SCHOOL OF MEDICINE
AND PUBLIC HEALTH

# Medical Findings in Physical Child Abuse Cases

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## Types of Physical Abuse

- **Burns**
- **Bruises**
- **Bites**
- **Fractures**
- **Abusive head trauma**
- **Blunt trauma to internal organs**

## Bruising Accidental vs. Inflicted

- **History**
  - **Mechanism**
  - **Discrepancies in story and presenting injuries**
  - **Developmental history**
- **Physical Exam**
  - **Location**
  - **Size**
  - **Shape**
  - **Pattern**

## Those That Don't Cruise Don't Bruise

## Bruising in the Pre-Cruising Infant



**Be suspicious of bruising in children less than 9 months.**

**Ask parent how it happened.**


**Suspect abuse or medical illness.**

## Abusive Bruising Location


- **Bruises are rare in pre-cruisers, but are common in infants cruising and walking**
- **In a study of 973 children, only 2 younger than 6 months had bruises**

## Sentinel Injuries in Infants

ARTICLE

Sentinel Injuries in Infants Evaluated for Child Physical Abuse

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KEY WORDS
abuse, bruising, infants, maltreatment, screening, abusive head trauma

WHAT'S KNOWN ON THIS SUBJECT: Although it is known that relatively minor abusive injuries sometimes precede more severe physical abuse, the prevalence of these previous injuries in infants evaluated for abuse was not known.

WHAT THIS STUDY ADDS: A history of bruising or oral injury in a precruising infant evaluated for abuse should heighten the level of suspicion because these injuries are common in abused infants and rare in infants found not to be abused.

## Sentinel Injuries in Infants

**Sheets, et al. Pediatrics 131(4) 2013**

- **Relatively minor abusive injuries can precede serious physical abuse in infants**
- **Determined how often abused infants had a previous history of sentinel injuries when compared with infants who were not abused**
- **Sentinel injury defined a previous injury reported in the medical history that was suspicious for abuse because the infant could not cruise or the explanation was implausible**

## Sentinel Injuries in Infants

**Sheets, et al. Pediatrics 131(4) 2013**

- **Case-control, retrospective study of 401 <12 month-old infants evaluated for physical abuse in a hospital based setting**
- **Of 200 definitely abused infants, 27.5% (n=55) had a previous sentinel injury**
- **None of the nonabused group had sentinel injuries**

## Sentinel Injuries in Infants

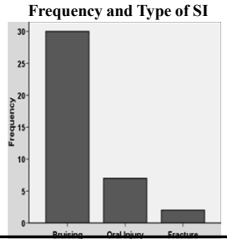
**Sheets, et al. Pediatrics 131(4) 2013**

- **Type of sentinel injury in the definitely abused cohort**
  - **Bruising (80%)**
  - **Intraoral injury (11%)**
  - **Other injury-fracture (7%)**

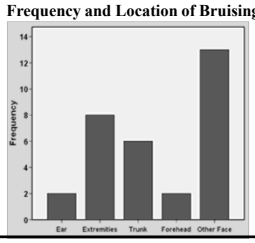
## Sentinel Injuries in Infants

**• Most sentinel injuries were bruises on the non-forehead face, trunk and extremities. *Bruising and oral injuries are significant at p= <0.001 using a one sample binomial exact test.**

**Frequency and Type of SI**




**Frequency and Location of Bruising**

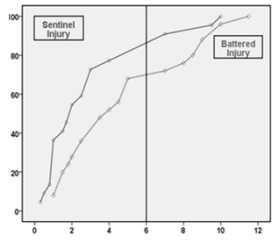



## Sentinel Injuries in Infants

**Sheets, et al. Pediatrics 131(4) 2013**

- **Sentinel injuries occurred in early infancy: 66% at 3 months of age and 95% at or before the age of 7 months.**
- **Medical providers were reportedly aware of the sentinel injury in 41.9% of cases.**
  - *** Of these, 56% of the medical providers were not concerned about abuse**

## Sentinel Injuries in Battered Infants




- Mean time interval between SI and battering injury ≈ 1.6 mo.
- 25% of battered infants had SIs
- Mean age at time of SI ≈ 3.2 mo.
- Proportion of SIs occurring
  - at or before 7 mo. = 91%
  - at or before 4 mo. = 77%
  - at or before 2 mo. = 54%

Sheets & Koszewski (Presented Helfer 4/18/2010- Philadelphia)

## Sentinel Bruises/Oral Injuries Precede Serious Abuse

## Ask about prior bruises or blood coming from the mouth

## Recognition of sentinel injuries and appropriate intervention can prevent abuse

## The Results….

# Systems Issues

- **$210,000.00-Lifetime cost estimate for each case of child physical abuse**
- **Prevention of further abuse through early detection and effective intervention has potential for huge financial savings**

Fang X, Brown DS, Florence CS, Mercy JA. The economic burden of child maltreatment in the United States and implications for prevention. Child Abuse Negl. 2012;36 (2):156–165

## Testing for Abuse in Children With Sentinel Injuries

Daniel M. Lindberg, MD[a], Brenda Beaty, MPH[a], Elizabeth Juarez-Colunga, PhD[a], Joanne N. Wood, MD, MSHP[a], Desmond K. Runyan, MD, DrPH[a]

abstract

OBJECTIVE: Child physical abuse is commonly missed, putting abused children at risk for repeated injury and death. Several so-called sentinel injuries have been suggested to be associated with high rates of abuse, and to imply the need for routine testing for other, occult traumatic injuries. Our objective was to determine rates of abuse evaluation and diagnosis among children evaluated at leading children's hospitals with these putative sentinel injuries.

METHODS: This is a retrospective secondary analysis of the Pediatric Health Information System database. We identified 30 355 children with putative sentinel injuries. We measured rates of abuse diagnosis and rates of testing commonly used to identify occult injuries.

RESULTS: Among all visits for children <24 months old to Pediatric Health Information System hospitals, the rate of abuse diagnosis was 0.17%. Rates of abuse diagnosis for children with at least 1 putative sentinel injury ranged from 3.5% for children <12 months old with burns to 56.1% for children <24 months with rib fractures. Rates of skeletal survey and other testing that can identify occult traumatic injury were highly variable between centers and for different injuries.

CONCLUSIONS: Several putative sentinel injuries are associated with high rates of physical abuse. Among eligible children with rib fracture(s), abdominal trauma, or intracranial hemorrhage, rates of abuse were more than 20%. Future work is warranted to test whether routine testing for abuse in these children can improve early recognition of abuse.

Lindberg, D. et al. Testing for abuse in children with sentinel injuries. *Pediatrics* November 2015; 136(5) 1487.

