OBJECTIVES:
Review differential diagnoses that may mimic traumatic injuries
CASE STUDY #1:

AA is a 3 yo Male who presents with altered mental status following being found on floor of daycare with “shaking” like movements.

EMS called and received Ativan enroute.
CASE STUDY #1:

In ED, waxing and waning exam:

• Opening eyes to pain and verbal stimuli (Name)

• Cries “Mommy” and “Ow” with PIV placement – Otherwise quiet

• Reaches for extremity w/ PIV placement

What is his best GCS?
CASE STUDY #1:

ABC intact – D-Stick WNL

IV access obtained — Screening labs, including serum drug screen sent

Worsening neuro exam – With repeated attempts of nailbed pressure:
  • Eye opening
  • Weak moaning
  • Withdraws all extremities, ? RLE weakness

Next Steps?

Exam otherwise benign – No signs of external trauma
CASE STUDY #1:

Confirmed ETT placement → Head CT
CASE STUDY #1:

HPI:
• Per daycare, “small” fall from slide earlier in the day – No LOC – Acting himself – No obvious injuries
• Wrestling with 5 yo brother last night and may have bumped his head on wooden bed – Unwitnessed but heard crying – Went to bed soon after

PMH:
• Previously healthy and has been growing well – No allergies – UTD on vaccines
• Head Circumference > 97%
• Denies excessive bleeding with circumcision
CASE STUDY #1:

Family History:

• Sudden death of paternal aunt at 12 yo
• Mother with heavy menstruation requiring OCP

ROS:

• R-sided headaches x 1 week (Parents attribute to “sinus infection” given recently URI symptoms)
• “Clumsy”
• Recently with prescription glasses
CASE STUDY #1:

Lets Review...

Large intraparenchymal hemorrhage presenting with questionable seizure and worsening neuro exam requiring intubation

What is the cause of AA’s intracranial findings?

- Accidental Trauma (Witnessed vs Unwitnessed)
- Non-Accidental Trauma
- Minor trauma complicated by bleeding diathesis
- Vascular abnormality
- I have no idea
CASE STUDY #1:

Traumatic Intracranial Hemorrhage include subdural, epidural, subarachnoid, intraventricular, or intraparenchymal:

- **Subdural**: Crescent-shaped, concave appearance
- **Epidural**: Lens-shaped, convex appearance
- **Subarachnoid Hemorrhage**
- **Intraventricular Hemorrhage**
**CASE STUDY #1:**

*Traumatic* intraparenchymal hemorrhage:

- Typically associated with major trauma (and other injuries)
- Frontal and temporal lobes, especially at surface
- Exam dependent on location and size of hemorrhage
CASE STUDY #1:

Bleeding Diathesis:
- Any significant PMH or FH?

- Screening labs
  - PT/PTT/INR WNL
  - vWF Antigen and Activity; Factors 8, 9, 13

- Hematology Consult

What is Von Willebrand disease (vWD)?
- Most common hereditary blood-clotting disorder
- Due to deficiency in the quality or quantity of von Willebrand factor (vWF), a protein required for platelet adhesion

![Diagram showing normal clotting vs. clotting with vWD](image-url)
CASE STUDY #1:
Additional Unknown or Unreported Trauma – Consider NAT

