Non-Accidental Pediatric Trauma

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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"

US Dept Health and Human Services, *Child Maltreatment 2012*, (Dec, 2013)

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

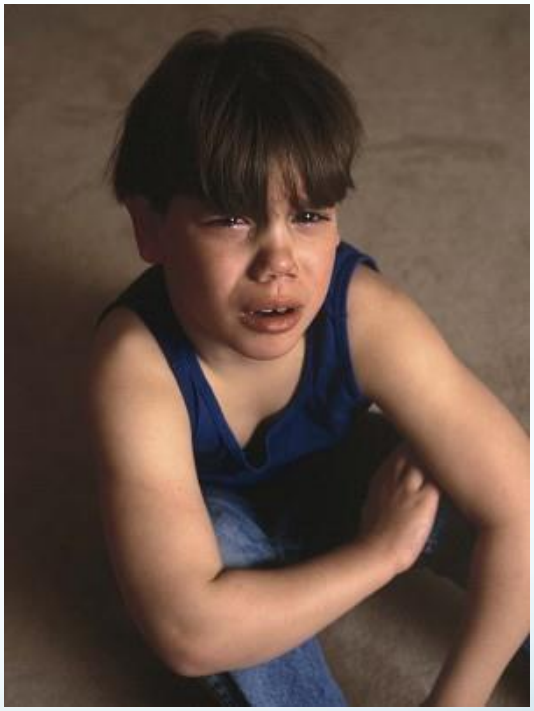
Introduction

- 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

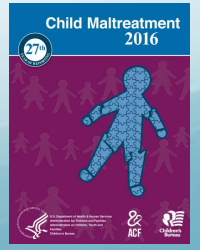
Patterns of Injury

- 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)



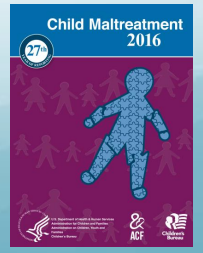
- 4.1 million referrals to CPS
  - (3.1 million in 2008)
- 7.4 million children involved
- 1 report every 7.7 seconds
- 676,000 confirmed victims
- The estimated annual cost of child abuse/neglect in the USA in 2016 was **$124 Billion**



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)

Race	Total Victims	Rate/1000
Hispanic	38,310	8.1
White	14,119	6.0
African-American	9,324	19.6
Asian	1660	1.6
Native American	644	19.2

US Dept Health and Human Services, *Child Maltreatment 2016*

California
Victims by Type (2016)

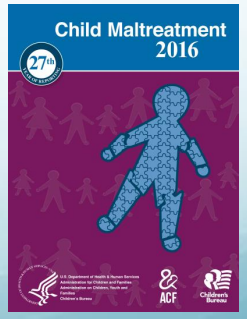
Type of Abuse	Total
Neglect	59,125
Psychological	8,033
Physical abuse	5,936
Sexual abuse	3,617
Other	307

US Dept Health and Human Services, *Child Maltreatment 2016*

Deaths from Abuse (2016)

Year	CA	USA
2012	130	1621
2013	139	1551
2014	134	1588
2015	127	1589
2016	137	1700

