Child sexual abuse

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Assistant Professor of Pediatrics, EVMS

Myths about sexual abuse

• Normal-appearing, well educated, middle-class people don’t molest children
• Children who are being abused would immediately tell their parents
• Children who are being abused will show physical evidence of abuse

It’s normal to be normal

• Abnormal findings in 14% of cases referred to sexual abuse evaluation program with perpetrator conviction, guilty plea, or confession
  — Adams, Pediatrics 1994;94:310-317
• 4% of 2384 children referred for sexual abuse exams had abnormal examinations
  — Heger, Child Abuse Negl 2002;26:645-659
• Physical examination abnormalities in 7% of cases resulting in felony conviction
  — Delong, Pediatrics 1989;84:1022-1026

It’s normal to be normal

• 75% of 204 children with reported penile-vaginal penetration had a normal examination
  — Adams; Arch Pediatr Adolesc Med 1996;150:850-857
• 82% of 36 pregnant females ages 12 to 17 had normal examinations
  — Kellogg; Pediatrics 2004;113:e67-e69
• Few examination differences between abused and non-abused children, but only abused children had hymenal transections
  — Berenson; Am J Obstet Gynecol 2000;182:820-834

Why Are Sexual Abuse Exams Usually Normal?

• Genital and anal structures heal rapidly and completely
• Genital and anal structures are elastic, allowing penetration without injury
• Many sexually abusive acts do not involve injury (fondling, pornography)
• When a child says penetration occurred, the act often involves objects placed between the labia or buttocks, rather than through the hymenal ring or into the anus
14 year old who is 4 weeks pregnant (Kellogg et al, 2004)

Frog leg position

Knee Chest Position

Qtip examination

Foley catheter examination
Annular

Crescentic

Redundant

Hymenal appearance in infancy

Hymenal appearance in childhood

Hymenal appearance in adolescence
Evaluation of potential sexual assault

- History of injury (interview of patient, caregiver)
- Physical exam
- Forensic evidence collection
- STI testing
- Prophylaxis of STIs, pregnancy

Forensic evidence collection

- Collected within 72 hours of assault
- Contains:
  - Instructions
  - Swabs for body fluid collection
  - Slide for smear/wet prep
  - Comb for pubic hair collection
  - Envelopes for hair and debris
  - Envelopes for clothing worn during assault
  - Tubes for blood collection
  - Seal to prevent evidence tampering

<table>
<thead>
<tr>
<th>STI</th>
<th>Sex Abuse?</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonorrhea</td>
<td>Diagnostic</td>
<td>Report</td>
</tr>
<tr>
<td>Chlamydia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syphilis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichomonas</td>
<td>Highly suspicious</td>
<td>Report</td>
</tr>
<tr>
<td>Condyloma</td>
<td>Suspicious</td>
<td>Report</td>
</tr>
<tr>
<td>Herpes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Hymenal Bruising

Prepubertal

Pubertal

Acute

Healed
Acute                                               Healed

CHKD Child Abuse Program
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Fractures, burns, and bruises

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Bruises

What causes bruises?

• Bruises are caused when soft tissue is compressed between 2 hard surfaces and blood vessels leak blood into tissue
• Swelling is secondary to inflammation
• Swelling resolves over first 2-3 days

Incidence and Prevalence

• Bruises uncommon in infants <6 months old
• “Those who don’t cruise rarely bruise”
• Two characteristics separate abusive from accidental bruises:
  LOCATION
  PATTERN

Common excuses parents give to explain infant bruising

• The baby bruises easily
  – And so do I
• He slept on a pacifier
• His sibling/the dog/his father plays rough with him
• He hits himself in the face with his own hands
• He hit himself with a bottle or toy
• He crawled into something