## Sentinel Injuries and Age at Risk

TABLE 1 Putative Sentinel Injuries

| Candidate Injuries | Age at Risk, mo | ICD-9-CM Codes | Source |
|---|---|---|---|
| Bruising | <6 | 920–924 | Harper et al[27]; Sugar et al[26] |
| Burns | <6 | 940–949 | DeGraw et al[30]; Hicks and Stoltz[57] |
| Oropharyngeal injury | <6 | 873.6–873.7 | Thackeray[22]; Maguire[36] |
| Femur/humerus fracture | <12 | 812, 820–821 | Leventhal et al[25]; Scherl[39]; Strait[40] |
| Radius/ulna/tibia/fibula fracture | <12 | 813, 823, 824 | Leventhal et al[25]; John[41] |
| Isolated skull fracture | <12 | 800–804[a] | Deye et al[42]; Wood[55]; Laskey[43] |
| Intracranial hemorrhage | <12 | 800–801, 803–804, 851–853[a] | Wood[17], Trokel[18]; Kemp[44] |
| Rib fracture(s) | <24 | 807.0, 807.1, 807.4 | Rubin et al[12]; Maguire[45] |
| Abdominal trauma | <24 | 863–869 | Lindberg et al[9,46]; Trokel[28] |
| Genital injury | <24 | 922.4, 878 | Carpenter[47] |
| Subconjunctival hemorrhage | <24 | 372.72 | Sheets et al[24]; DeRidder[48] |

[a] ICD-9 codes that signify skull fracture with intracranial hemorrhage (eg, 804.2) were included in the group with intracranial hemorrhage, not with subjects who have isolated skull fractures.

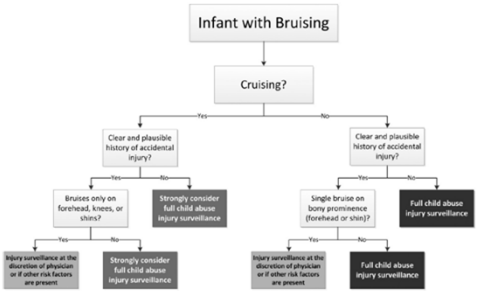
## Testing Rates for Children Presenting with Sentinel Injuries

TABLE 3 Rates of Abuse Diagnosis and Testing for Children With Putative Sentinel Injuries

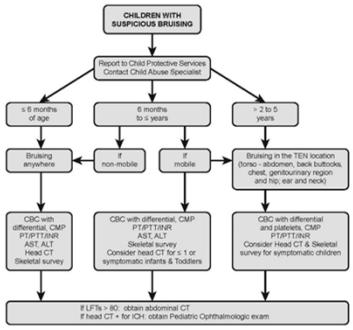
| Candidate Injury | % With Abuse Diagnosis, Mean (Range) | % With Skeletal Survey, Mean (Range) | % With Neuroimaging, Mean (Range) | % With Hepatic Transaminases, Mean (Range) |
|---|---|---|---|---|
| Age <6 mo | | | | |
| Bruise(s) | 8.3 (1.1–21.5) | 20.0 (5.4–30.8) | 44.0 (19.9–60.1) | 14.9 (2.5–24.0) |
| Burn(s) | 3.5 (0–6.9) | 13.1 (0–23.3) | 15.7 (4.9–29.4) | 15.9 (0–44.1) |
| Oropharyngeal injury | 17.0 (0–41.7) | 31.9 (11.1–62.5) | 39.5 (11.1–62.5)* | 26.1 (7.1–40.0) |
| Age <12 mo | | | | |
| Femur/humerus fracture | 18.9 (7.1–51.4) | 59.8 (40.9–82.0) | 63.8 (43.3–84.7) | 35.2 (9.8–71.2) |
| Radius/ulna/tibia/fibula fracture | 19.2 (3.5–49.5) | 42.8 (25.0–78.9) | 45.1 (25.5–78.9) | 25.7 (8.0–64.8) |
| Isolated skull fracture | 4.3 (0.3–11.8) | 40.6 (21.5–74.5) | 79.6 (66.6–95.4) | 19.8 (1.5–47.8) |
| Intracranial hemorrhage | 26.3 (10.7–42.9) | 59.0 (42.3–81.6) | 89.3 (75.8–96.9) | 49.6 (15.9–71.4) |
| Age <24 mo | | | | |
| Rib fracture(s) | 56.1 (11.5–71.6) | 81.5 (69.2–94.9) | 90.6 (78.2–98.6) | 73.1 (11.5–87.7) |
| Abdominal trauma | 24.5 (0–47.4) | 31.9 (18.2–57.9) | 58.7 (36.4–75.7) | 74.3 (55.8–91.8) |
| Genital injury | 12.3 (0–21.4) | 18.5 (0–40.0) | 20.0 (0–45.0) | 16.5 (39.5–89.5) |
| Subconjunctival hemorrhage | 9.6 (0–22.0) | 14.3 (5.9–36.6) | 19.7 (10.9–38.2) | 14.7 (0–35.4) |

Rates are percentages after excluding visits noted to be transfers from another institution.
* Ranges for SS and neuroimaging are identical because the 2 institutions with the highest and lowest rates of testing in this group obtained neuroimaging in all children who received SS.

## Evaluation of the Infant with Bruising




Petska, H and Sheets, L. Sentinel injuries: Subtle findings of physical abuse. *Pediatric Clinics* October 2014; 61(5) 923-935.



## Medical Evaluation of the Infant with Bruising

- Head CT < 6 months old and in those with abnormal neurologic exam
- Skeletal survey < age 2
- Laboratory studies to screen for abdominal injury
- Screening for occult drug injury
- Bleeding disorder laboratory evaluation
- Dilated ophthalmologic exam if AHT suspected

Petska, H and Sheets, L. Sentinel injuries: Subtle findings of physical abuse. *Pediatric Clinics* October 2014; 61(5) 923-935.

## Facial Bruising as a Precursor to Abusive Head Trauma

Clinical Pediatrics
52(1) 86-88

DOI: 10.1177/0009922812441675
http://cpj.sagepub.com
SAGE

Hillary W. Petska, MD[1], Lynn K. Sheets, MD[2], and Barbara L. Knox, MD[1,3]

- Bruising is most common presentation of child abuse in infants
- Bruising occurs in <1% of precruising children
- Often a precursor injury to abusive head trauma
- Facial/head bruising is highly suspicious for abuse in children < 6 months old
- A systematic review by Maguire et. al, the head, and in particular the face, was the most common site for abusive bruises

## Bruising in Children Location


**Normal locations:**

- Anterior tibia and knee
- Forehead
- Upper leg
- (Rarely on face and trunk)
- Concerning for abuse
  - Bruises on buttocks, trunk, hands, and back

## Vertical Linear Buttock Bruises

- **Unique pattern indicates severe forces**
- **Represents crimping or shearing injury**

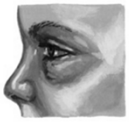
**Feldman KW. Patterned abusive bruises of the buttocks and pinnae. *Pediatrics*. 1992;90:633-636**

## Patterned Injuries

## Dating Bruises "The Dogma"

Acute bruise with marked swelling (1-3 days)

Purple (1-5 days)



Green (5-7 days)

Yellow (7-10 days)

Brown (>10 days)

**©John A. Craig: Clinical Symposia, Ciba-Geigy, 1991**

# Dating Bruises
## The Literature

- **Estimation of the Age of Bruising"** ***Archives of Diseases of Children, 1996***
- **"Dating of Bruises in Children: An Assessment of Physician Accuracy"** ***Pediatrics, 2003***
  - **Direct exam by physicians**
  - **Poor accuracy with dating**
  - **Poor interrater reliability**

ILLUSTRATIVE CASE

Frena Tears and Abusive Head Injury

*A Cautionary Tale*

*Jonathan David Thackeray, MD*

**Sublingual Hematoma: When to Suspect Child Abuse**

Clinical Pediatrics
2014, Vol. 53(8) 809–812

DOI: 10.1177/0009922814529184
cpj.sagepub.com
SAGE

Matthew R. Kudek, BS[1] and Barbara L. Knox, MD, FAAP[2,3]

- **7 month old male infant presented to ER with swelling and discoloration to floor of child's mouth**
- **Mother home alone with child and 2 yo sibling**
- **Thinks child may have sucked too hard on pacifier or fallen down with a toy in his mouth** (Pulls to stand only)
- **Denies recent trauma**

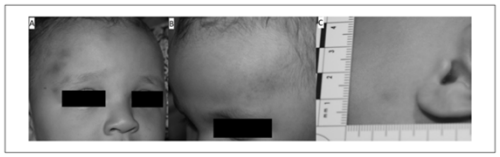


Figure 1. Bruises noted on the child's right forehead (A), nonblanching petechial bruising on the left forehead (B), and a circular bruise on the left cheek (C).