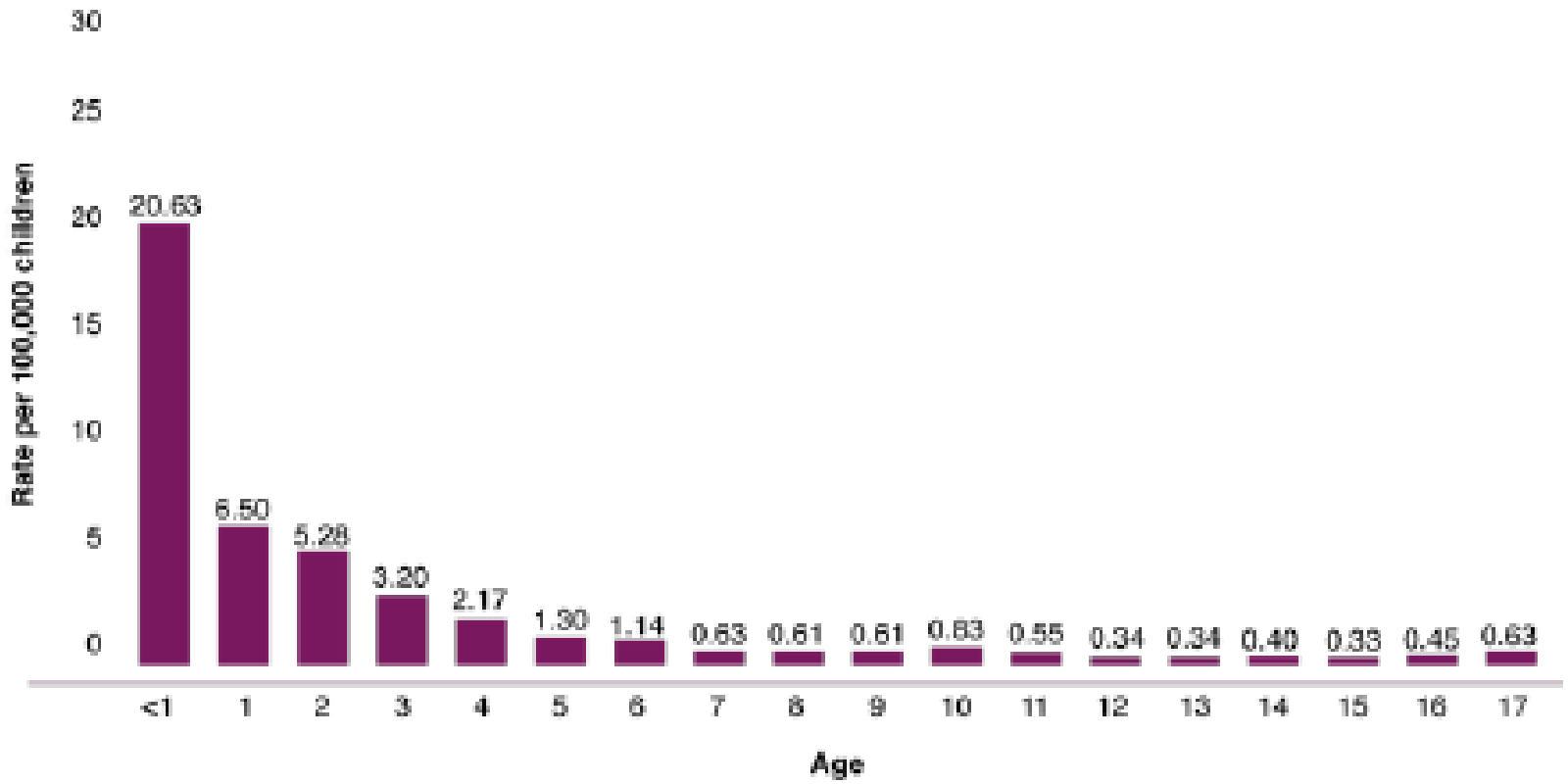
- USA
  - 4.4 deaths / day
  - 44% <1 y/o
  - 77% < 3 y/o
  - 82% < 4 y/o
- California
  - 1 death every 2.6 days



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

Cause	CA (%)	IE (%)
Homicide	35.5	34.3
Drowning	28.8	34.3
Suffocation	21.4	17.1
Auto vs Ped	7.0	5.7
Struck by object	4.5	2.8

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Non-Fatal Injury Related Hospitalizations, 2011

Age < 1 yr

Reason for hospitalization	CA (%)	IE (%)
Unintentional Fall	45.6	28.8
Homicide / Assault	18.9	34.9
Unintentional Poisoning	12.8	7.4
Unintentional Burn	11.9	11.4
Unintentional Suffocation	10.7	4.0

Non-Fatal Injury Related Hospitalizations, 2011

Age < 1 yr

Reason for hospitalization	CA (%)	IE (%)
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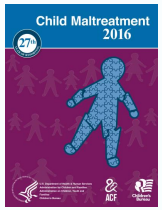
Homicide / Assault	18.9	34.9
Unintentional Poisoning	12.8	7.4
Unintentional Burn	11.9	11.4
Unintentional Suffocation	10.7	4.0

Victims (2016)

- Boys and girls are abused at about an equal rate
- More boys die than do girls (58% vs 41%)

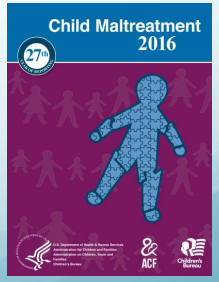


- One fifth of victims are placed in foster care
- Children < 1 y/o are most likely to be abused

