Non-Accidental Pediatric Trauma

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Medical Director Pediatric Trauma Services

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Chief, Pediatric Critical Care
Child Abuse and Neglect

“at a minimum, any ACT or FAILURE TO ACT on the part of a parent or caretaker, which results in death, serious physical or emotional harm, sexual abuse or exploitation, or an act or failure to act which presents an imminent risk of serious harm”

Introduction

- Higher morbidity/mortality than accidental trauma
- Types of injury, delay in diagnosis/management
- Physician led away from possible traumatic cause for patient’s condition
- History vague, trauma depicted as minor
Introduction

- Trauma resuscitation “Golden Hour” often lost, sometimes days until care
- Head trauma most common, followed by abdominal trauma, burns, thoracic trauma
- Transport approach just like accidental trauma victim
  - Possible occult multiple-organ injury
  - Meticulous investigation vital for the forensics evaluation
Patterns of Injury

- Accidental
  - Unilateral
  - Isolated injury
  - Amorphous shape
  - Prominent bone areas
  - Posterior aspect of body
  - One age of injury

- Non-accidental
  - Bilateral/symmetrical
  - Multiple injuries
  - Well-defined shape
  - Soft tissue areas
  - Anterior aspect of body
  - Multiple ages of injury
How Big a Problem in USA?  
(2016 National Data)

- 4.1 million referrals to CPS  
  - (3.1 million in 2008)
- 7.4 million children involved
- 1 report every 7.7 seconds
- 676,000 confirmed victims
- The estimated annual cost of child abuse/neglect in the USA in 2016 was $124 Billion

US Dept Health and Human Services, Child Maltreatment 2016
How Big a Problem in CA? (2016 Data)

- 460,071 referrals
  - #1 in USA for total referrals
  - #2 is Florida – 351,850
- 388,696 children investigated
- 73,307 confirmed victims
  - (down from 76,026 in 2012)
- 55,304 Perpetrators

US Dept Health and Human Services, *Child Maltreatment 2016*
# California Victims by Race (2016)

<table>
<thead>
<tr>
<th>Race</th>
<th>Total Victims</th>
<th>Rate/1000</th>
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<tbody>
<tr>
<td>Hispanic</td>
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<tr>
<td>White</td>
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<tr>
<td>African-American</td>
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<tr>
<td>Asian</td>
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<tr>
<td>Native American</td>
<td>644</td>
<td>19.2</td>
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</table>

US Dept Health and Human Services, *Child Maltreatment 2016*
## California Victims by Type (2016)

<table>
<thead>
<tr>
<th>Type of Abuse</th>
<th>Total</th>
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<tbody>
<tr>
<td>Neglect</td>
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<tr>
<td>Psychological</td>
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<tr>
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<tr>
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<td>307</td>
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</table>

US Dept Health and Human Services, *Child Maltreatment 2016*
Deaths from Abuse (2016)

<table>
<thead>
<tr>
<th>Year</th>
<th>CA</th>
<th>USA</th>
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<tbody>
<tr>
<td>2012</td>
<td>130</td>
<td>1621</td>
</tr>
<tr>
<td>2013</td>
<td>139</td>
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<td>2015</td>
<td>127</td>
<td>1589</td>
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<tr>
<td>2016</td>
<td>137</td>
<td>1700</td>
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- USA
  - 4.4 deaths / day
  - 44% <1 y/o
  - 77% < 3 y/o
  - 82% < 4 y/o
- California
  - 1 death every 2.6 days

US Dept Health and Human Services, *Child Maltreatment 2016*
Exhibit 4-B Child Fatalities by Age, 2016

Children <1 year old died from abuse and neglect at three times the rate of children who were 1 year old.

Based on data from 44 states. See table 4-4.
Inland Empire
Injury Related Deaths, 2011
Age 0-4

<table>
<thead>
<tr>
<th>Cause</th>
<th>CA (%)</th>
<th>IE (%)</th>
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</thead>
<tbody>
<tr>
<td>Homicide</td>
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<td>34.3</td>
</tr>
<tr>
<td>Drowning</td>
<td>28.8</td>
<td>34.3</td>
</tr>
<tr>
<td>Suffocation</td>
<td>21.4</td>
<td>17.1</td>
</tr>
<tr>
<td>Auto vs Ped</td>
<td>7.0</td>
<td>5.7</td>
</tr>
<tr>
<td>Struck by object</td>
<td>4.5</td>
<td>2.8</td>
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</table>
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Non-Fatal Injury Related Hospitalizations, 2011