<table>
<thead>
<tr>
<th>Historical Indicators of Abuse</th>
<th>Physical Exam Findings</th>
<th>Suggestive Injuries:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- No/vague explanation for significant injury</td>
<td>Bruising</td>
<td>Skeleton</td>
</tr>
<tr>
<td>- Explanation inconsistent with the child’s physical and/or developmental capabilities</td>
<td>- &lt; 6 months or non-ambulatory</td>
<td>- Rib fractures</td>
</tr>
<tr>
<td>- Different witnesses provide different explanations</td>
<td>- Unusual locations</td>
<td>- Multiple fractures</td>
</tr>
<tr>
<td>- Change in important detail</td>
<td>- Patterned</td>
<td>- Long bone fractures &lt; 6 months</td>
</tr>
<tr>
<td>- Delay in seeking medical care without reasonable explanation</td>
<td>- Patterned</td>
<td>- Metaphyseal fractures</td>
</tr>
<tr>
<td>- Previous history of inflicted injury</td>
<td>- Stocking, glove pattern</td>
<td>Head</td>
</tr>
<tr>
<td>- Multiple no-shows and missed care opportunities</td>
<td>- Mirror image burns of the extremities</td>
<td>- Subdural hematoma with or without skull fracture</td>
</tr>
<tr>
<td></td>
<td>- Immersion</td>
<td>- Unexplained intracranial injury</td>
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<tr>
<td></td>
<td><strong>Bite Marks</strong></td>
<td>Poisoning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Including illegal drugs, prescribed controlled substances, ethanol</td>
</tr>
<tr>
<td></td>
<td><strong>Burns</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Patterned</td>
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<tr>
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<td>- Immersion</td>
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<tr>
<td></td>
<td><strong>Facial Injury</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Torn frenulum in non-ambulatory child</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ear injury</td>
<td></td>
</tr>
</tbody>
</table>
CASE STUDY #1:

Low Risk MOI
Underlying Bleeding Diathesis
Large intraparenchymal hemorrhage
Large intraparenchymal hemorrhage
Large intraparenchymal hemorrhage
Additional Unreported Trauma?
Large intraparenchymal hemorrhage

Let’s Review...
CASE STUDY #1:

In interim, Neurosurgery at bedside and recommends OR for craniotomy
CASE STUDY #1:

SIGNIFICANT ROS: HA? Clumsy?

ICH TYPE: Isolated Intraparenchymal hemorrhage

DIFFERENTIAL DX: R/O’ed common dx

OR FINDINGS...
CASE STUDY #1:

Ruptured AVM (Arteriovenous malformation):
- Direct arterial to venous connections without an intervening capillary network
- Sporadic congenital developmental vascular lesions
  - 0.1 % of the population
  - 10 and 40 years
- Presentation:
  - Intracranial hemorrhage (41-79%)
  - Seizure (11-33%)
  - Headache?
  - Focal Neurological deficit
Medicine is a science of uncertainty and an art of probability.

William Osler
CASE STUDY #2:

BB is a 10 mo AA Female who presented to PCP with “puffy” LLE and refusal to bear weight → LLE XR revealed L femur fracture → Referral to ED

In ED, BB well appearing with exam notable for swelling to upper left leg

Next steps?
- Orthopedics consult
- Obtain additional labs/imaging
- Social Work consult
- All of the above

So, what labs/imaging?
CASE STUDY #2:

Skeletal Survey with multiple fractures (L 6th-8th ribs, L humerus, R radius, L radius, L tibia, and L femur) and periosteal bone/cortical irregularity concerning for possible additional fractures (R humerus; L fourth metacarpal; R third metacarpal; R tibia; R third metatarsal)

Screening labs significant for elevated WBC (14.8), Hgb (9.5), elevated AlkPhos (1020)

Orthopedics placed a LLE splint

Report filed with Child Protective Services and CC admitted for further evaluation
CASE STUDY #2:

HPI:
- 3/21/18 – LLE “Puffy” but not tender to touch; Irritable (Attributed to teething)
- 3/22/18 – Babysitter noted refusal to bear weight
- No known trauma

PMH:
- Uncomplicated pregnancy and delivery -- No prenatal vitamins
- L distal radius buckle fracture (1/2018) – Noted to be “guarding” LUE – No known trauma – Treated with cast
- Otherwise healthy
CASE STUDY #2:

Family History - Negative for:
- Easily broken bones
- Dental abnormalities
- Short stature

ROS:
- Poor weight gain noted at 9 mo WCC
- Hair loss x 2 mo
- Breastfed – Solids introduced at 6 mo (Sweet potatoes, puffs, and some yogurt)
- No medications or supplements
- Meeting developmental milestones
CASE STUDY #2:

Let’s Review...