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

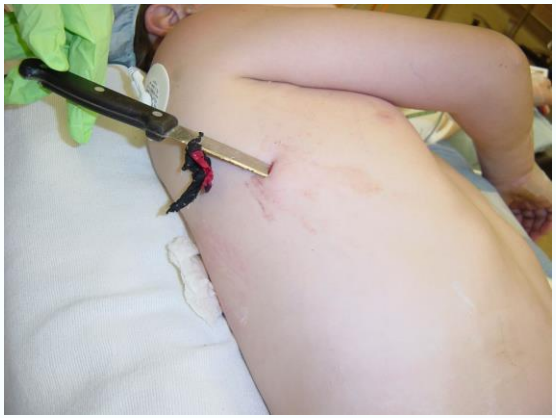
- Treatment or maltreatment of a child that indicates harm or threatened harm to the child's health or welfare. To deprive the child of the necessities such as food, clothing, shelter, supervision, medical care and education. This is defined in terms of whether or not the child's basic needs are met.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

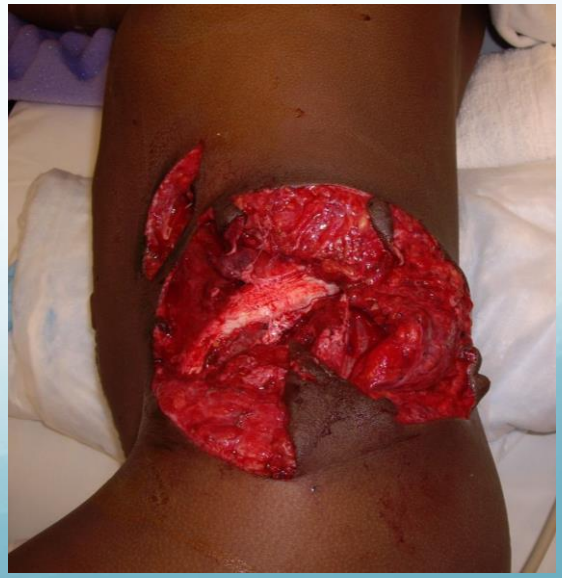
Neglect

- 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.