Locations of accidental and abusive injuries


<table>
<thead>
<tr>
<th>Accidental</th>
<th>Inflicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shins</td>
<td>Upper arms</td>
</tr>
<tr>
<td>Lower arms</td>
<td>Upper anterior thighs</td>
</tr>
<tr>
<td>Under chin</td>
<td>Trunk</td>
</tr>
<tr>
<td>Forehead</td>
<td>Genitals</td>
</tr>
<tr>
<td>Hips</td>
<td>Buttocks</td>
</tr>
<tr>
<td>Elbows</td>
<td>Face</td>
</tr>
<tr>
<td>Ankles</td>
<td>Ears</td>
</tr>
<tr>
<td></td>
<td>Neck</td>
</tr>
</tbody>
</table>
Accurate dating of bruises by color is not possible because:
• color varies with depth of bruise and skin color
• rate of healing varies with location on body
• timing of bruise appearance depends on depth
  – superficial bruises appear early
  – deep bruises may take days to appear

Myths about aging of bruises

Visual aging of bruises inexact
• Bruise with yellow is >18 hours; bruise with yellow, green, or brown is old
  • Studies have shown that there is low interrater reliability in estimation of color of bruises
  • Any color can be present in new, intermediate, or old bruises
• Red, blue, purple color means bruise is fresh
  • Red, blue, or purple color can be present anytime from one hour after injury to resolution of injury
  • Bruises of same age on same person can vary in color

Incidence and Prevalence

- Children sustain approximately 116,000 injuries related to fire/burns each year
- >500 children die yearly from burns
- Approximately 20% of burns are inflicted
- Among children ages 4 and younger hospitalized for burn injuries, 65% are scald burns, 20% are contact burns
- Hot tap water accounts for nearly 1 in 4 burns among children
- Flame burns – 13%
- Electrical, chemical – 2%

www.safekids.org/assets/docs/research/burn-scalds.pdf

Classification of Burn Injuries

<table>
<thead>
<tr>
<th>Degree</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial</td>
<td>Epidermis layer is involved; blisters may be present</td>
</tr>
<tr>
<td>Partial</td>
<td>Extends into the dermis causing blistering and tissue loss</td>
</tr>
<tr>
<td>Full</td>
<td>Entire dermis, appendages, nerves destroyed, no pain</td>
</tr>
<tr>
<td>Fourth</td>
<td>Extends into the muscles, bones, and joints</td>
</tr>
</tbody>
</table>

Time required to sustain burns

<table>
<thead>
<tr>
<th>Degrees (F)</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>10 minutes</td>
</tr>
<tr>
<td>122</td>
<td>5 minutes</td>
</tr>
<tr>
<td>127</td>
<td>1 minute</td>
</tr>
<tr>
<td>130</td>
<td>10 seconds</td>
</tr>
<tr>
<td>135</td>
<td>4 seconds</td>
</tr>
<tr>
<td>140</td>
<td>1 second</td>
</tr>
<tr>
<td>149</td>
<td>0.5 second</td>
</tr>
</tbody>
</table>


Features of abusive burns

- Burns usually involve lower trunk, buttocks, perineum, arms, and legs
  - Can appear as “stocking” or “glove” burns
- More likely to have clear demarcation between burns and normal skin, with absence of splash marks
- Can see sparing of buttocks, soles of feet, flexor creases

Properties of mature vs immature bones

- Adult cortical bone strongest in compression, weaker in tension, weakest in shear loading
- Immature bone weakest in compression
  - An edge effect exists in the transition from cortex to metaphysis, making the metaphysis more susceptible to failure in compression

Mechanical properties of mature and immature bone

- Children's bones have lower mineral content than adult bone, and are more elastic, but less stiff
- Children's bones can absorb relatively more energy before permanent deformation and fracture occurs
- Explains some fractures that are unique to children (i.e., greenstick, buckle (torus) fractures)

References:
Ogden et al. (1995). Improved detection of pediatric elbow fractures by understanding their mechanics.
John et al. (1996). Improving detection of pediatric elbow fractures by understanding their mechanics.
John et al. (1996). Improving detection of pediatric elbow fractures by understanding their mechanics.