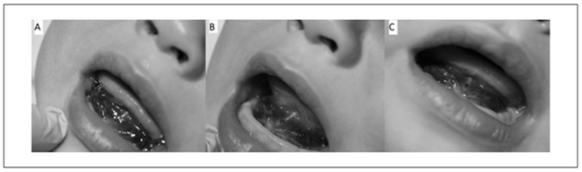
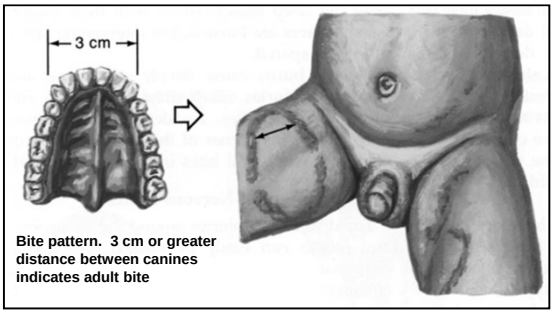


Figure 2. Sublingual hematoma and partial lingual frenal tear causing elevation of the tongue and concern for potential airway obstruction (A-C).

## Biting

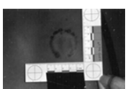



Bite pattern. 3 cm or greater distance between canines indicates adult bite

©John A. Craig: Clinical Symposia, Ciba-Geigy, 1991

## Bite Injuries: A Special Bruise that Deserves Special Treatment

- Get child to the hospital so the bite may be swabbed; General guideline- adult ≥ 3 cm.
- Have the swabs sent to a forensic lab
- Photograph
  - color photos with a standard in the picture (such as a ruler or coin)
  - Black and white photos



- Consult a forensic odontologist

## Forensic Evidence Collection: Recognition of Bites

- Contusions caused by 2 possible mechanisms:
  1. Positive pressure from closing of teeth with disruption of small vessels
  2. Negative pressure from suction and tongue thrusting

Luyet, F, Knox, B. et al. Patterned Bruises on 2 Infants. Contemporary Pediatrics. 2013
Kellogg, N. Oral and Dental Aspects of Child Abuse and Neglect. Pediatrics 2005

## Forensic Evidence Collection: Recognition of Bites

- Blood group substances can be secreted in saliva
- DNA from mouth epithelial cells may be deposited into bite
- Swab using double-swab technique
- Send to forensic laboratory/crime lab for analysis
- Maintain chain of custody

Luyet, F, Knox, B. et al. Patterned Bruises on 2 Infants. Contemporary Pediatrics. 2013
Kellogg, N. Oral and Dental Aspects of Child Abuse and Neglect. Pediatrics 2005

## Dating Abusive Bites

- There is no available literature documenting physician or dentist ability to accurately date on onset of a bite injury to a child
- Forensic odontologists can identify perpetrator(s) via photodocumentation/impression
- Swabs to State Crime Lab

# Fractures

- The most common abuse-related injury (excluding soft tissue injury)
- Documented in 11-55% of physically abused children
- In one large series of abuse related fractures:
  - 76%: Long bones
  - 8%: Skull
  - 8%: Rib cage

King et al: Analysis of 429 fractures in 189 battered children; Journal of Pediatric Orthopedics, 988(8):585-589

## Myths about fractures

- Spiral fractures are nearly always abusive
  - Fact: Spiral fractures can be accidental if a twisting mechanism is implicated.
- Babies bones break easily
  - Young infants have flexible bones that bend before they break
- There should be bruises over inflicted fractures
  - Bruises over inflicted fractures are rare

## Fracture Location According to Association With Bruising

ARCH PEDIATR ADOLESC MED/VOL 162 (NO. 9), SEP 2008 Peters et al

| Fracture Site | Total Fractures, No. | No Bruise or Bruise Not Near Fracture, No. | Bruise Near Fracture, No. (%) |
|---|---|---|---|
| Skull | 71 | 35 | 32 (45.1) |
| Face | 1 | 0 | 1 (100) |
| Rib | 317 | 298 | 29 (9.1) |
| Humerus | 33 | 30 | 3 (9.1) |
| Radius | 29 | 26 | 2 (6.9) |
| Ulna | 19 | 14 | 1 (5.3) |
| Femur | 66 | 55 | 5 (7.6) |
| Tibia | 64 | 61 | 2 (3.1) |
| Fibula | 7 | 6 | 1 (14.3) |
| Spine | 4 | 4 | 0 |
| Pelvis | 1 | 0 | 1 (100) |
| Clavicle | 7 | 7 | 0 |
| Acromion | 2 | 2 | 0 |
| Metacarpal | 3 | 3 | 0 |
| Metatarsal | 2 | 2 | 0 |

## Fracture Specificity
## High specificity:

- Rib fractures, especially posterior
- Classic metaphyseal lesions (CMLs)
- Scapular fractures
- Spinous process fractures
- Sternal fractures

## Abusive Rib Fractures

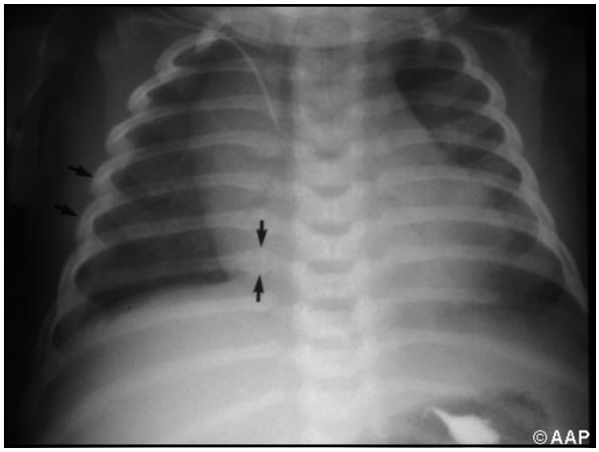
- Relatively common
- 90% seen < 2 yrs of age
- Posterior rib fractures most specific

## Rib Fracture Causes

- Uncommon with birth trauma
- Not cardiopulmonary resuscitation, especially posterior rib fractures
- Compressive forces, not direct blows
- Seldom see overlying bruises
- After fractures, infant is usually asymptomatic

## Rib Fractures

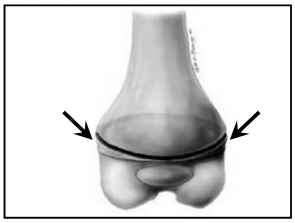
©Radiographics 2003




## Classic Metaphyseal Lesions

- Long bone fractures
- Weakest part of growing bone
  - Chondro-ostoid junction (primary spongiosa of metaphysis)
  - Near subperiosteal bone collar