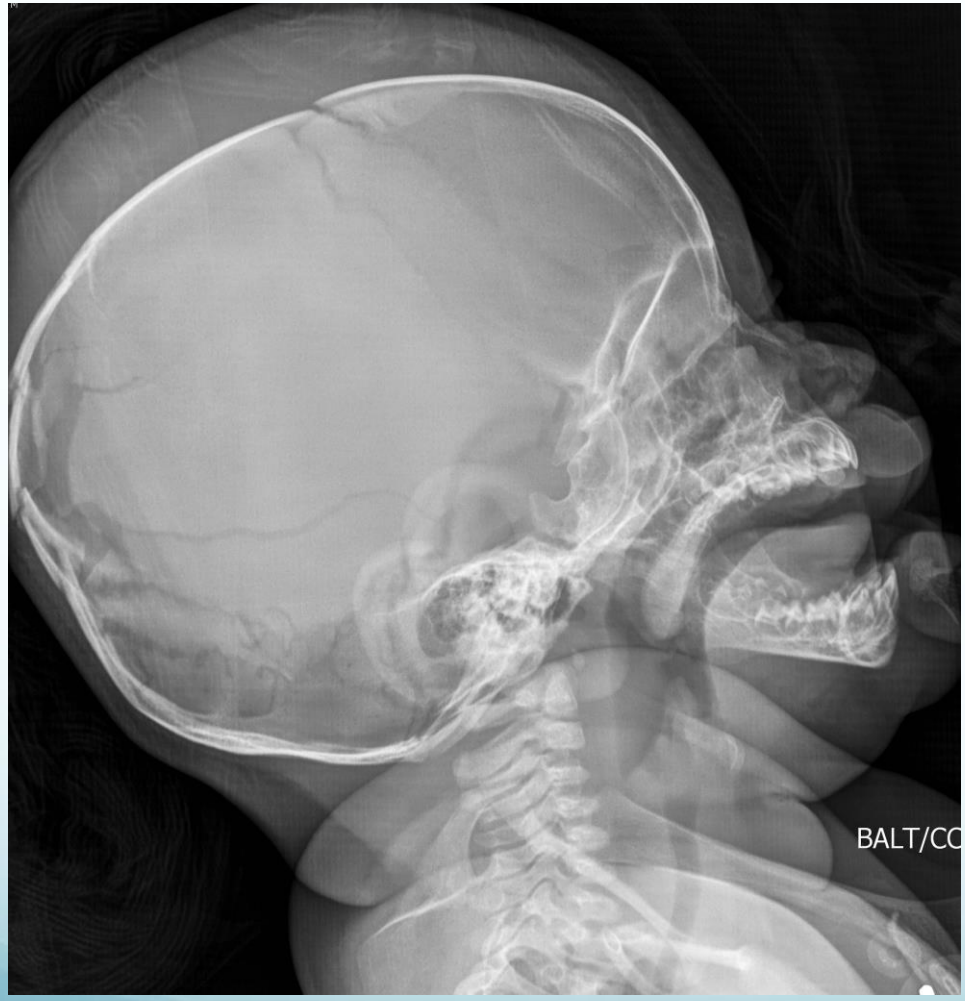
Indicators of Possible Abuse

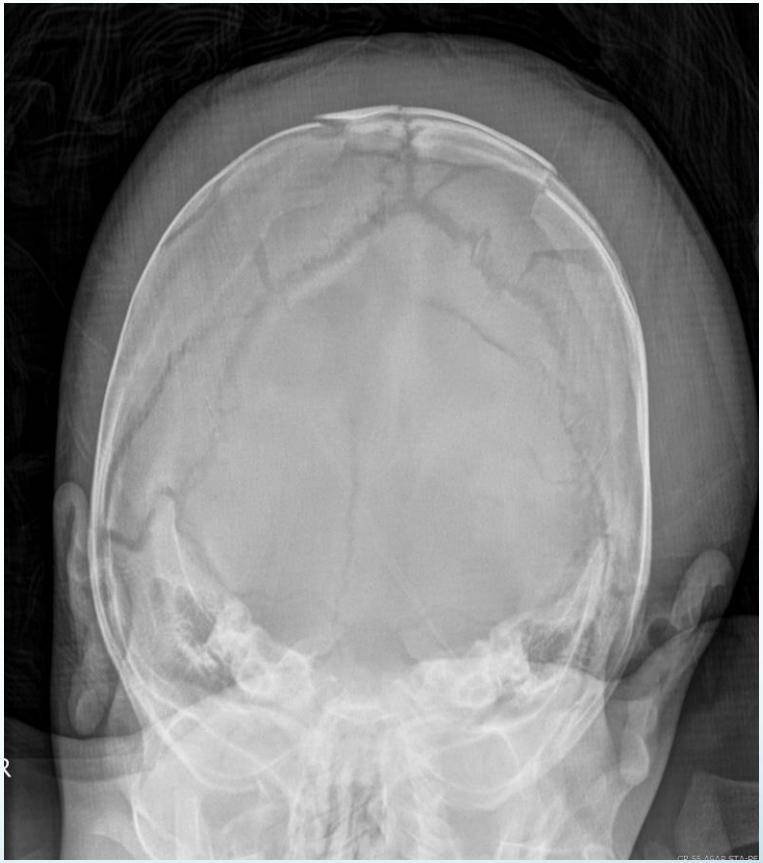
- Parental lack of concern for child's injuries or pain
- Delay in seeking medical treatment
- Visits to multiple ER's
- Inability/unwillingness to comfort the child
- History is incompatible, varying, vague or absent
- Parents may even refuse to be interviewed
- Absent or exaggerated response to injury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