Abusive head trauma

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Abusive Head Trauma (AHT):
Definition
- Diagnosed by presence of intracranial bleeding/cerebral edema
- Retinal hemorrhages present in about 70% of cases
- History often absent or does not explain findings
- Can have fatal intracranial injury without externally visible trauma
- Associated non-cranial injuries highly concerning for abuse

AHT: Epidemiology
- Highest incidence in children under one year of age, with peak incidence in children aged 6 weeks to 4 months
- Peak incidence of ITBI corresponds to increase in infant crying, which is a normal developmental occurrence
- Can occur in children as old as five years; adult cases in literature
- Prevalence of shaking as form of discipline as high as 2%
  - Random digit-dial telephone survey in North Carolina
- Many adults and teenagers do not realize the dangers of shaking

Incidence of AHT
- 1000-1500 cases in the US every year
  - Misdiagnosis, underreporting are likely to make the true number higher
- Estimates of incidence reveal that 95% of serious intracranial injury occurring in children under 1 year of age, and 85% of serious intracranial injuries in children under 2 years of age, are due to inflicted trauma
- At least 2000 children die from abuse and neglect every year; AHT accounts for 10-12% of child abuse and neglect deaths

AHT: Definition of terms
- Extraaxial spaces defined by: dura mater (outermost layer), dura arachnoid, and pia arachnoid layers (adherent to brain)
- Dura is double-layered membrane; outer layer (periosteal layer) adherent to inner table of skull at sutures, and inner layer (meningeal layer) with attachments to underlying dura arachnoid

Anatomy of dural layers
AHT: Anatomy

- Potential subdural space lies between the inner dural layer, and dura arachnoid
- Contains bridging veins which extend from brain surface, penetrate arachnoid, and cross subdural space into the intradural space to empty into the dural venous sinuses

Contact Head Injuries

- skin/scalp/subgaleal contusion
- skull fracture
- epidural hematoma
- focal subdural hematoma
- cortical contusion

Inertial Brain Injuries

Confirmed Inertial Injuries
- interhemispheric/diffuse SDH
- concussion
- gliding contusions/lacerations
- diffuse axonal injury

Possible Inertial Injuries with Shaking
- cranio-cervical junction injuries
- diffuse retinal hemorrhage/retinoschisis

AHT: Biomechanics

- Shaking causes angular acceleration of brain tissue, with high peak accelerations, which cause damage
- Bridging veins between skull and brain are snapped, causing cerebral contusions and intracranial bleeding
- Shearing often occurs at junction of gray and white matter
- Infant brain susceptible to injury because of large head size, relatively weak neck muscles, large subarachnoid space, delicate bridging vessels

AHT: Mechanism

- Perpetrator often holds child by chest, compressing the chest while forcefully shaking at full arm extension
- Forces involved are much greater than those involved in normal parenting
- Usually large size differential between perpetrator and victim; adult (or adult-sized person) required
- Rib and extremity fractures can result
AHT: Biomechanics

- Properties of infant and mature brain differ
- Some studies have shown that shaking alone is not sufficient to cause injury
- Injury thresholds have been set using primate data, or (adult) human cadavers; not known if these thresholds apply to infants
- Newest studies using crash-test dummies show impact of head on chest, as well as on upper back with severe shaking; this may be ample force to generate serious injury

AHT: Clinical presentation

- Variable, depending on extent of injury
- Sleepiness, lethargy
- Irritability
- Poor feeding
- Vomiting
- Loss or alteration of consciousness
- Seizures
- Apnea

Subdural Hematoma

Normal CT

Subdural hematoma

Diffuse axonal injury
Biomechanics of Retinal Hemorrhages

- Most likely mechanism is through vitreous traction
  - shaking produces traction on the tightly adherent vitreous, causing retinal injury