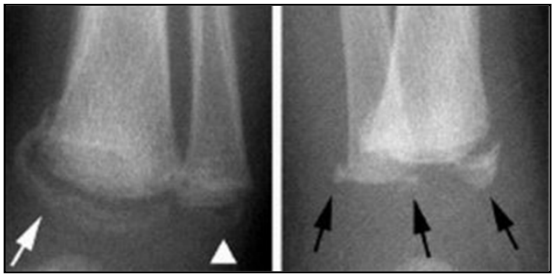
## Metaphyseal Fracture



- Series of microfractures across the subepiphysis
- Manual “to and fro” manipulation causes a shearing injury across the bone end



## Metaphyseal Fracture





## CML

- Requires shearing forces <u>not</u> produced in accidental trauma
- Possibly produced during shaking where limbs flail about
- Also consider twisting and jerking

## Long Bone Fracture
### Spiral

Spiral fractures in young children may occur accidentally but often due to abuse

Twisting of extremity

©John A. Craig: Clinical Symposia, Ciba-Geigy, 1991

## Long Bone Fracture-Spiral

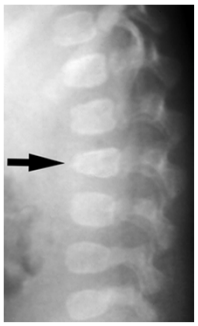

Humerus


Femur

### Fracture Specificity: Moderate specificity

- Multiple fractures, especially bilateral
- Fractures at different ages
- Epiphyseal separations
- Vertebral body fractures/subluxations
- Digit fractures
- Complex skull fractures

Vertebral body compression fracture in a shaken 3-month-old boy



Lonergan, G. J. et al. Radiographics 2003;23:811-845

RadioGraphics



## Metacarpal fractures


## Common but low specificity:

- Subperiosteal new bone formation
- Clavicle fractures
- Long bone shaft fractures
- Linear skull fractures

## Temporary Brittle Bone Disease

- Paterson: 39 patients reported with fractures in infancy
- Controversy arises because:
  - -Fractures are classic child abuse fractures
  - -No identified etiology
  - -Paterson's theory of a temporary enzyme deficiency has no basis in science

## "Temporary Brittle Bone Disease"

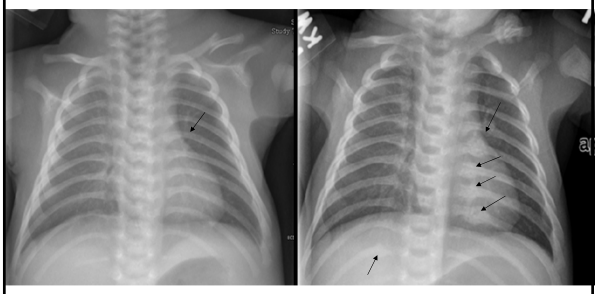
- Other theories suggest a lack of prenatal movement leads to brittle bones
- Disease coincidentally improves after foster placement
- The disease is not diagnosed outside of court

## Dating Fractures: General Considerations

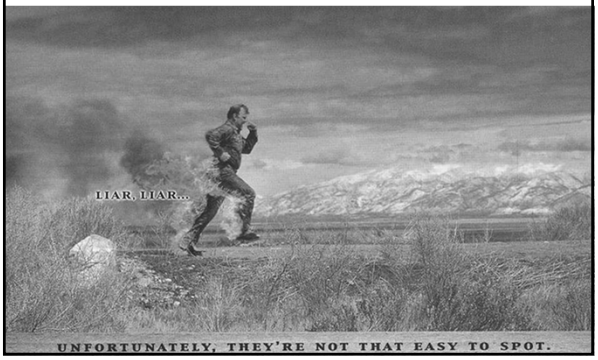
- Healing varies by age, location and severity
- Some fx's like CML's and skull fx's are not amenable to radiologic dating
- Delay in treatment (immobilization) will lead to a delay in healing
- Dating estimates should be expressed in conservative ranges

## Follow-up Skeletal Surveys

- **Follow-up skeletal survey in 10-14 days to look for additional sites of injury that may not be seen on initial study**
  - **Skull films are not repeated**
  - **Nuclear Bone scan can also be considered but has some limitations.**



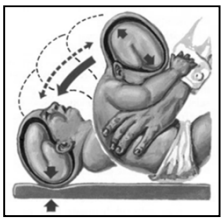
## Diagnosis of AHT



## Abusive Head Trauma

- **Characterized by**
  - **Traumatic brain injury**
  - **Extra-axial hemorrhage (subdural or subarachnoid)**
  - **85% with retinal hemorrhages; 50-70% with other injuries such as bruising and fractures**
- **Prevention- focus on coping with crying and detection of abuse before it escalates**

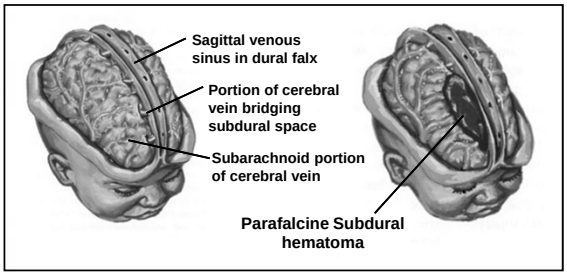
## Abusive Head Trauma
### "Shaken Baby Syndrome"



- **Violent shaking or sudden impact causes excessive brain movement and damage to the cerebral bridging veins**



## Abusive Head Trauma
### "Shaken Baby Syndrome"



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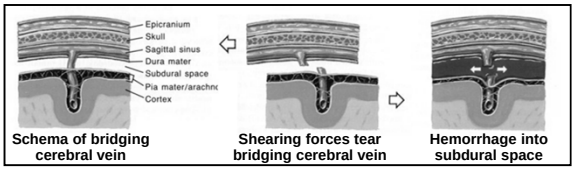


Schema of bridging cerebral vein | Shearing forces tear bridging cerebral vein | Hemorrhage into subdural space

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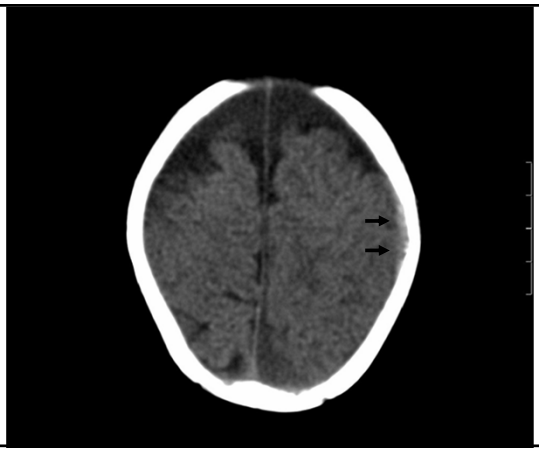
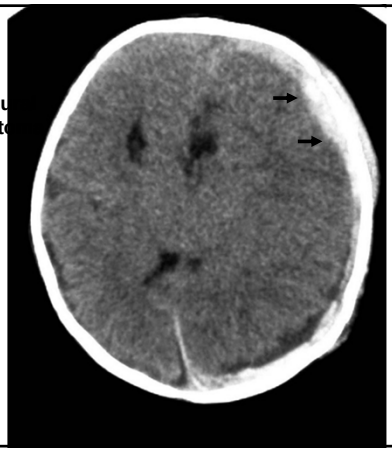