Age < 1 yr

<table>
<thead>
<tr>
<th>Reason for hospitalization</th>
<th>CA (%)</th>
<th>IE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unintentional Fall</td>
<td>45.6</td>
<td>28.8</td>
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<tr>
<td>Homicide / Assault</td>
<td>18.9</td>
<td>34.9</td>
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<tr>
<td>Unintentional Poisoning</td>
<td>12.8</td>
<td>7.4</td>
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<tr>
<td>Unintentional Burn</td>
<td>11.9</td>
<td>11.4</td>
</tr>
<tr>
<td>Unintentional Suffocation</td>
<td>10.7</td>
<td>4.0</td>
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# Non-Fatal Injury Related Hospitalizations, 2011

**Age < 1 yr**

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</table>
Victims (2016)

• Boys and girls are abused at about an equal rate

• More boys die than do girls (58% vs 41%)

• One fifth of victims are placed in foster care

• Children < 1 y/o are most likely to be abused

US Dept Health and Human Services, Child Maltreatment 2016
Perpetrators (USA)

- 518,136 perpetrators in 2016
- 83.8% were related caregivers
- ~78% were parents
  - 83.8% biological
- Women abused children more frequently than men
  - (54% vs 45%)

US Dept Health and Human Services, *Child Maltreatment 2016*
Origins of Abuse (Stress)

- Parental / guardian factors
  - Substance abuse, poor education, mental health
  - Single parent, abuse as a child

- Child related factors
  - Handicapped, hyperactive, multiple birth, premie
  - Picky eater, toilet training issues, normal negativism
  - Illegitimate or unwanted

- Social / situational factors
  - Unemployment, financial stress, lack of support
  - Unrelated caregiver - eg mom’s new boyfriend as caregiver
  - Housing, family discord, domestic violence
Neglect

- Treatment or maltreatment of a child that indicates harm or threatened harm to the child’s health or welfare. To deprive the child of the necessities such as food, clothing, shelter, supervision, medical care and education. This is defined in terms of whether or not the child’s basic needs are met.

- Neglect of safety and medical care are abuse, are reportable, are criminal
Neglect

- Physical Indicators in child
  - Failure to thrive / malnutrition
  - Lack of medical / dental care
  - Dirty / poor personal hygiene
  - Quietness, isolation, apathy
  - Anxiousness, clingy

- Parental indicators that may be observed
  - Lack of cuddling
  - Indifferent response to separation, seem disconnected from the child
  - Inability to feed the child
  - Lack of perception for the child’s needs
Other Forms of Neglect: i.e. Child Endangerment

- Domestic Violence
- Drowning - (lack of supervision)
- Fire arms – (lack of supervision)
- Unrestrained MVA
- Intoxicated caregiver
Physical Abuse

Definition: The deliberate infliction of physical injury on a child, or any act which results in a non-accidental physical injury.
Indicators of Possible Abuse

- Parental lack of concern for child’s injuries or pain
- Delay in seeking medical treatment
- Visits to multiple ER’s
- Inability/unwillingness to comfort the child
- History is incompatible, varying, vague or absent
- Parents may even refuse to be interviewed
- Absent or exaggerated response to injury
- Brought in for unrelated problem, but with obvious signs of injury
Suspicious History

- No History - in highly supervised age group
- Vague history…(“He must have….”, “I found him this way”, “He was this way when I got him…”)
- Caretakers give conflicting/variable histories
- History of minor/common trauma given to explain a severe or unusual injury
- Third party is blamed: Pet or sibling (consider developmental stage of the sibling)
- Victim is blamed - “he hit his head with a rattle”
“Rolled off a futon” (about 18 inches high)
Bruises
# Bruising

## Table 1
Determining the Age of a Bruise by Its Color

<table>
<thead>
<tr>
<th>Color of Bruise</th>
<th>Age of Bruise</th>
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</thead>
<tbody>
<tr>
<td>Red (swollen, tender)</td>
<td>0–2 days</td>
</tr>
<tr>
<td>Blue, purple</td>
<td>2–5 days</td>
</tr>
<tr>
<td>Green</td>
<td>5–7 days</td>
</tr>
<tr>
<td>Yellow</td>
<td>7–10 days</td>
</tr>
<tr>
<td>Brown</td>
<td>10–14 days</td>
</tr>
<tr>
<td>No further evidence of bruising</td>
<td>2–4 weeks</td>
</tr>
</tbody>
</table>
Same injury, different lighting
Dating Bruises

