When the Shoe Doesn’t Fit: Putting Together the Pieces of Non-Accidental Trauma

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Spare the rod and spoil the child.

Ten year old Mary Ellen McCormack lived in the Hell’s Kitchen section of Manhattan. There were no laws protecting children from their parents. The case was brought by the American Society for the Prevention of Cruelty to Animals.

History

- Caffey, 1946
  - 6 children with chronic subdural and long bone fractures
  - “corner fracture”: a small piece of bone is avulsed due to shearing forces on the fragile growth plate
  - “bucket fracture”: fracture through the growth plate
  - noted these peculiar fractures in children with subdural hematomas

- Kempe, 1962
  - proposed *manhandling and violent shaking* as mechanisms of injury
  - “Battered Child Syndrome” coined

Child Abuse, at minimum

- Any recent 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 a serious risk of imminent harm.

Myth

- NAT easy to recognize
- It is *NOT* and it is important
  - Unrecognized ➞ return home
  - 25% risk of further serious injury
  - 5% risk of death
- 2 million children per year in US
Child Abuse: Physical

An injury is inflicted upon a child via a variety of non-accidental means including hitting with a hand, stick, strap or other object; punching, kicking, shaking, throwing, burning, stabbing or choking to the extent that demonstrable harm results.

Physical abuse should be suspected when an injury is unexplained, unexplainable, or implausible.
Elements of abuse

- Most often occurs in the home
- Three elements are involved to create an abusive environment:
  - Unplanned pregnancy
  - Abused as a child
  - Financial stressors
  - Substance abuse
  - Lack of support systems
  - Abusive partners
  - Unstable living conditions
  - Mental or emotional disturbance

Environmental Risk Factors

- Military background
  - Misunderstanding of normal developmental stages of childhood with inappropriate expectations of the child
  - Lack of control or poor impulse control

Extrinsic Risk Factors

- Conditions altering parent-child bonding:
  - Prematurity
  - Extended neonatal hospitalization
  - Parent illness or disability
  - Adolescent parents
  - Colic
  - Congenital deficiencies or abnormalities
  - Developmental delays of the child
  - Hyperactivity

The Obvious

- Burns
  - Immersion
    - Uniform pattern
    - Demarcation
  - Cigarette
- Bites
- Inflicted bruises

Abuse wisdom is not obvious. You must see the subtle and notice the hidden to be victorious. - Sun Tzu
What should create suspicion?

- No one or only the reporting person witnessed injury
- Injury blamed on younger sibling or playmate
- Injury described as “self-inflicted”
- Injury inconsistent with child’s developmental level
- Discrepant history
  - Not consistent with severity of injury
    - Caregiver describes minor trauma, child exhibits major injury
  - Details inconsistent, change over time
- Delay in seeking care
- Story is inconsistent with the injury

“Killers”

10 years experience with falls from height

- 246 children <5 years old divided into two groups:
  - fallen off bed or sofa (n=161)
  - fell in hospital from bed, crib or exam table (n=85)
- Results (all falls <3 feet)
  - 3 clavicular fractures (ages: 6 months-5 years)
  - 2 skull fractures (ages: <6 months)
  - 1 humerus fracture (age: <6 months)
- Hospital group: 1 skull fracture ("no serious sequela")
- Conclusions:
  - Severe head injuries do not occur when children fall out of bed
  - Fractures can occur when children fall out of bed

Killer Beds

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Killer Stairs

- 363 patients 1 month-18.7 years of age with injuries from falls down steps
- Mean age 55 months (54 patients <1 year of age)
- Definitive child abuse cases not included
- Results:
  - 6% had fractures: 72% extremity, 28% skull
  - No rib, vertebral, pelvis or femoral fractures
  - No intracranial hemorrhages or cerebral contusions
  - Of infants who fell in the arms of caretakers, 40 percent (4/10) sustained skull fractures

Conclusions

- No correlation between severity of injury and number of steps fallen down
- Stairway injuries are much less severe than free falls of the same total vertical distance
- Multiple, truncal and proximal extremity injuries are unusual in stairway falls
317 children who presented with the mechanism of injury being a “fall”

<table>
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<th>Fall Height (feet)</th>
<th>Number died</th>
<th>Total</th>
<th>Case fatality rate (%)</th>
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<tr>
<td>1-4</td>
<td>7</td>
<td>100</td>
<td>7.0</td>
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<tr>
<td>5-9</td>
<td>0</td>
<td>65</td>
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<tr>
<td>10-45</td>
<td>1</td>
<td>118</td>
<td>0.8</td>
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</table>

<table>
<thead>
<tr>
<th>Type of fall</th>
<th>Number</th>
<th>Associated Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing fall</td>
<td>2</td>
<td>(none)</td>
</tr>
<tr>
<td>Fall from bed / table</td>
<td>2</td>
<td>(none)</td>
</tr>
<tr>
<td>Fall down stairs</td>
<td>1</td>
<td>Bruising on arms, labia, thighs</td>
</tr>
<tr>
<td>Fall in arms of adult</td>
<td>2</td>
<td>(1) bruising on scalp, ear; SDH; RH and (2) RH; SDH; old tibia fracture</td>
</tr>
</tbody>
</table>

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Conclusion

• If the histories are correct, then the risk of death in children who fell from a height of 1-4 feet was eight times greater than for those who fell from 10-45 feet.
• The findings may be explained by assuming the histories of short falls were false and that the children died from other, untold, trauma.
• 3/7 children who died from alleged short falls had physical findings on examination consistent with child abuse.

