<table>
<thead>
<tr>
<th>RSV positive vs. negative</th>
<th>Influenza positive vs. negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 7% SBI vs. 12.5% SBI$^{20}$</td>
<td>• 2.5% SBI vs. 13.3% SBI$^{17}$</td>
</tr>
<tr>
<td>• Majority UTI</td>
<td>• Only 123/835 infants were influenza-positive</td>
</tr>
<tr>
<td>• Not powered to assess bacteremia and meningitis risk</td>
<td>• All SBI in influenza group (3) were UTI</td>
</tr>
<tr>
<td></td>
<td>• Not powered to assess bacteremia or meningitis risk</td>
</tr>
</tbody>
</table>
Step-by-Step Approach

• Multicenter, prospective, 11 PEDs
• ≤90 d, ≥38°C, 2012-2014
• FWS: normal exam, no respiratory or diarrhea process
• Previously healthy, term, no antimicrobial history, no hospitalization, no chronic illness
Step-by-Step Approach

- Blood and urine for all
- Low risk if:
  - Well appearing
  - >21 days of age
  - No leukocyturia
  - PCT <0.5 ng/mL
  - CRP ≤20 mg/L
  - ANC ≤10,000/mm³
Step-by-Step Approach—Results

- 2185 infants
  - 504 with bacterial infections
  - 87 with invasive bacterial infections
- First 3 steps identified 79.3% of IBI (missed 4 sepsis, 1 bacterial meningitis)
- Low risk
  - 0.7% (n 7) risk of IBI (6 had fever <2 h)
Watch for new guidelines
Fever Without Localizing Signs**

- 3-36 months
- Well appearing, healthy children
  - Evaluation for SBI frequently not considered until temperature of ≥39C
UTI most common

- UTI risk 2-24 months, febrile (38.0)\(^{28}\)
- >1% risk—2 criteria for girls, 3 for circumcised boys
  >2% risk—3 criteria for girls, 4 for circumcised boys
  - Temperature >39°C
  - Absence of another source of infection
  - Uncircumcised male (alone, >1% risk)
  - Nonblack male or white female
  - Age <12 months females
  - Fever ≥2 d females or >24 h males
Occult Bacteremia**

- Rare since *Haemophilus influenzae* type b and *Streptococcus pneumoniae* vaccines
- In one study of 3-36 months, healthy “routinely immunized” children from 1998-2003\(^{14}\)
  - 352 true positive cultures/37,133 drawn (0.95%)
  - 656 contaminant organisms (1.8%)
  - 2001-2003, excluding ill patients—only 0.25% “occult bacteremia”
Occult Bacteremia—Evaluation **

- No need for CBC/blood culture if completely immunized
  - 3 doses of PCV7 or PCV13 and at least 2 Hib
  - Some experts feel two doses of PCV7 or PCV13 may be adequate

- Incompletely immunized children warrant a CBC
  - If WBC ≥15,000 → obtain blood culture and cover with ceftriaxone for possible occult bacteremia
Occult Pneumonia**

• In one study of children <10 years with temperature >38.0 and chest x-ray ordered for possible pneumonia\(^2\)
  – 5.3% of those with NO clinical signs of pneumonia had x-ray confirmed occult pneumonia
  – More likely with fever for >3 days as well as cough
  – Without cough, 0.28% had occult pneumonia
Practice Changes You May Wish to Make

• Assess for and treat pain from minor injuries
• Utilize non-pharmacological pain control
• Educate families and staff about the benefits of fever
• Treat fever for patient comfort, not for your comfort
Thank You!

Brett.McAninch@chp.edu
Additional General Pediatrics Content Specifications

For your review
Acute Respiratory Distress Syndrome (ARDS)

• Most severe form of acute lung injury
  – Bilateral pulmonary infiltrates and severe hypoxemia with noncardiogenic pulmonary edema
• Most common etiologies in children**
  – Pneumonia
  – Systemic infection
  – Severe Trauma
  – Aspiration
ARDS—Clinical Features**

- Inflammatory disease of the lung with sudden onset of pulmonary edema, hypoxia and respiratory failure
- Generally develops 24-72 hours after the associated acute disease
- Findings
  - Tachypnea often first
  - Dyspnea becomes progressively severe
  - Hypoxia often is out of proportion to the underlying disease
  - Crackles from pulmonary edema
  - Fever (either due to underlying process or cytokine release)
ARDS—Complications**

• Air-leak syndromes
  – Pneumothorax, pneumomediastinum, pneumopericardium, pneumoperitoneum, subcutaneous emphysema

• Ventilator-induced lung infections

• Multiple organ dysfunction syndromes
Impending Coma**

- Coma (GCS of ≤8)—both components of consciousness (arousal and awareness) are diminished
- Less profound states of impaired consciousness
  - Stupor, lethargy, obtundation
    - Imprecise terms
    - Difficulty maintaining attention, tend to fall asleep unless stimulated, respond poorly (if at all) to questions and commands
Cerebral Edema—Clinical Findings**

• Localized edema → focal findings on neurologic exam
• Increased intracranial pressure (ICP)
  – Mental status change, decreased level of consciousness or irritability
  – Papilledema
• Impending herniation
  – Asymmetric pupils (anisocoria)—uncal herniation
  – Cushing’s Triad
    • Hypertension
    • Bradycardia
    • Irregular breathing
Impending Hepatic Failure**

• May have nonspecific prodrome including abdominal pain, malaise. May have fever.