- 9 Confirmed Fractures (LUE, RUE, LLE, L ribs) and 5 Possible Fractures (L hand, R hand, RLE, R foot, RUE)
- No reported trauma

What do you think is the cause of CC’s fractures?

- Metabolic/Genetic Bone Disease
- Normal childhood trauma
- Endocrine/Bone Health Disease
- Non-accidental Trauma
CASE STUDY #2:

Skeletal Survey (Additional Information):
Overall bones mildly demineralized with “some irregularity and haziness to the distal metaphyses involving the majority of the long bones and they do have a somewhat flared appearance although there does appear to be a zone of regional calcification”

Skull sutures are mildly diastatic

Anterior rib ends mildly prominent with a cup appearance

With this information, does your opinion change?
CASE STUDY #2:

Consults:

Metabolism
• Genetics testing for OI (Osteogenesis imperfecta)
• Urine testing → Ruled out renal fanconi syndrome, cystinosis and renal wasting syndrome

Nutrition
• Vitamin levels (Zinc, Vitamin A&E) → WNL

Ophthalmology:
• Dilated exam → Negative for retinal hemorrhages and crystal deposition (May be associated with cystinosis)
CASE STUDY #2: Osteogenesis imperfecta (OI):

- Rare (1 in 20,000 births) connective tissue disorder that affects collagen formation
- Varied presentation – May include:
  - Excess or atypical fractures
  - Short stature
  - Scoliosis
  - Blue sclerae
  - Opalescent teeth that wear quickly
  - Joint laxity
  - Wormian bones
  - Easy bruisability
CASE STUDY #2:

Endocrine consult:

KNOWN LABS:
- Low Calcium
- Low Phosphorous
- High Alk Phos
- Very High PTH

PMH:
- Exclusively breastfed
- No Vitamin D supplement
- Alopecia

PATIENT CHARACTERISTICS:
- African American
- Winter birthday

PENDING LABS:
- Vitamin D
CASE STUDY #2:

Additional Evidence:
- Pending Vitamin D = < 3
- Calcium improved on Vitamin D supplement

DIAGNOSIS: Vitamin D deficiency rickets

Treatment:
- S/p 50,000 units of vitamin D
- Continue 2,000 units cholecalciferol daily
- Continue calcium carbonate 50 mg/kg/day

So what is Rickets?
Deficient mineralization and architectural disruption of the growth plate

Classified according to predominant mineral deficiency
CASE STUDY #2:

Bowing of the femurs, metaphyseal cupping

Cupping and fraying of metaphyses

Growth plate widening
CASE STUDY #2:

Widening of the ribs at the costal-chondral junction

Widened Sutures
CASE STUDY #2:

Reappearance of Dense Zone of Provisional Calcification
CASE STUDY #2:

So what happened???

“Fractures are uncommon in rickets and we therefore support further evaluation on the etiology of her fractures”
CASE STUDY #2:

SCAN team conclusion:

• “Fractures are known to occur in a small percentage of children who have vitamin D deficiency rickets. Accidental fractures in the setting of rickets are most often seen in mobile infants or toddlers. Even in the setting of vitamin D deficiency rickets we would not expect an infant's bones to break spontaneously or with routine childcare.”

• “Given the number of fractures in different stages of healing without any mechanism to explain the fractures, as well as the unexplained abrasions to her armpits, even in the setting of Vitamin D deficiency, inflicted trauma remains a possibility as the cause of her fractures”

What presentation is not highly concerning for NAT?