Subdu
Hemat



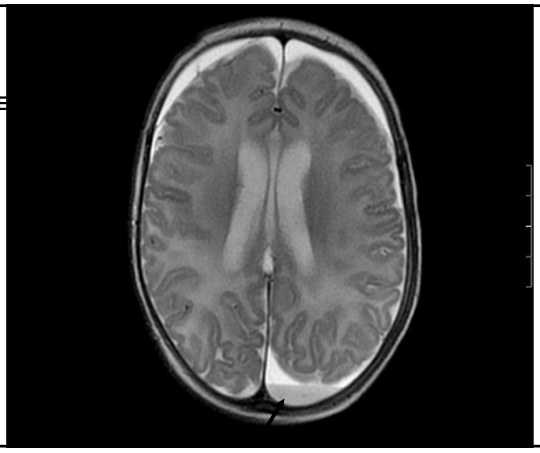
## Subdural Hematoma Dating

- Acute (1-3 days) and sub-acute (3-14 days) SDH is high density on CT
- Density decreases as blood cells and hemoglobin breakdown

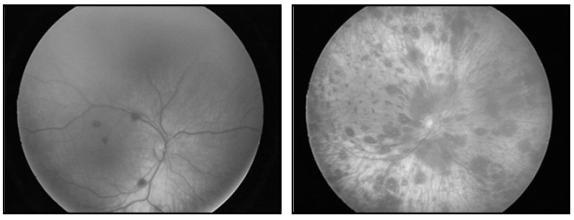
## Subdural Hematoma Dating

- MRI (Magnetic Resonance Imaging) is often done as a secondary test in non-accidental SDH and brain injury.
- MRI signal intensity of SDH can be used to more accurately date SDH based on the chemical breakdown of h

| | | | Appearance | |
|---|---|---|---|---|
| Phase | Time | Hemoglobin, Location | T1-Weighted MRI | T2-Weighted MRI |
| Hyperacute | < 24 h | Oxyhemoglobin, intracellular | Isointense or hypointense | Hyperintense |
| Acute | 1-3 d | Deoxyhemoglobin, intracellular | Hypointense | Hypointense |
| Early subacute | >3 d | Methemoglobin, intracellular | Hyperintense | Hypointense |
| Late subacute | >7 d | Methemoglobin, extracellular | Hyperintense | Hyperintense |
| Chronic | >14 d | Ferritin and hemosiderin, extracellular | Hypointense | Hypointense |



## Retinal Hemorrhages



Few Diffuse

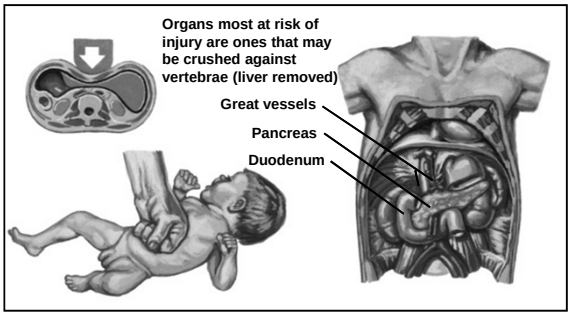
## Retinal Hemorrhages

- 85% of AHT cases also have retinal hemorrhages present
- Physicians cannot accurately date retinal hemorrhages
- RH pattern assists in the diagnosis of head trauma
  - -RH through all layers and out to the ora serata is highly specific for head trauma

## Evaluation of AHT in Children

- Detailed History
- Head C-T, MRI
  - Consider CT of chest and abdomen
- Skeletal survey
- Dilated ophthalmologic examination
- Bleeding studies
- LFT's

## Abusive Abdominal Injury

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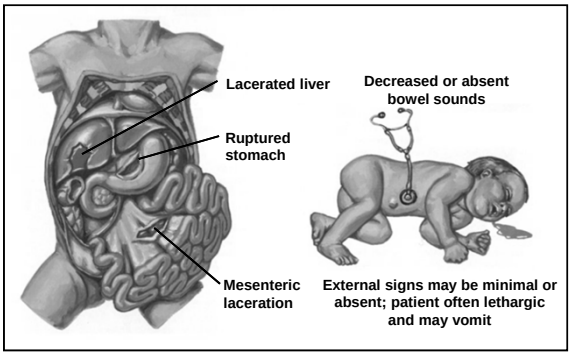
## Abusive Abdominal Injury

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## Simple Household Falls

- Stairway falls in children rarely result in serious injury
- Joffe and Ludwig reported no intestinal perforations in 363 children who had stairway falls
- Authors found no difference in the number or severity of injuries in falls <,>, or = 4 steps
- Huntimer et al performed a literature search spanning 29 years of blunt abdominal trauma resulting in intestinal perforations-no stairway falls were reported for any of the 312 cases of small intestinal perforations

## Dating the Injury

- Poor data on this topic
- Bowel wall hematoma injuries have delayed symptoms for hours or days (vomiting/pain as obstruction develops)
- Peritonitis can clinically present within hours of sustaining the injury
- For blunt liver trauma, when ALT>AST, the injury was older than 12 hrs.
- The larger the splenic or liver laceration, the quicker the signs of hypovolemic shock (presentation within minutes to hours)

## Medical Evaluation

- The American Academy of Pediatrics recommends screening tests for abdominal injury in all physically abused children to evaluate for occult injuries
- Screening laboratory studies
  - CBC
  - Liver Function Tests
    - AST >450 and ALT >250 identified in children with liver damage from blunt trauma

| **ABDOMINAL INJURIES** | **ABUSE** | **ACCIDENTAL** |
|---|---|---|
| AGE OF PATIENT | ***< 5 years old*** | ***> 5 years old*** |
| HISTORY OF TRAUMA | ***ABSENT*** | ***PRESENT*** |
| ASSOCIATED BRUISES | ***60%*** | ***INFREQUENT*** |
| ASSOCIATED FRACTURES or HEAD TRAUMA | ***FREQUENT*** | ***INFREQUENT*** |
| LIVER LACERATION | ***LEFT LOBE*** | ***RIGHT LOBES*** |
| HOLLOW VISCUS INJURY | ***65%*** | ***8%*** |
| HOLLOW VISCUS TYPE | ***SMALL BOWEL*** | ***COLON*** |
| ISOLATED KIDNEY or SPLENIC INJURY | ***RARE*** | ***FREQUENT*** |
| MORTALITY | ***20-40%*** | ***5%*** |

# Time-Temperature Scales

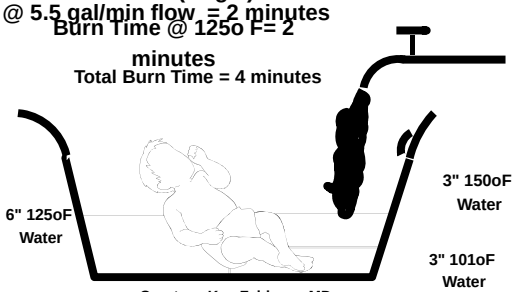
## Exposure Time to Cause 2nd Degree Burns

| Temp. (F) | Adult Skin | Child Skin |
|---|---|---|
| 127 | 60 seconds | 60 seconds |
| 130 | 30 | 10 |
| 140 | 3 | 1 |
| 150 | 2 | < 1 |
| 158 | 1 | < 1 |