Suspicious History

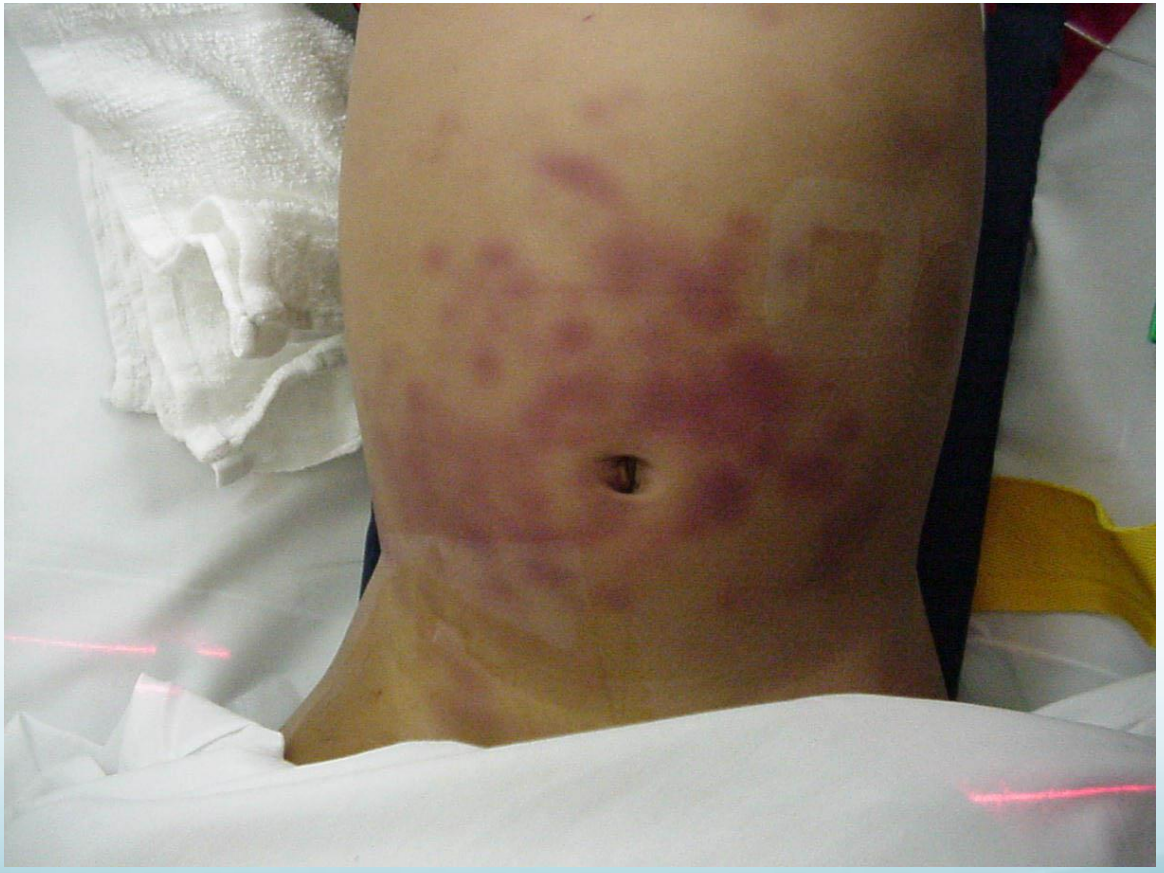
- No History - in highly supervised age group
- Vague history…("He must have….", "I found him this way", " He was this way when I got him…"
- Caretakers give conflicting/variable histories
- History of minor/common trauma given to explain a severe or unusual injury
- Third party is blamed: Pet or sibling (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