• In one pediatric acute liver failure data set\textsuperscript{26}
  – Encephalopathy in 53% of patients
  – Seizure 7%
  – Ascites 22%
Intestinal Obstruction—Management**

- Signs include abdominal distention and bilious vomiting
- Identification and treatment of cause
  - Volvulus
  - Intussusception
  - Adhesions from prior surgery
  - Hernia
- Treatment**
  - Monitoring
  - Fluid resuscitation, IV crystalloid
  - Bowel decompression—nasogastric tube
  - Consider parenteral antibiotics if concern for necrosis or perforation
  - Surgical consult
Brain Death Criteria

• Prerequisites for Initiating
  – Normal, age-appropriate physiologic parameters
  – Absence of sedative/analgesic/neuromuscular blockade/anticonvulsants
  – Irreversible and identifiable cause of coma
• Two examiners separated by an observation period
• Physical examination
  – Coma
  – Loss of all brainstem reflexes
  – Apnea (in the setting of $\text{PaCO}_2 \geq 60\text{mmHg}$ and $\geq 20\text{mmHg}$ above baseline)
  – Flaccid tone and absence of spontaneous or induced movements excluding spinal cord events
Brain Death Ancillary Tests**

- Not required to establish brain death
- Not a substitute for the neurologic exam

- EEG without electrical activity
- Radionuclide cerebral blood flow study without flow or cellular uptake
Malignant Hyperthermia

• Genetic disorder of skeletal muscle presents with hypermetabolic crisis when given halogenated inhalational anesthetic or succinylcholine

• Conditions with susceptibility to malignant hyperthermia from triggering anesthetics or succinylcholine**
  – Myopathies
    • central core myopathy, multiminicores disease, King-Denborough syndrome, Native American myopathy

• Conditions with severe hyperkalemia or rhabdomyolysis from succinylcholine or triggering anesthetics
  – Duchenne and Becker muscular dystrophy
Hymenoptera stings

- Bees, wasps, yellow jackets, hornets and ants
- Majority cause only local reactions
- Severe anaphylactoid reactions
  - ~3% of the population; 0.4—0.8% of children
- Removal of the stinger as quickly as possible minimizes the amount of venom delivered (within 10-20 seconds)
  - Scrape with credit card or fingernail
  - Avoid squeezing the stinger with tweezers—may release more venom
Hymenoptera stings—Education**

• Teach families
  – Proper removal (ideally within 10-20 seconds)
  – Signs of serious reactions and when to seek care
    • Sudden difficulty breathing
    • Weakness, collapse or unconsciousness
    • Hives or itching of entire body
    • Swelling affecting ability to see, eat or urinate
<table>
<thead>
<tr>
<th>Large local reactions (2-18%)</th>
<th>Systemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Erythema</td>
<td>• Urticaria</td>
</tr>
<tr>
<td>• Swelling</td>
<td>• Angioedema</td>
</tr>
<tr>
<td>• Pain</td>
<td>• Wheezing, shortness of breath, stridor</td>
</tr>
<tr>
<td>• Itching</td>
<td>• Nausea, vomiting, abdominal pain</td>
</tr>
<tr>
<td></td>
<td>• Dizziness, hypotension</td>
</tr>
</tbody>
</table>
Hymenoptera Stings—Treatment**

Large local reactions
• Symptomatic treatment
• Cool compresses, elevation, local wound care
• Antihistamine for significant itching
• May consider prednisone for very large reactions

Systemic
• Epinephrine 0.01 mg/kg
  1:1000 IM (thigh) gives most rapid absorption and higher levels
• Diphenhydramine, steroids, H2 blockers as adjuncts
# Additional Anticipatory Guidance**

## Tick removal
- Grab as close to surface as possible with fine tipped tweezers
- Pull upward, constant, steady pressure (minimize breaking off mouth parts in the skin)
- Remove any mouth parts if possible
- Clean the skin with rubbing alcohol, iodine scrub or soap and water

## Minimize insect bites
- Avoid high risk areas
- Dress in long pants and long-sleeved shirt
- Avoid bright colors and strong scents
- Use insect repellent before going outdoors (children >6 months)
- 30% DEET or 5-10% picaridin
Firearm Safety**

- Best prevention is to not have guns
- Talk to adults in homes where children play about guns

- If guns are in the home
  - Keep unloaded and locked
  - Lock and store bullets in a separate place
  - Hide the keys to locked boxes/cabinets/safes