- Can be difficult

- All that can be determined is that bruising will show a progression of color changes with time and that initially the colors red, purple, and blue will be seen and some time later brown, green, and yellow may appear, often in combination

- Bruises sustained at the same time may be of different colors
Differential Diagnosis

- Mongolian spots - congenital
- Bleeding disorders - Hemophilia, ITP
- Henoch-Schonlein Purpura - vasculitis induced by abnormal immune response
- Ethnic/cultural alternative medical therapies - Cupping or coining
Typical Accidental Bruises

- Ambulatory child
- Poorly padded areas or boney prominence
  - Shins, knees, elbows
  - Chins
  - Midline forehead
  - Midline back - over spinous process
- Non-specific pattern / shape
- Limited number of lesions
Typical Sites of Inflicted Injury

- Head and neck: >60% injured children
- Face
- Ears: highly unusual in accidental events
- Buttocks
- Inner thighs and genitalia
- Back
- Abdomen: bruises may be subtle
Head and Neck
Face / Ears

Face

Ear

Conjunctival hemorrhage

Jaw-line (Shaken Baby)
Associated Intra-oral Injuries

Torn frenulum upper lip

Lower lip puncture by teeth after being hit in the mouth. Note the bruise under the tongue
Buttocks / Back

Whip marks to buttocks

Paddle marks to back
Genitalia / Inner Thigh
Pattern of Bruising

- Bruise pattern commonly mimics the object causing the injury

- High impact injuries
  - Negative image of the object used surrounded by a rim of petechiae where capillaries have been stretched and torn

- More forceful injuries
  - Positive image of the object when vessels are ruptured directly
Slap (outline of fingers)
Typical strangulation marks

Mark left by thumb

Marks left by other nails
Bite marks

• **Bites** - manifestation of uncontrolled, primitive behavior

• **Location:**
  - Head and neck 42%
  - Trunk 29%
  - Limbs 24%
  - Breast/genitals 5%

• **Size:**
  - Canine to canine >3 cms typically indicates an adult
Bites
Burns

- 10% all forms of abuse
- Scalding hot liquid most common
- Suspicious if no indication of withdrawal of burned body part
- Abuse may escalate over time
  - Repeated/progressively more severe → death
- Types of Burns
  - Contact: Hot object presses against skin
  - Splash: Hot liquid poured onto child
  - Immersion: Held in hot water
Contact Burn
Cigarette burns to foot - different stages of healing
Cigarette burn to chest - note the laparotomy
Scalding water poured on feet - third degree burn
(same child)
Differential Dx

- Staph impetigo
- Contact dermatitis
- Erythema multiforme (herpes, influenza, mumps, etc)
- Stevens-Johnson Syndrome (SJS)
- Toxic epidermal necrolysis (TEN)
Abusive Head Trauma
(formerly “Shaken Baby Syndrome”)

- Caused by vigorously shaking an infant
  - Presumably in anger, and to get the child to stop crying

- This violent shaking can cause:
  - Severe and permanent brain damage
  - Spinal cord injury
  - Retinal hemorrhages
  - Death

- May have NO external signs of trauma

- Hx is often…..” I found him this way”

- Transport team to place cervical collar at first suspicion
How common is AHT?

- Estimated 1000 - 1500 cases / year in USA
- Usually between 3 - 8 months of age
  - Reported in newborns - 4 years
- Up to 25% of victims will die of their injuries
- Most common cause of abuse related deaths
- Most common cause of serious intra-cranial injury in children < 1 year old.
- Many have associated injuries
  - Rib fractures
  - Bruises
  - Extremity fractures
Missed Abusive Head Trauma

- 173 children with head injury
- 31% was initially missed
  - 28% of patients were subsequently re-injured
  - 41% had medical complications related to delay in diagnosis
  - 4 of 5 deaths might have been prevented

Carol Jenny et al: Analysis of Missed Cases of Abusive Head Trauma: JAMA 281#7
Etiology of the brain injury

- Large head / weak neck muscles
- Head bounces forward and backward, twists – shear injury, rotational injury
- Extension of medulla oblongata
  - Lower brainstem
  - Causes apnea
  - Subsequent hypoxia / cerebral edema
- Tearing of bridging vessels produces bleeding around the brain (SDH, SAH)
  - A marker of severity of injury
  - Not the usual cause of death
- Cellular injury \( \uparrow \) vasoreactivity damaged axons
  - Cerebral edema
  - Diffuse axonal injury
  - Traumatic axonal injury
Presentation of AHT