Retinal hemorrhages

Retinal Hemorrhages

Normal eye  Retinal hemorrhages

Encephalomalacia

Short-term outcomes

- Mortality from abusive head trauma is high, with figures varying from 12% - 30%
- Children with injuries from non-accidental trauma have more severe injury, and worse outcomes, than children with accidental trauma
- 25% - 33% of abusive head injury victims leave the hospital without any obvious neurologic deficit

Long-term outcomes

- Following families long-term is difficult, since families unstable; because of confidentiality restrictions, not many studies done involving long-term follow-up
- Some studies have shown that, of those who left the hospital without apparent deficits, very few remain normal
Long-term outcomes

- Abnormalities include behavior problems, poor vision, cognitive deficits, mental retardation, hemiparesis
- Special education required for many
- Can take years for epilepsy or behavioral and neuropsychological abnormalities to be recognized

Defense theories about AHT

- Short falls cause severe injuries
- Babies are fragile
- Injuries could happen spontaneously
- Injuries are the result of a medical condition
- AHT does not exist
- It’s head injury, but my client didn’t do it

Timing of injuries

Research suggests immediate onset of symptoms after inflicted trauma events (Nashelsky et al 1995; Starling et al 2004)
- In 52/57 cases in which perpetrator confessed to head trauma, immediate symptom onset noted
- The other five cases were either not checked on for several hours after event, or caretaker did not provide information about symptom onset

Evaluating the Potential Effects of a Fall

<table>
<thead>
<tr>
<th>Decreased Risk</th>
<th>Increased Risk</th>
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<tbody>
<tr>
<td>lower height</td>
<td>greater height</td>
</tr>
<tr>
<td>initial velocity 0</td>
<td>+ initial velocity</td>
</tr>
<tr>
<td>soft surface</td>
<td>hard surface</td>
</tr>
<tr>
<td>lower mass</td>
<td>greater mass</td>
</tr>
<tr>
<td>high pt. elasticity</td>
<td>low pt. elasticity</td>
</tr>
<tr>
<td>large impact area</td>
<td>small impact area</td>
</tr>
<tr>
<td>low I, ω, and Iω</td>
<td>high I, ω, or Iω</td>
</tr>
</tbody>
</table>

Childhood Falls

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Cases</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>Helfer</td>
<td>246</td>
<td>All falls from beds, 3 linear skull fx, no deaths</td>
</tr>
<tr>
<td>1987</td>
<td>Nimityongkul</td>
<td>76</td>
<td>All falls from bed/cribs, 97% minor injuries, 1 linear skull fx, no deaths</td>
</tr>
<tr>
<td>1988</td>
<td>Joffe</td>
<td>363</td>
<td>All stairway falls, 92% minor injury, 6% distal fx, 1 concussion, no deaths</td>
</tr>
<tr>
<td>1991</td>
<td>Williams</td>
<td>106</td>
<td>All witnessed falls, 77 minor injuries, 14 severe injuries (5-40 ft), no lethal injuries &lt;10 feet, 1 death at 70 ft</td>
</tr>
<tr>
<td>1993</td>
<td>Lyons</td>
<td>207</td>
<td>All witnessed falls from cribs/beds, 29 minor injuries, 1 linear skull fx, no death</td>
</tr>
<tr>
<td>1991</td>
<td>Chadwick</td>
<td>317</td>
<td>Reported falls, 7 deaths &lt; 4 ft (all falls below head to be false), 0 deaths 4-10 ft, 1 death &gt; 10 ft</td>
</tr>
</tbody>
</table>

Childhood Falls

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Description</th>
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<tbody>
<tr>
<td>2008</td>
<td>Chadwick</td>
<td>Meta-analysis of literature on short falls</td>
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<tr>
<td>2010</td>
<td>Haney</td>
<td>122 children who fell before age 2 years</td>
</tr>
<tr>
<td>2010</td>
<td>Osifo</td>
<td>12 children ages 3 years or less</td>
</tr>
<tr>
<td>2011</td>
<td>Shields</td>
<td>31284 balcony falls in children</td>
</tr>
</tbody>
</table>

2008 Chadwick: Meta-analysis of literature on short falls. National Electronic Injury Surveillance System (NEISS) found 3 short fall deaths among 400,000 children, calculated rate 0.625 cases per million young children per year; California Epidemiology and Prevention for Injury Control Branch (EPIC) database found 6 short fall deaths per 2.5 million children in five years, or 0.48 cases per 1 million children per year.