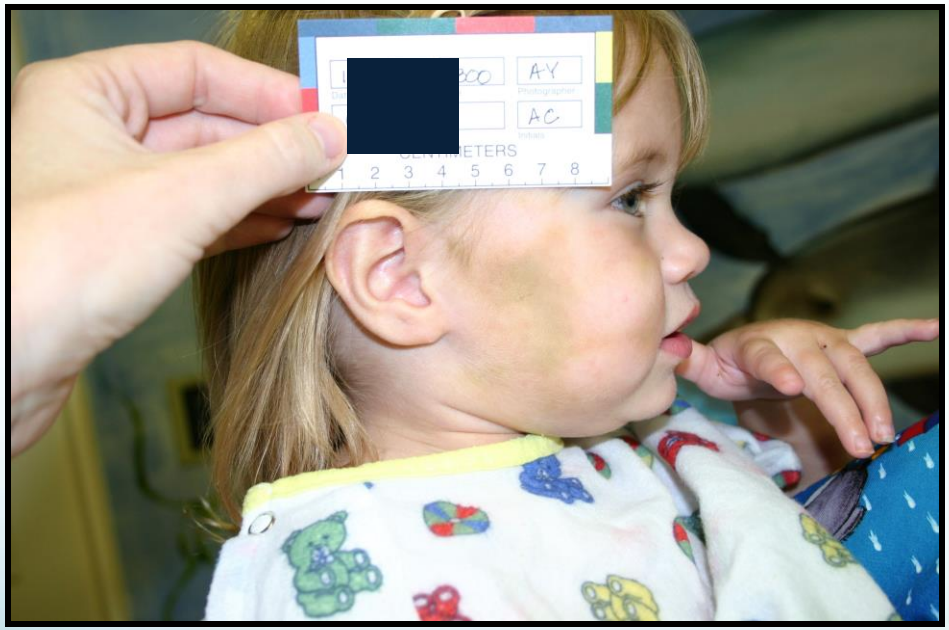
Bruising

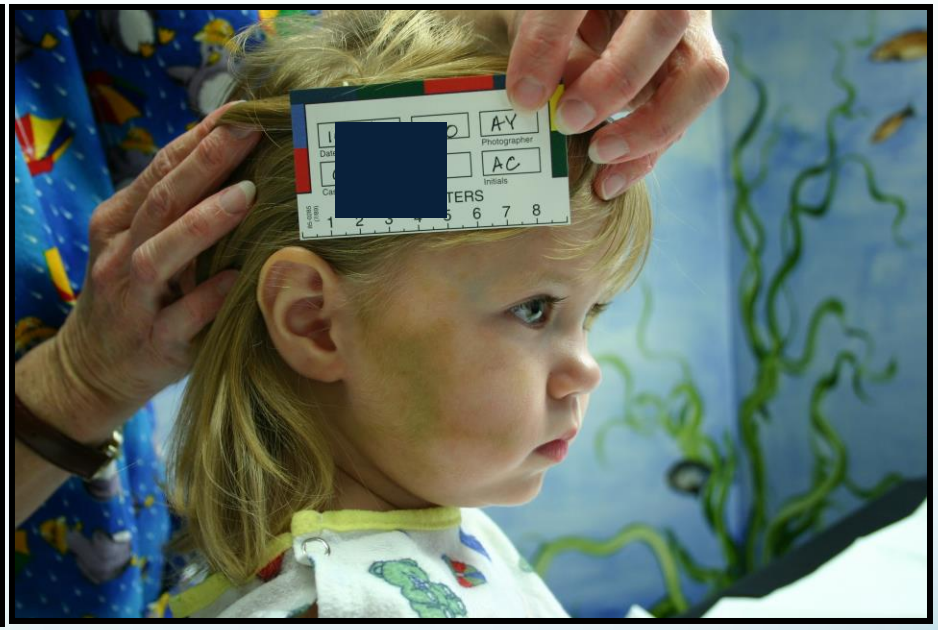
Table 1
Determining the Age of a Bruise by Its Color

Color of Bruise	Age of Bruise
Red (swollen, tender)	0–2 days
Blue, purple	2–5 days
Green	5–7 days
Yellow	7–10 days
Brown	10–14 days
No further evidence of bruising	2–4 weeks

US Dept of Justice, NCJRS

Same injury, different lighting

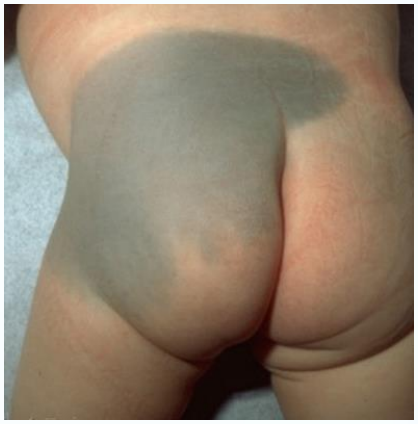




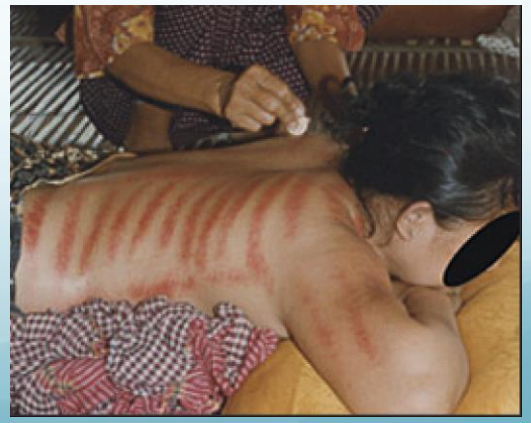
Dating Bruises

- 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

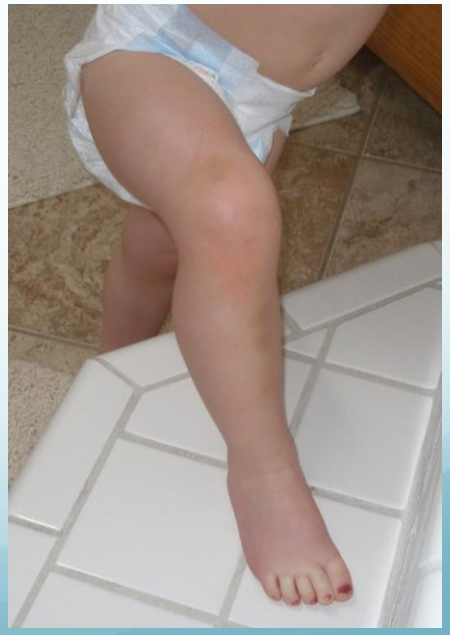


- Mongolian spots - congenital
- Bleeding disorders - Hemophilia, ITP
- Henoch-Schonlein Purpura - vasculitis induced by abnormal immune response
- Ethnic/cultural alternative medical therapies - Cupping or coining