- May have no external signs of injury
- Nonspecific symptoms
  - Irritability
  - Vomiting
  - Comatose in severe injury
- Shear injury +/- increased ICP
  - Lethargy
  - Seizures
  - Apnea
- Retinal hemorrhages
  - May be absent, unilateral or bilateral
  - Often involve multiple layers of the retina
  - Usually extend to periphery (which is NOT typically seen in accidental RH)
- CSF bloody or xanthochromic
Prognosis of AHT

- Worse than accidental brain injury
- Permanent brain injury
- Blindness
- Neck and spinal injuries
- May have long term developmental delays after initial recovery
- MRI better for assessing axonal injury, HIE, infarction, SAH, age of injuries
Retinal Hemorrhages

- Occur in 19-37% of newborns
  - Generally gone in 8 - 21 days, occasionally last 4 - 6 weeks
  - Head MRI of neonates with RH found 0% with ICH
- Have been reported after
  - CPR (9 of 117 pts: 2 prolonged CPR, 4 NAT, 1 HTN, 1 MVA, 1 drowning)
  - ECMO (13%, mostly neonates)
  - Meningitis, aneurysms, and coagulopathies, endocarditis
  - MVA w/ side impact and rotational injury
- Do not seem to occur after seizures
Retinal Hemorrhages and **Accidental Head Injury**

- Christian et al. *(J Pediatrics)* Three case reports of RH in accidental injury (fall down steps in walker, fall through railing onto cement floor, and fall from father’s arms). But ALL the RH’s were limited.

- Alario et al. *(ADJC)* 50 kids <2 yr. Well documented accidental head injury. NO retinal hemorrhages.


- Elder et al. *(J Ped Child Health)* 25 children with accidental head injury. No RH.

- Buys et al. *(Ophthalmology)* 79 head injured children. 75 accidental - NO RH. 3 NAT all with RH’s. 1 indeterminate.

- Duhaime et al. *(Pediatrics)* 100 consecutive head injuries. 10 pts with RH. 9 due to abuse. 1 due to MVA,

- Betz et al. *(Forensic Sci Internat)* looked at area of hemorrhage and mechanism. Accidental = 1.1 - 3.3% surface area. NAT = 19 - 73%.
Retinal Hemorrhages

- Retinal hemorrhage is a finding that must be considered in context
- Frequently, but not exclusively, associated with abusive head trauma
- When due to NAT, is usually extensive extending into periphery
Fractures

- 25 - 50% of children with documented NAT will have fx’s
- The younger the patient with a fx, the higher the probability of abuse

10 m/o with head injury after a broken arm that wasn’t reported to CPS
Highly Suspicious Fractures

- Posterior rib fx
- Metaphyseal fx
- Scapular fx
- Vertebral fx
- Sternal fx
- Hands and feet - especially if non-ambulatory
- Midshaft humerus in < 3 yr
- Femur fx in any non-ambulatory child
Mechanism of Posterior Rib Fx’s

1 posterior transverse process of adjacent vertebrae is the fulcrum

2 lateral

Note: post rib fx’s are NOT seen after CPR
Multiple Rib Fractures
(and a humerus fx)
Metaphyseal Fracture

- Also called….
  - Corner fracture
  - Bucket handle fx

- Etiology
  - Flailing while being shaken
  - Twisting and torquing the extremity while pulling or yanking
Multiple Metaphyseal Fractures
Moderately Suspicious Fractures

- Multiple fractures
- Fractures in different stages of healing
- Complex skull fx’s
- History becomes very important in evaluation of these injuries
Common Fractures - Not Specific to NAT

- Common in abuse, but also frequently accidental
- Single long bone fx’s
- Simple linear skull fx’s
- Mid clavicle fx’s
Femur fractures

- Non-ambulatory child
  - Highly suspicious
- Ambulatory child
  - Usually accidental
- Spiral fractures
  - Common in both abuse AND accidental injury unless non-ambulatory
  - 8-36% of fx’s in one NAT series
- Need an accurate hx
Differential Diagnosis - NAT fractures

- Accidental fracture
- Osteogenesis imperfecta
- Metabolic bone disease (eg. Rickets)
- Birth trauma
Skeletal survey: X-rays of the bones

- 3 views of skull
- 2 view all long bones
- 4 views ribs
- Entire spine
- Hands and feet

- Any child < 2 years if suspect abuse
- 2-5 yr old, 22% have findings, should be ordered on case by case basis
- Over 5 yrs, screening extremely low yield, not recommended
Imaging: Bone Scan

- Radionuclide bone scan: more sensitive but less specific so cannot be used in court