- Torn frenulum in 5 mo
- Spiral tibia fracture in 2 yo who tripped while playing soccer
- Bruising to pinna, lateral neck, and abdomen in 3 yo
- Bilateral parietal skull fractures with underlying SDH in 1 mo following roll from couch
“I already diagnosed myself on the Internet. I’m only here for a second opinion.”
CASE STUDY #3:

CC is a 16 yo Female with abdominal pain (10/10), RLE pain/weakness/paresthesia, and generalized back pain s/p improperly restrained MVC (Lap belt only)

In ED, GCS = 15, ABC intact, Decreased strength and movement of RLE

IV access obtained — Screening labs sent

PRN IV Fentanyl given with decrease in pain (5/10)
CASE STUDY #3:

Abdomen/Pelvis CT --> No free fluid in pelvis, no solid organ injury. Possible abdominal rectus injury, no discrete hematoma

RLE/Pelvis/T-L Spine XR --> Negative for fracture
CASE STUDY #3:

HPI:
• Stationary vehicle was T-boned. No airbag deployment. No LOC. No loss of bowel/bladder function

PMH:
• Asthma – Albuterol PRN for wheezing
• Obesity – BMI 35
• DM Type II – Recently diagnosed -- Diet and lifestyle modifications -- D-Sticks at home 100-120s
• Depression – No medications – No active therapy
• PSF at 12 yo
CASE STUDY #3:

Family History:
• Mother and Maternal Grandmother – DM Type II

Social History:
• “Difficult” year due to unexpected move with change in schools

ROS:
• Negative polyuria, polydipsia, polyphagia
• Has been “tearful” recently
CASE STUDY #3:

**Lets Review...**

16 yo F with questionable abdominal muscle hematoma and RLE pain/weakness/paresthesia s/p improperly restrained MVC

**What are the next steps??**

- Administer 2 Tylenol and encourage CC to ambulate
- Maintain spinal precautions with bedrest and logrolls only
- To OR for emergent exploratory laparotomy
- Administer high dose IV corticosteroids for possible SCI
CASE STUDY #3:

Neurology Consult:
- MRI T- and L- Spine -- Limited by orthopedic hardware but no gross abnormality
- Exam significant for:
  - Normal strength with decreased movement (Pain?)
  - Decreased LE reflexes

Endocrine consult (Due to newly diagnosed DMII):
- Metformin (500 mg with dinner)
- D-sticks overall stable in 90s-100s
CASE STUDY #3:

Physical and Occupational Therapy consults:

- CC paused in standing following ~30 feet reporting that her right LE "stopped working" and was "stuck". CC maintained WBing through bilateral LE with (-)knee buckling x 1 minute before advancing right LE to continue walking stating it "just became unstuck."

- Pt avoids upright sitting due to complaints of severe pain with attempts to actively concentrically contract abs however demonstrates strong eccentric contraction of abdominals during functional mobility without complaint. Pt also complaints of significant pain with passive trunk/hip flexion.

- Pt with (+) moaning, facial grimacing, altered movement patterns with all mobility, however intermittently joking and laughing with this PT when provided conversation for distraction
CASE STUDY #3:

So what is the cause of DD’s symptoms?

- Spinal Cord Injury
- Conversion Disorder
- “Faking it”
- Neuropathy due to DMII
- Pain
So what is the cause of DD’s symptoms?

**Spinal Cord Injury**
- Parasthesias and weakness s/p trauma
- MRI WNL
- Exam inconsistencies

**Neuropathy secondary to DMII**
- Known complication of DMII
- Doesn’t acct for weakness
- Acute onset following trauma

**Musculoskeletal Pain**
- Improperly restrained MVC
- Muscle hematoma on CT

- Doesn’t acct for parasthesias
CASE STUDY #3:

**HPI:**
- Onset after stress or psychological or physical trauma

**Patient Characteristics:**
- Female
- Mental health disorder

**PRESENTATION:**
- Altered motor or sensory function
- Inconsistent findings throughout exam

Conversion Disorder
CASE STUDY #3:

Conversion Disorder:
- Neurologic symptoms that are inconsistent with a neurologic disease, but cause distress, and/or impairment
- In children:
  - Females > Males
  - Age: 10-15 yo
- Presentation:
  - Motor function deficits
  - Often after emotional stress or minor injury
- Risk Factors: Prior sexual abuse and preexisting psychiatric disease (e.g., anxiety, depression)

Key Findings during Physical Exam
- Inconsistency at different points in the examination
- Incongruity between the symptoms and recognized disease

“Patient's pain report conflicting with functional assessments in addition to inconsistent findings throughout examination.”
CASE STUDY #4:

Behavioral Health Consult:

• CC reports being “worried” about her pain, being more tearful and sensitive than usual, and experiencing some brief flashbacks.