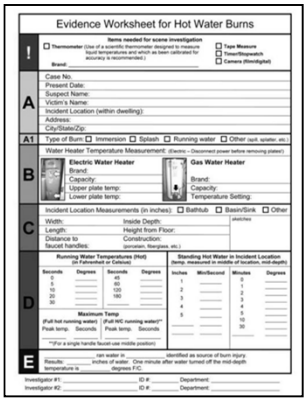
Adapted from Feldman KW et al. Tap water scald burns in children. Pediatrics, 1978;62:1-7
Moritz AR, Henriques FC. Studies of thermal injury, II: The relative importance of time and surface temperature in the cutaneous burns. Am J Pathology. 1947 23:695

**Child left in comfortable water. Parent returns to find hot running, child burned.**

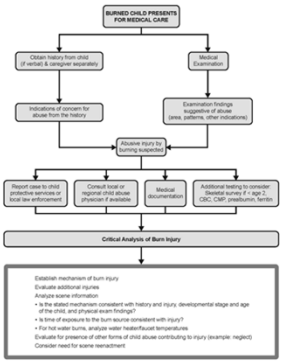
**To add 3" (11 gal) @ 5.5 gal/min flow = 2 minutes**
**Burn Time @ 125o F= 2 minutes**
**Total Burn Time = 4 minutes**




Courtesy Ken Feldman, MD




Adapted with permission from Phylip J. Peltier, District Attorney Investigator (retired), Paradise, CA, and from Peltier, PJ, Purdue, G, Shepherd, JR: Burn injuries in child abuse. U.S. Department of Justice Office of Juvenile Justice and Delinquency Prevention 1997;19




## Scald Burns

- **The majority of all scald burns are accidental and due to splash/spill injury by fluids other than tap water, such as soups, hot beverages and other cooking liquids and occur in the home environment**
- **Having a child in the kitchen while cooking is one of the greatest risk factors for sustaining a burn injury**

## Scald Injuries Resulting from Liquids Other than Water

- **Hot beverages, foods, grease, oils, or wax can reach temperatures much greater than the boiling point of water (212 F)**
- **Have greater viscosity**
- **Result in deeper, more significant burn due to higher heat source and prolonged contact with the skin**

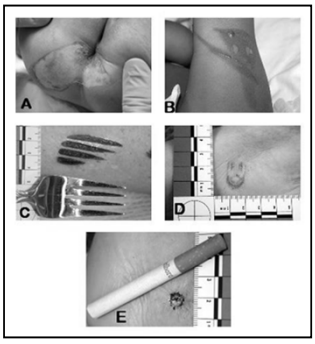
## Contact Burns

- Result in thermal injury to the skin secondary to prolonged contact with the hot or smoldering source
- Typically produce a branding injury characterized by:
  - Distinct margins
  - Grouped burn lesions
  - Clearly inscribed patterns
  - Injuries on parts of the body normally covered

## Dry Contact Burns

- May include injuries resulting from objects such as a curling iron, steam iron, flat iron, radiator/grill grate, cigarette lighter, or various kitchen utensils
- The pattern left on the skin by curling iron burns can help in differentiating accidental from abusive injury mechanisms

## Pattern Burn Injury



## Flame Burns

- Most often secondary to house fires in the pediatric population
- Abusive flame burn injury secondary to holding a child's skin in contact with flame or to ignition of clothing as a consequence of abuse or neglect also occurs
- ~10% of abusive pediatric burns were caused by fire or flames

## Friction/Pressure Burns

- Innocent pressure injuries may be confused with dry contact burns
- Constricting bands from tight clothing causes a cutaneous pressure injury resembling a ligature mark
- A non-circumferential injury can be produced if pressure form the constricting garment is augmented in certain anatomic locations

## Investigations

## Information needed for investigation

- Anatomic location of the burn
- Source producing the injury
  - Hot tap water:
    - Water heater temperature
    - Water coming from the faucet
    - Free flowing or pooled water
  - Chemical:
    - Source contact time
- Explanation of the burn injury (Are there varying accounts?)

Richardson A. Cutaneous manifestations of abuse. In Reece RM: Child Abuse Medical Diagnosis and Management, 1994

## Information needed for investigation

- Date/time the burn injury reportedly occurred
- Location of the child at the time of the burn
- Presence or absence of clothing
- Presence or absence of witnesses to the burn
- Time from burn occurrence to presentation for medical care
- Child and parent's reaction to the burn
- Developmental level of the child
- Prior injury or accidents
- Family composition and home environment

## Concerns for abuse

- History reported not consistent with mechanism of the injury
- Unexplained delay in seeking medical care
- History of previous injury or repetitive accidents
- Presentation of coexisting injuries
- Presence of supervisory and/or environmental neglect
- Presentation for care with a non-related adult or non-parental relative
- Multiple/changing explanations for the injury
- Unwitnessed injury
- Injury attributed to siblings and/or pets
- Apathetic parents regarding the child's injury
- Unexplained burns in a delayed child
- Developmental level of the child inconsistent with reported mechanism of injury
- Submissive child with flat affect or lack of appropriate emotional response to pain

Adapted with permission from Farley, RH, Reece, RM: Recognizing When a Childs Injury or Illness is Caused by Abuse. U.S. Dept of Justice, Office of Juvenile Justice and Delinquency Prevention, 1996; 8-9.
Also Adapted from references 9, 121, & 124

## Physical Examination Findings

**Areas Highly Concerning for Inflicted Injury:**

- **Hands**
- **Feet**
- **Genital region**
- **Buttocks**

**Patterns of Injury Concerning for Abuse**

- **Large surface area of burn**
- **Uniform degree of burn injury**
- **Full thickness burn**
- **Presence of sharply delineated burn margin**
- **Symmetrical burns**
- **Absence of burn in areas of skin flexion**
- **Sparing of skin with surrounding burn secondary to contact with cooler surfaces (doughnut burns)**
- **Scald injury without splash/drip marks**

## Other Findings Concerning for Abuse or Neglect

- Infected burns
- Chronic burns
- Burns in various stages of healing
- Burn appearance is older than stated history
- Concomitant cutaneous injuries

## Additional Medical Testing: Need for a Skeletal Survey?

- **Hicks and Stofli evaluated the frequency of occult fractures in children with suspicious burns compared to children with other forms of physical abusive injury**
- **Study found 14% of pediatric burn cases with positive skeletal surveys with occult fracture**
- **Newer information documents 16.3% of children presenting with burns also had fractures present**
- **Supports the need for skeletal survey imaging in children less than age 2 with suspicious burns**

## Strength of the Medical Evidence

- History of prior accidents
- History incompatible with physical exam
- Burns inconsistent with the developmental level of the child
- Differing or inconsistent historical accounts of the injury
- Inappropriate parental affect
- Delay in seeking care

## Strength of the Medical Evidence

The following are frequently reported in the literature as being present in inflicted burn injury:

- Patterned of injury
- Burns localized to the genitalia, perineum, buttocks, and bilateral lower extremities
- Presence of additional injuries
- Older injuries

## Child Torture as a Form of Child Abuse

- Identified a subset of child victims who appear to be tortured
- Child torture not defined in the medical literature
- Percent of these cases is 1 in 125 child abuse cases
- Severity warrants institution of preventive measures

## Medical Definition for Child Torture?

- Extreme abuse that goes beyond typical physical abusive injuries and does not fit medical definitions or diagnostic criteria
- Strengthens child protection system's ability to protect child within the law

## Unique Characteristics of Torture

- Intentional infliction of physical and psychological pain
- Withholding necessities of life with elements of cruelty
  - Warmth
  - Food, water, fluids
  - Clothing
  - Access to others
  - Access to toilet
  - Ability to move free of confinement