Typical Accidental Bruises

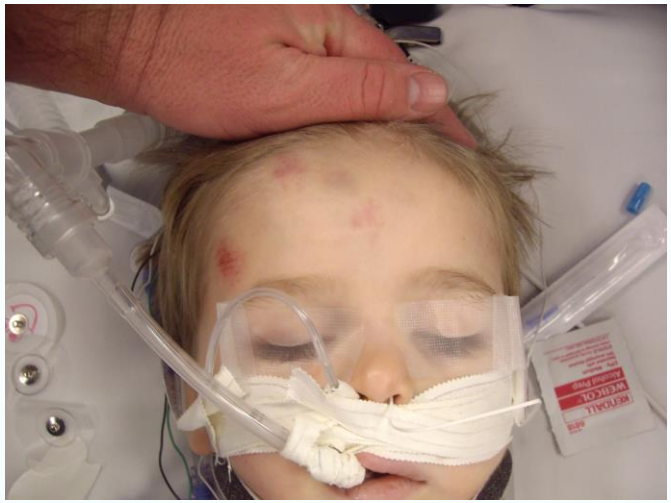
- Ambulatory child
- Poorly padded areas or boney prominence
  - Shins, knees, elbows
  - Chins
  - Midline forehead
  - Midline back - over spinous process
- Non-specific pattern / shape
- Limited number of lesions

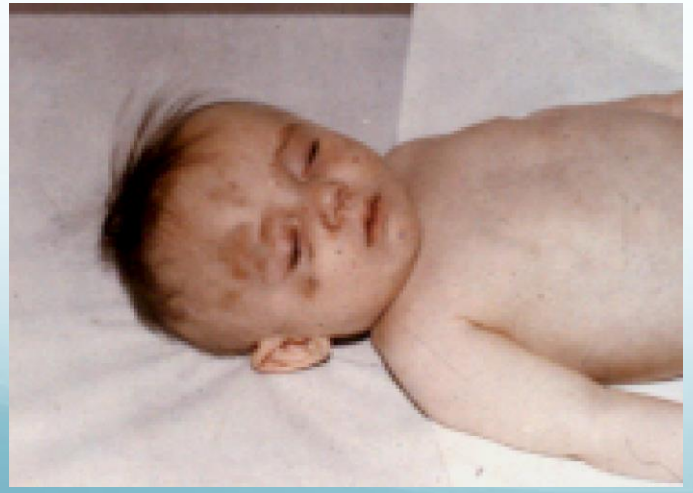


Typical Sites of Inflicted Injury

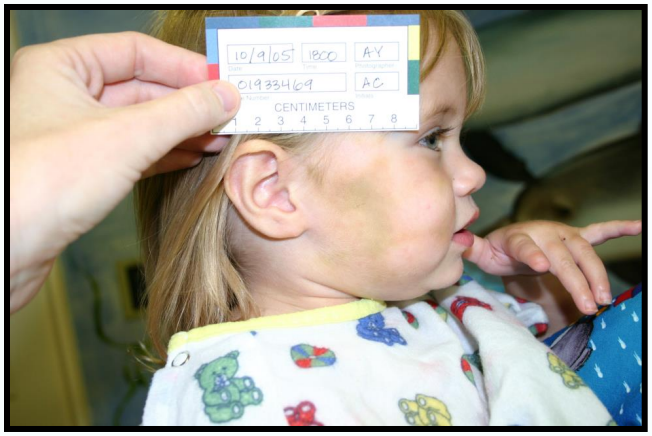
- Head and neck: >60% injured children
- Face
- Ears: highly unusual in accidental events
- Buttocks
- Inner thighs and genitalia
- Back
- Abdomen: bruises may be subtle