• CC also indicated that she has close, supportive relationships with her mother and identified several positive cognitions in relation to her hospitalization and treatment such as PT is important to "help her walk again."

Conclusion:

• “Although conversion disorder is in the differential, diagnosis cannot be made at this time. Conversion disorder is a diagnosis of exclusion....Pain may be secondary to recent traumatic events and she may be anxious in walking because of concerns about current strength. CC appears willing to engage in PT and would like to participate in treatment to regain baseline function."
CASE STUDY #3:

What happened?

- Daily PT and OT

- Behavioral Health Recommendations:
  - Continued monitoring of her mood symptoms
  - SW to provide information regarding outpatient psychology services

- Validation of feelings – Utilize family support

- Spontaneous resolution of reported parenthesis – Improvement in voluntary strength and movement of LE – Improvement in gait and clearance by PT/OT
Many of life's failures are people who did not realize how close they were to success when they gave up.

- Thomas Edison
CASE STUDY #4:

DD is an 8 yo Male with PMH of global developmental delay and seizure disorder who presented to OSH ED with erythema, peeling skin, and blisters.

Skin cultures sent and antibiotics administered.

Transferred to CHOP PICU.

Physical Exam:

- Neurological and hemodynamically stable.
- “Widespread well demarcated areas of erythema with diffuse peeling, erosions of skin and tense bullae involving his back, buttons and posterior legs. With sparing of his genital area, face/mouth and intergluteal areas.”
CASE STUDY #4:

HPI:

• Arrived home from school in usual state of health

• Woke from afternoon nap with dirty diaper (Stool). Father quickly placed in bathtub with running (not submerged) “lukewarm” water. Irritable and unable to complete bath

• As father dried DD’s back he noted his "skin started peeling”, followed by reddened appearance, and then formation of blisters.
CASE STUDY #4:

PMH:
• Underlying genetic mutation in STSBP1 gene → Global developmental delay (Non-verbal, Non-ambulatory), intractable epilepsy
• Medications: Trileptal (Oxcarbazepine), Keppra (Levetiracetam) and Depakote (Divalproex) – No history of drug reactions – No recent changes
• MRSA

Family History:
• Reviewed and non-contributory

ROS:
• Usual state of health prior to skin findings
CASE STUDY #4:

Physical Exam:

• Neuro:
  • Non verbal (Cries, Moans) - Generalized spasticity - Patient able to sit with moderate support as well as roll over

• Skin:
  • Chapped lips, but no sloughing, no oral mucosal erosions or sloughing.
  • Normal conjunctivae
  • Widespread and well-demarcated areas of erythema, diffuse peeling, erosions, and tense bullae involving localized areas of his back, buttocks, and posterior
  • Petechial lesions of the upper back and collections of small and discrete ecchymoses of the upper arms and elbow areas.
  • Marked sparing of the anterior surfaces, axillae, intergluteal areas, and perineum, and posterior skin creases
CASE STUDY #4:

Admission:
CASE STUDY #4:

Hospital Day #2:
CASE STUDY #4:

Hospital Day #5:
CASE STUDY #4:

How would you like to treat DD?
- Intubate for pain control
- Dermatology consult
- Wounds left open to air
- SCAN consult

Hospital Course:
Dermatology Consult → Skin Biopsy
Empiric antibiotics
Topical Wound Care
SCAN consult
CASE STUDY #4:

What is cause of DD’s skin findings???