2010 Haney: 122 children who fell before age 2 years. 209 short falls (bed, couch, changing table; all falls 4 ft or less), 24% of falls with injuries (bruises, bumps, scars); no serious injuries.

2010 Osifo: 12 children ages 3 years or less. Falls from varying heights, including from a staircase, into a pit, from furniture; and 3 without fall information. 2 without injuries, 4 with bruises/lacerations, 6 with moderate injuries (head injury, penetrating trauma); no deaths.

2011 Shields: 31284 balcony falls in children. Fall heights ranged from 5 to 87.5 feet, most falls 12.5 feet or less; 2 deaths (girls ages 6 and 11 years), with fall heights ranging from 10 to 30 feet.
Childhood falls

- If given a history of serious injury with fall from short distance, history is usually factitious
- Fall from couch, bed, crib, changing table can rarely cause a linear parietal skull fracture; there is almost never a serious or life-threatening injury from such a fall
- Falls down stairs seldom result in serious head injury

Do deaths happen as a result of short falls?

- Deaths due to short falls do occur but are extremely rare
  - 0.14 - 0.22 deaths/year/100,000 children aged 0-4 years
  - 0.056 - 0.44 deaths/1,000,000 short falls in children aged 0-4 years
- Special subtypes of short falls may have a higher mortality rate, but it is still very low
Neglect
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Forms of neglect
• Educational
• Medical
• Physical
• Nutritional

Educational neglect
• When child not enrolled in school
• Fails to attend school
• Special educational needs not being met

Medical neglect
• Nonadherence with medical recommendations
  – A severe asthmatic not getting or taking prescribed medications
• Delay or failure in getting health care
  – Problems that a parent can reasonably be expected to recognize, but fails to do so
• Refusal of medical treatment
  – Parents refuse medical treatment on religious grounds, or because alternative treatment is preferred

Physical neglect
• Inadequate protection from environmental hazards
• Inadequate supervision
• Inadequate hygiene
• Failure to provide adequate shelter
• Inadequate clothing
Failure to thrive

- Growth failure occurs in 10% of young children
- Represents 1 - 3% of all pediatric admissions
- It crosses all socioeconomic levels
- Most FTT is mixed in etiology, even organic FTT often includes a non-organic component
- Nonorganic etiology accounts for 70%-80% of growth failure

Common Dietary Pitfalls

- overdilution of formula
- large amounts of cereal or food in bottle
- excessive fruit juice, soda, or water
- inappropriate food texture
- infrequent feeds (quiet children)
- no set feeding times
- no high chair
- grazing
- distractions from feeding
- feeding struggles

Social Problems in Malnutrition

- Family disorganization
- Social isolation
- Post-partum or other depression
- Substance abuse
- Violence
- Parental stress
- Poverty
  - food shortages at end of month
  - lack of cooking facilities
  - crowding, leading to distractions

Physical Examination: Growth Assessment

- weight, height, head circumference
- plot measurements on proper growth curves
- serial measurements are crucial, one point on a graph is meaningless
- patterns of growth may suggest specific diagnoses

- Evaluation of growth chart is imperative
- A single point cannot make the determination of FTT
The child with failure to thrive: 1) has not taken, 2) has not been offered, or 3) has not retained adequate calories for growth.

Percent of median weight for age as an indicator of severity of malnutrition

- 75-90% of median = mild
- 60-74% of median = moderate
- <60% of median = severe

For instance, a 12 month old girl who weighs 7.3 kg has a median (50th%) weight of 9.7 kg. She is at 75% of her median weight, indicating mild FTT.