Bruising

Fractures

• Any fracture can be the result of abuse
• No fracture is pathognomonic of abuse
• Some fractures, however, have greater specificity for abuse
Mechanisms of Injury in Fractures

- Combination of forces at play in most fractures
- Spiral fractures: caused by torsional forces
- Transverse fractures: caused by bending
- Oblique fractures: caused by combination of compression, loading, bending, or more complex loads
- Common Metaphyseal Lesion (CML) (Bucket Handle): caused by shearing or traction/twisting

Fracture Specificity

- Diagnosis relies on more than fracture specificity
- History (or lack of history)
- Age and development of the child
- Other examination findings
- Consideration and elimination of underlying medical conditions

Fractures

- Fractures with a High Specificity for Child Abuse, < 2 years:
  - Characteristic metaphyseal lesion (CML)
  - Posterior rib fractures
  - First rib fractures
  - Spinous process fractures
  - Sternal fractures
- The femur, humerus, and tibia are the most common long bones fractured in child abuse

Rib Fractures in Infants and Toddlers

- Probability of abuse varies across studies
- Lacking MVC, known violent trauma, or postsurgical history, the probability of abuse is about 70%
- Eliminate bone disease and probability increases
Rib Fractures

- Compressive forces, not direct blows
- Seldom see overlying bruises
- After fractures, infant is often relatively asymptomatic
- Relatively common in child abuse
- 90% seen younger than 2 years

Rib Fractures

- Anterior/posterior compression
- Most abuse – posterior
- Rarely associated with accidental trauma
  - Very elastic, flexible chest walls
- CPR:
  - Many critically ill children receive CPR and have no evidence of rib fractures
  - CPR does not cause posterior rib fractures

Shaken Baby Syndrome

- Shaken Baby Syndrome (SBS)
- Shaken Impact Syndrome
- Inflicted Head Injury
- Abusive Head Trauma
- Shaken Infant Syndrome
- Non-accidental Head Injury
- All these are synonymous
SBS

- Violent back and forth shaking of infant
- Usually held with hands around chest
- Acceleration forces 50-490 G's or more
  - Sneeze = 2.3
  - Slap on the back = 4.1
  - Princess Diana = 70 (chest)
- Retinal hemorrhages, subdural and/or subarachnoid hemorrhages and little or no evidence of external cranial trauma

Who are the victims?

- Normal
- Physical Anomalies
- Developmentally or physically delayed
- "Difficult" temperament
- May remind parent of someone else
- Premature
- Does not meet expectations of parent
- Majority between 1 month – 1 year of age

SBS is characterized as much by what is obscure and subtle as what is immediately identifiable.

- 31% of children (<3 yrs of age) with abusive brain injury seen by physicians did not have the diagnosis recognized on the first visit
- The mean time to correct diagnosis was 7 days (0-189)

SBS was more likely to be unrecognized in very young white children with intact families & in children without seizures or respiratory problems.

Clinical Features

- Violent shaking – put to bed either hoping for recovery or unaware
- As a result, the history might be
  - SIDS-like
  - Wouldn’t wake up from nap
- May have:
  - Vomiting
  - Lethargy
  - Irritability

What does it look like to us?

- Normal or close to normal appearing
- Seizing
- Comatose
- Unable to suck or swallow
- No vocalizing
- Respiratory distress
- Cardiac arrest

The one thing they all have in common is delayed presentation.
Retinal Hemorrhages

- Present in 85% of the cases
  - Higher in children who have died
- Sometimes missed
- Retinal folds and detachments
- Traumatic retinoschisis (splitting of retinal layers)

What *doesn’t* cause retinal hemorrhages

- “Retinal hemorrhages occurring after cardiopulmonary resuscitation, birth and nTBI are generally unilateral and almost always localized to the posterior pole of the retina in a single layer in the retina.”

SBS Outcome

- 20% mortality
- 50% severe morbidity
  - Cerebral palsy
  - Paralysis
  - Vision loss or blindness
  - Mental retardation
  - Epilepsy

Know the signs.....

- When the story doesn’t match the injury
- When the story doesn’t match the physical exam
- The story keeps changing
- Delay in seeking care
- Blame on those who cannot defend themselves
Every 7 minutes, a child in this country is abused.

The longer the abuse persists, the younger the child at the age of onset, the closer the relationship of the abuser, and the more severe the abuse, the worse the prognosis.