## Unique Characteristics of Torture

- Withholding necessities to gain submission
- Malnutrition and medical neglect
- Emotional abuse and cruelty
- Power and control analogous to intimate partner violence

## Unique Characteristics of Torture

**Psychological maltreatment includes:**

- **Spurning**
- **Terrorizing**
- **Isolating**
- **Exploiting/corrupting**
- **Denying emotional responsiveness**
- **Mental health, medical, and educational neglect**

**The APSAC Handbook on Child Maltreatment, Second Edition, 2002**

## "Scapegoating"

- **Involves both physical and psychological abuse which targets one child in the family who becomes the only abuse victim**
- **Siblings join in blaming victim for caretaker's abuse of that child**
- **Siblings demonstrate empathy defects, which may protect them from effects of witnessing the abuse process**

**Hollingsworth, J, et al. Journal of Emotional Abuse. Vol. 7(4) 2007**

## Common History Findings

- **No remorse by perpetrator and typically involves first degree relative**
- **Females actively/passively participate in all cases**
- **Siblings coerced to abuse**
- **Severe physical abuse starts under auspice of corporal punishment**
- **Homeschooling/kept at home**
- **Victim as scapegoat**

## Medical or Forensic Interview Child Torture Disclosures

- Rules of the home
  - toilet
  - food
  - sleep
- Bizarre forms of disciplines
- Forced positions/holding of objects
- Isolation/spurning/threats
- Confinement

## 15 year old girl

- Found walking on the side of the road in winter wearing pajamas (no shoes, socks, coat)
- Law enforcement called to scene and child taken by EMS to hospital
- Father alleged to medical staff he was “fearful for his family’s safety” and child “threatened his wife with a knife”
- Father put bars on window in basement after child escaped to look in garbage for food

## 15 year old girl

- Father and stepmother installed security devices in the home to control access into pantry/escape from home
- Chronically starved

  Weight 70 lbs. (avg. weight for a 9 ½ yr. old)

  Height 50% for an avg. 11 ½ yr. old

  Gained 17 lbs. within one week in the hospital

## 15 year old girl

- Disclosed sexual abuse by stepbrother
- Locked in basement for years
  - No access to toilet
  - If voided/stooled, father and stepmother would look for it
  - Forced to eat stool and lick urine off floor/suck out of underwear
  - All bedding/toys removed

## 15 year old girl

- Child "homeschooled" after crying every day at the end of school
  - Did not want to get on school bus
  - Did not want to go home
- Child told multiple times she would be killed by stepmother via "slitting her throat" and that father would shoot her with a gun
- Symptoms of PTSD

## 15 year old girl

- Investigation by law enforcement
  - --Photos of cupboards document large quantity of food
  - -Cell phone showed texts between stepmother and "boyfriend" describing how much she hated and wanted to kill child
  - Staged scene
  - -Child response on taped forensic interview

## Seven Prior CPS Contacts

- March 2011-Child Neglect (Screened out)
- June and September of 2009 – Child Neglect (Screened out)
- March 2007-Sexual abuse
- January 2007 –Sexual abuse
- June 2006-Sexual abuse
- May 1997-Child Abuse (malnourishment substantiated)

(Several more concerns added to “already open cases”)

## 14 Year Old Girl

- Hispanic female found in closet by a social worker investigating truancy of child and siblings
- Initially did not respond to her name
- Lacerations on her head with dried blood
- Law enforcement took child to hospital

## 14 Year Old Girl

- Lacerations and contusions of varying ages
- Bite mark on right anterior shin
- Numerous scars on face, back, abdomen
- Left 5$^{th}$ metacarpal bone acute fracture, healing left 3$^{rd}$ metacarpal fracture, acute transverse fracture of the right patella
- Emaciated with regression of previously reported breast development

## 14 Year Old Girl

- Child stated injuries were self induced, caused by fighting with other children, or was unable to remember
- During hospitalization, child disclosed ongoing severe physical and psychological abuse

## 14 Year Old Girl

- Mother repeatedly struck child with metal pipes, skillet, baseball bats, and glass candle
- Child forced to hide injuries with sunglasses, hats, and long sleeved clothing in all seasons
- Stabbed in abdomen and right forearm with kitchen knife

## 14 Year Old Girl

- No medical care for serious injuries: knife abdominal stabbings and arm stab wound with exposed bone
- Forced to eat a dead mouse while father and 9-year-old sister laughed
- Forced to eat roaches, spiders, and insects covered in poison
- Bound with duct tape and plastic bag placed over head and body: threatened with drowning in lake

## 14 Year Old Girl

- Father digitally penetrated child's vagina
- 9-year-old sister participated in abuse by:
  - Encouraging father to place more tape on mouth so child could not breathe
  - Defecating in toilet so mother could force child's face into soiled toilet water

## 17 Year Old Male

- Adopted from a Russian orphanage at age 10 along with three siblings in 2004
- Adoptive parents already had 4 biologic children and 2 adopted children from Guatemala
- Between March 2004 and June 2009, 7 different reports made to CPS about adoptive parents abusing or neglecting several of the non-biologic children

## 17 Year Old Male

- Beaten by older orphans in Russia
- After adoption, disenrolled for "home schooling" toward end of 7$^{th}$ grade
- From April 2008 until end of January 2010, had regular sessions of psychotherapy and family therapy with two different psychologists
- Diagnosed with major depressive disorder and reactive attachment disorder (RAD)

## 17 Year Old Male

- From July 2007-July 2011, child was reported to have run away approximately 20 times
- In June 2011, left the adoptive parent's residence for a total of 46 days (age 17)
- Placed in foster care in July 2011 following disclosures of harsh and humiliating punishment by adoptive parents

## Disclosures

- Physical abuse

-"We would be slapped in the face when telling a lie"…Slapped as many times as our age

- Struck with belt/stick/hand as many times as age
- Told to kneel on rocks for 20-30 minutes while adoptive parents use profanity toward child
- Strangled child and sprayed pepper spray in face
- Pull ears when wanted to take to a different room and sibling's ear got "ripped and was bleeding"
- Adoptive children disciplined differently from biologic kids

## Disclosures

- Forced exercise
  - -Starting at 5:30 am, got a certain number of rocks to pick up
  - -Had to carry 1,656 rocks from a field, put them on a patio, Mom would count them, and put back in corner of field
  - -Got one 10 minute break for lunch (peanut butter sandwich and warm water left sitting in hot sun)
  - -Had to repeatedly push hand powered lawn mower over same area all day

## Disclosures

- Food and water deprivation
  - -Mother stopped feeding adoptive children for one week
  - -Locked in one room with no toilet or water
  - -Provided bucket in room for urine and feces
  - -Kept bucket in room
  - -Gave water
  - -At end of week, Mother threw in 10 loaves of frozen bread and forced children to eat all loaves immediately

## Disclosures

- Psychological abuse
  - -Isolated from others except household
  - -Forced adoptive children to stand naked in front of parents and biologic children while parents/biologic kids ate.
  - -Had parents and biologic kids make fun of body parts/humiliated
  - -17 yo singled out as the “bad child” and received the brunt of punishments
  - -Not allowed to have tv/games/food in room while biologic kids were
  - -Had to do all household chores

## 17 Year Old Male

- In foster home, no concern with stealing, truancy, or hoarding behaviors
- Described as a “very respectful…good kid”
- Following high school graduation, enlisted in US Marine Corps