Physical Examination: Signs of Malnutrition
- Decreased pulse, temperature, BP
- Decreased activity, apathy, hypotonia
- Decreased adiposity
- Prominent ribs and bone structures
- “Old” skin, pallor
- Sparse fragile hair
- Heart murmur from anemia
- Protuberant abdomen, HSM

Case 1
Case 3
Fatal Starvation

- Meade, J For Sci, 1985
- Kloiber, J For Sci, 2004
- Calculated daily caloric requirements necessary to prevent death
- Approximated number of days that food was withheld

Medical Diagnoses

- N= 122 inpatient
  - av. age 25 months
- Yield of tests:
  - 8%
- Anatomic = 12
  - 2 Pyloric stenosis
  - 3 UTI
  - TB, Malrotation, Celiac Sprue
  - Hypercalcemia

Berwick, Arch Dis Child 57:347 1982
Indications for Hospitalization

- below birth weight at 6 weeks
- infant less than 6 months
- head circumference falling off curve at < 6 months
- signs of abuse/ gross physical neglect
- failure of outpatient therapy
- pursuit of organic diagnosis
- home unsafe/ caretaker inadequate

Types of Nonorganic Failure to Thrive

- Neglectful
- Accidental
- Poverty-related
- Deliberate starvation

Early brain development

- Brain growth accelerated early in life
  - Brain is ¼ adult size at birth
  - Brain is 80% of adult size by age 3
  - Brain is 90% of adult size by age 5
- Majority of brain growth in early childhood results from synaptic or dendritic growth (growth of connections between brain cells) and myelination (coating of nerve axons with waxy substance)

Dendrite formation

- At birth, neurons (brain cells) are present, but poorly connected
- A substantial portion of brain growth in early childhood results from formation of dendrites
  - Dendrites sprout from nerve cell
  - Dendrites connect (synapse) with other neurons
  - Each neuron develops hundreds of dendrites over time
- Exuberant growth period results in massive burst of synapse formation after birth
- Synapse formation continues into early childhood
- Pruning of synapses begins in middle childhood, continues through adolescence

Myelination

- Myelination is the other process beginning early in childhood
  - Myelin is a fatty coating on the axon of the neuron
- Myelination of nerve cell axons results in faster signal processing
- Process continues into the early 20s, sometimes up to age 30
- Malnourishment is the only environmental factor known to disrupt myelination

Frank, Ped Clinics of North Am, 1988
Effects of nutritional neglect

Cognitive/developmental deficits
- Decreased IQ
- Poorer performance in school
- Slower language development
- Slower fine motor development
- Problems with feeding

Substantial variance in severity of developmental impairments

Social/emotional deficits
- Deficits in social responsiveness
- Negative affect
- Insecure attachments
  - Anxious, avoidant behavior
- Behavioral disturbances
  - Impulsive
  - Disorganized behavior

Outcomes

- Growth
- Emotional Development
- Intellectual Development

Growth
- Treated adequately most children catch up to some degree
- On follow-up most children are smaller than peers
  - 25-30% have weights and heights below the 3rd percentile
  - Some children reach near normal after intensive years-long therapy
- Severe growth failure leads to decreased brain growth and smaller head circumference

Emotional Development
- High incidence of emotional disorders
- Significantly lower social maturity
- Significantly more behavior problems
- Increase in psychiatric services
Intellectual Development

- Borderline or retarded intelligence
- Significant school difficulties
- Delayed speech
- Delayed conceptual thinking
- Decreased language and reading skills
- Decreased math skills
- Repeated grades
- Poor impulse control
- Poor attention span
- Poor memory

Other Outcomes

- Impaired immunocompetency
- Combination of neglect and FTT causes worse cognitive outcome than nutritional deprivation itself (Mackner CAN 1997)
- Early postnatal FTT is a risk factor for future serious parenting deficiencies (Skuse J Med Screen, 1995)

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