- Stevens-Johnson syndrome (SJS) and Toxic Epidermal Necrosis (TEN)
- Staphylococcal scalded skin syndrome (SSSS)
- Thermal Burn Injury
- Erythema multiforme
### CASE STUDY #4:

**Stevens-Johnson syndrome (SJS) and Toxic Epidermal Necrosis (TEN)**

<table>
<thead>
<tr>
<th>Use of AED</th>
<th>Thermal Burn Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>No recent change to AEDs</td>
<td>Pattern (sparing of skin creases)</td>
</tr>
<tr>
<td>No mucosal involvement</td>
<td>Rapidly evolving w/ pain, blanching, clear yellow exudate</td>
</tr>
<tr>
<td>No progression after several hrs</td>
<td>At risk for NAT</td>
</tr>
</tbody>
</table>

- Hypersensitivity reaction w/ severe mucocutaneous eruptions
- Mucosal involvement > 90%, usually at > 2 sites
- Medications leading trigger
- Presentation: Prodrome of fever and flu-like symptoms → Ill-defined, erythematous macules → Vesicles and bullae → Sloughing
- No splash marks
- Lack of irregular borders
CASE STUDY #4:

Staphylococcal scalded skin syndrome (SSSS)

- PMH of MRSA
- Tense blisters
- Atypical distribution
- Age

Erythema multiforme

- Blisters > 10% BSA
- Atypical distribution
- Age

• Cause: Epidermolytic toxins produced by certain strains of staphylococci
• No mucosal involvement
• Presentation: Generalized erythema → flaccid blisters and desquamation

• Acute immune-mediated
• Triggers: HSV
• Mucosal may or may not be involved
• Presentation: Distinctive target-like lesions, particularly on extremities
CASE STUDY #4:

Erythema multiforme

Staphylococcal scalded skin syndrome (SSSS)
CASE STUDY #4:

Stevens-Johnson syndrome (SJS) and Toxic Epidermal Necrosis (TEN))
CASE STUDY #4:

Biopsy Results:

- Partial-thickness, superficial epidermal necrosis with subepidermal blister formation. Negative for organisms.

- “Overall the histologic findings are consistent with some degree of epidermal injury resulting in blister formation; however, the exact etiology cannot be definitively determined”

So What Does This Mean???

Dermatology Final Opinion:

“These pathology findings in conjunction with the clinical history and physical examination findings remain concerning for partial thickness thermal burn injury. The lack of further progression while continuing to receive his usual medications would go against a toxic epidermal necrolysis or bullous drug eruption”
CASE STUDY #4:

Burns:

- Superficial: Epidermis only
- Partial-thickness: Epidermis and portions of the dermis
- Full-thickness: Extends through and destroy all layers of the dermis
- Deeper (fourth-degree): Extends through the skin into underlying soft tissues such as fascia, muscle, and/or bone
CASE STUDY #4:
CASE STUDY #4:

<table>
<thead>
<tr>
<th>TEMP (°F)</th>
<th>Approx TIME for 1st Deg Burn</th>
<th>Approx TIME for 3rd Deg Burn</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Safe for bathing</td>
<td>Safe for bathing</td>
</tr>
<tr>
<td>120</td>
<td>8 min</td>
<td>10 min</td>
</tr>
<tr>
<td>125</td>
<td>2 min</td>
<td>4 min</td>
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<tr>
<td>130</td>
<td>17 sec</td>
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<td>140</td>
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<td>160</td>
<td>Instant</td>
<td>0.5 sec</td>
</tr>
<tr>
<td>180</td>
<td>Instant</td>
<td>Instant</td>
</tr>
</tbody>
</table>
CASE STUDY #4:

Hospital Course:

- Report filed with CPS
- Analgesics
- Topical Wound Care (Mepilex AG to back; Antibiotic ointment and Adaptic to buttocks)
- Discharged home with family per CPS
- Burns healed by Injury Day #13
QUESTIONS?