## 17 Year Old Male Child

- Initial disclosure of extreme physical and psychological abuse occurring over childhood
- Step-mother perpetrator
- Abuse started at age 4 when his father dating stepmother
- Abuse started with physical injury and isolation (locked out on porch) as punishment

## 17 Year Old Male Child

- Father married stepmother
- Child reports near-daily beatings
- School officials report concerns of extensive bruising to child protective services
- Child stated stepmother started keeping him out of school if too many skin injuries
- Up to 4$^{th}$ grade, child reported he missed 30-40 days of school per year

## 17 Year Old Male Child

- Teacher documentation and interviews with law enforcement confirmed physical abuse
- School records documented missed school days
- Child not typically seen in family photos
- Forced to wear dresses and be photographed
- Called “Gay” by stepmother and threatened with photo release in dresses at school

## 17 Year Old Male Child

- Stepmother reported to father that child behaviorally disturbed
- Father agreed to allow stepmother to discipline child
- Stepmother tapes child in “out of control” situations

## 11 year old male child

- Air lifted to hospital with 40% partial and full thickness burns
- Toes disarticulated from remainder of foot
- Emaciated on exam; fallen off growth curve
- Chronic pressure ulcers on sacral region, hips, knees, and head

## 11 year old male child

- New and old loop mark injuries
- Diagnosed with pneumonia
- Anemic-Hemoglobin 6.6 at admission
- Transfused within 24 hours of admission and again three days later

## 11 year old male child

**History obtained from interview:**

- **Forced to stand in shower while others sprayed him with hot water from stove or shower head**
- **Hogtied and placed in bathtub and told he would be drowned**
- **Locked naked in dark cubby hole under the stairwell or a closet for days at a time**
- **"Choked" until passed out**

## 11 year old male child

**History obtained from interview:**

- **Kicked repeatedly in abdomen**
- **Forced to drink 3-liter pitchers of water until vomiting or passing out**
- **Noose placed on neck and forced to stand in shower for hours**
- **Penis pierced by non-related caregiver**
- **Fed one or less meals per day**

## Scene Investigation

## 4 ½ year old girl

- Aunt said child burned in bathtub
- Child found floating, unresponsive, and lifeless by neighbor
- Noted to have burns over most of lower body and scalp
- A neighbor reported hearing prolonged water running and “thumping” next door

## 4 ½ year old girl

- Scalp burn old and deeply eroded
- Resulted from hot fluid flowing onto scalp with face upturned
- Burn treated at home with alcohol application
- Entire lower body with immersion scald (50% TBSA)
- Popliteal and groin skip areas indicating restraint

## 4 ½ year old girl

- Face and upper arm with contact burns from a curling iron and hair dryer
- Eroded pressure injuries of wrists and ankles from being bound
- Ligature mark of neck
- Thin acute subdural hemorrhage and old yellow arachnoid staining
- Extensive old scarring on body

## 4 ½ year old girl

- Placed by CPS at age 3 ¼ along with 4 siblings with Grandmother, then Aunt due to maternal neglect and minor physical abuse
- All children reported discipline by belt whipping
- Reported patient punished for urine and bowel accidents
- Forced to sleep bound, hanging from a clothes rod in a closet

## Results

- Median age 7.5 years (9 mo--14.3 yrs)
- 36% died
- Duration of abuse (3 ½ mo-8 yrs)
- Severe combined form of intra-familial child maltreatment

## Results

- 100% with psychological abuse
- 89% victims of isolated
- 79% denied emotional responsiveness
  - Caregiver ignored child's attempts/need for social interaction
- 75% terrorized
  - 32% had threats of death made
- 54% degraded and/or rejected
- PTSD most common mental health disorder

## Results

- 61% physically restrained/bound
- "Stealing food" motivation for binding
- 89% food deprived
- 79% fluid restricted
- 68% forced position/standing
- 79% prevented from use of toilet
- 45% had siblings witnessed/forced to participate in extreme forms of abuse

## Common Physical Findings
### at Time of Medical Intervention or Death

- Beaten with skin injury 93%
- Malnutrition 89%
- Burns 61%
- Bone fractures 21%
- Received no care for injuries 100%

## Results

- Child torture occurs over time
- Knowledge and/or acquiescence of other caregivers and siblings
- Involvement of all adults in house different from other forms of abuse
- 60.8% of primary abusers were not child's biologic parent
- Female perpetrators were among perpetrators in each case

## Results

- Perpetrators demonstrated little or no remorse
- Many transferred blame onto others or blamed victim for precipitating the abuse or causing abuse to be necessary
- Utilized a framework of necessary discipline and corporal punishment to justify their abusive acts

## Summary of Key Findings

- Half of these cases had prior referrals and/or investigations by Child Protective Services
  - Intentional food/fluid restriction
  - Lack of supervision
  - Physical abuse
  - Neglect
- Prior CPS involvement ranged from 1-15 times

## Multidisciplinary Response

- Serial photographs of victim helpful
  - From time of presentation and after nutritional recovery
  - Child's voracious appetite and rapid weight gain belie allegations of eating, metabolic, or endocrine disorders

## Summary of Key Findings

- 47% of cases: child removed from school and "home schooled", causing abuse to escalate to torture
- 29% of school-age children were not allowed to attend school
- 2 children previously enrolled were dis-enrolled and received no further schooling
- "Home schooling" further isolates child after closure of previously open CPS case

## Medical Definition of Child Torture as a Form of Child Abuse

- Longitudinal experience characterized by at least two physical assaults or one extended assault
- Two or more forms of psychological abuse
- Neglect (active neglect of medical needs)
- Resulting in prolonged suffering, permanent disfigurement or dysfunction or death

## Multidisciplinary Response

- Health care providers failed to accurately diagnose children's injuries and malnutrition
- Frequently based evaluations solely on history reported by perpetrator
- Perpetrator's histories that children were suffering from behavioral or psychiatric issues accepted at face value

## Multidisciplinary Response

- Investigation requires careful questioning of victim, siblings, potential witnesses and caregiver(s)
- Scene investigation
  - Evidence of confinement and past injuries
  - Photographs to document availability of sufficient food in household

## Multidisciplinary Response

- **Dynamic of domination, power and control over victim**
- **Uniquely different from other forms of physical abuse where caretaker anger with loss of control common**
  - **System of rules, boundaries, patterns for managing targeted child**

## Prevention Opportunities

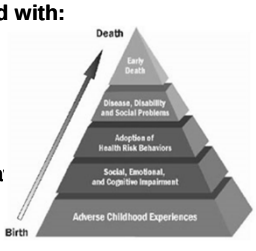
- Primary prevention – For example, Period of Purple Crying curriculum
  - –Normalizing crying
  - –Soothing crying infant
  - –Caregiver coping with crying


- Secondary prevention
  - –Intervene with caregivers who report infant distress
  - –Sentinel injury detection – prevents AHT/fractures
- Tertiary prevention
  - –Sentinel injury detection prevents further abuse

## Consequences of Child Abuse

**ACE Study**

- **Abuse highly correlated with:**
  - **Obesity**
  - **Substance abuse**
  - **Mental illness**
  - **Disease**
  - **Teen pregnancy**
  - **Smoking**
  - **High risk sexual beha**
  - **Work performance**
  - **Chronic disease**
  - **Premature death**




Felitti, et al., 1998; http://www.cdc.gov/ace/index.htm

## Contact Information

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