- Complement to skeletal survey
  - Can find occult fracture, confirm suspected fracture, verify a fracture that was poorly seen on series
  - Good for picking up rib fx’s and vertebral fx’s

- Positive area of injury must be confirmed with plain film
Inflicted Abdominal Trauma

- Second leading cause of fatal child abuse
- 40-50% mortality though 0.5% incidence, mostly children > 1 yr
- Occult, delay in presentation
- Hemorrhagic shock, peritonitis
- Blunt force to abdominal wall
  - Compression forces
  - Deceleration forces
- Burst injury solid organs, perforation hollow viscera, tears/hematoma formation at ligamentous attachment liver and small bowel
- Duodenal hematoma, liver laceration, pancreatitis
- Elevated LFT’s, abdominal CT scan
Sexual Abuse

- Careful genital exam
- Specialist to perform non-invasive culposcopic exam
- Video and photographic documentation
- Rape kit with law enforcement involvement
  - Before any washing or skin prep
- Surgical repair for internal lacerations
Box 122.1
Protocol for Medical Investigation of Child Abuse

- Physical examination for skin and genital trauma
- Photography of all injury
- Skeletal survey for children <5 years
- Bone scan (if skeletal survey results are negative)
- CT head scan for children <3 years
- Ophthalmology consultation to rule out retinal hemorrhage
- Abdominal trauma laboratory values
- Serum amylase/lipase
- Liver enzymes
- Urine analysis
- CT abdomen scan
- All nonverbal children
- Positive findings from abdominal examination
- Abnormal laboratory results

MRI of the head if AHT is identified on CT or is strongly suspected despite equivocal CT findings.
Transport Management

- ABCDE trauma evaluation on suspicion of NAT
- Neuroprotective measures
- Placement in spine precautions
- Activation of trauma protocol
  - Transport to ED
- Obtain/repeat necessary CT scans
- Prepare for OR
- CPS notification
- Accurate documentation
Report

- a reasonable SUSPICION of child abuse

- Call on telephone ASAP to Police department, Sheriff or CPS

- Follow up with a written report within 36 hours
Exhibit 2-C Report Sources, 2016

Professionals submitted the majority of screened-in referrals (reports) that received an investigation or alternative response.

<table>
<thead>
<tr>
<th>Report Sources</th>
<th>Professionals</th>
<th>Nonprofessionals</th>
<th>Unclassified</th>
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<td>Legal and Law Enforcement Personnel</td>
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Data are from the Child File. Based on data from 49 states. States were excluded from this analysis if more than 25.0 percent had an unknown report source. Numbers total to more than 100.0 percent due to rounding. Supporting data not shown.
IMMUNITY FROM LIABILITY:

- YOU ARE IMMUNE FROM LIABILITY FOR REPORTING SUSPECTED CHILD ABUSE UNLESS:
  
  1) You make a report that you know to be false
  
  2) You make a report with reckless disregard for the truth or falsity of that report
LIABILITY FOR FAILURE TO REPORT:

1) Child Abuse you know to exist

2) Child Abuse you reasonably should have known to exist

CRIMINAL = misdemeanor (6 mo jail/$1,000)

CIVIL = can be liable for future injuries suffered by the child at hands of same abusers
PICU Management

• Appropriate medical care
  • Differential diagnoses
• Accurate documentation
• Trauma team consult if not already performed
• Forensics consultation early
• Arrange for photography ASAP
• Independent CPS/law enforcement investigation
• Nonjudgemental family support
Fatal Child Abuse

- Family support
- Immediate reporting to Coroner’s office
- No removal of medical devices
- Collaboration with forensic pathologist/medical examiner
  - Autopsy
  - Scene investigation
Box 122.2
Scene Investigation Information

- Law enforcement jurisdiction
- Date, time, address of place of injury
- Witnessed by whom (or unwitnessed)
- First responders to scene
- Field interventions (CPR, intubation, drugs)
- Description of victim as found
- Description of environment
- Scene diagram (supplied by law enforcement)
- Interviews with parents, caretakers, witnesses
- Cardiopulmonary resuscitation
### Key Groups Needed for Tissue Procurement

- Pediatrician representing family’s request
- Organ procurement organization representative
- Medical examiner’s office
- District attorney’s office
Testifying in Court

- Accurate, legible documentation
- Preparation by prosecuting attorney
  - Review medical records
  - Understand court proceedings
- Stay calm, objective during questioning
- Brief answers, adhere to the facts
- *You are not on trial*
Data Sources
Questions?