Head and Neck

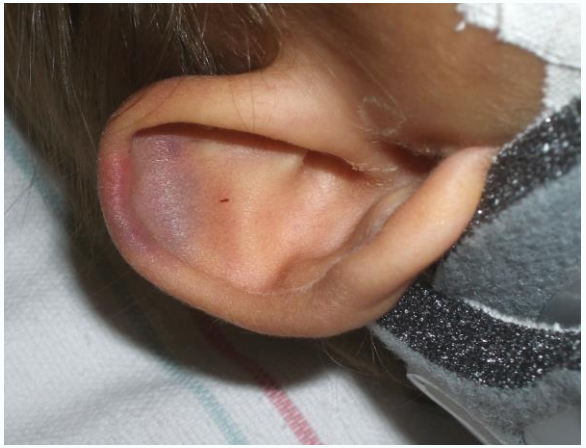




Face / Ears

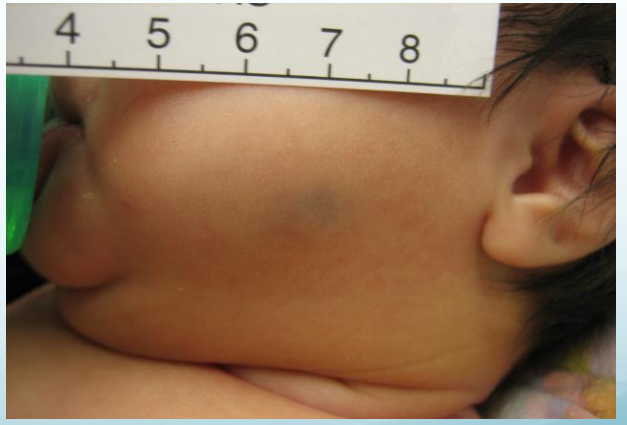


Face



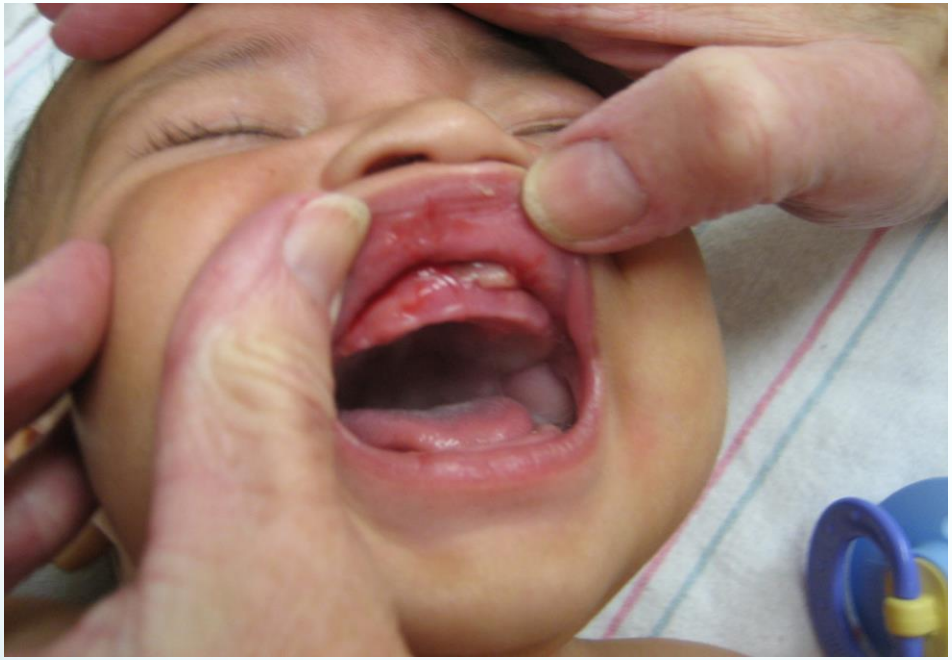
Ear

Conjunctival hemorrhage

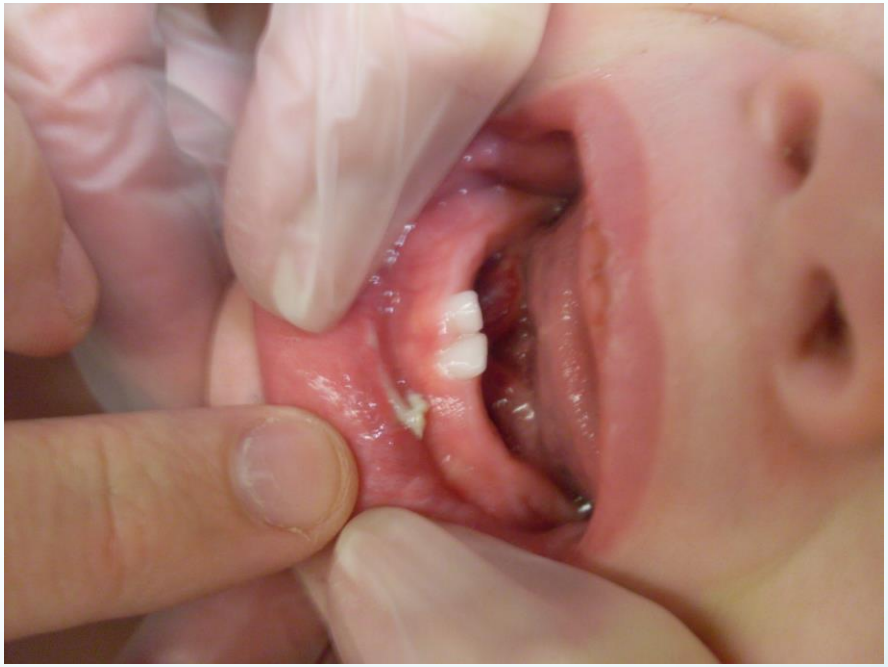


Jaw-line (Shaken Baby)

Associated Intra-oral Injuries

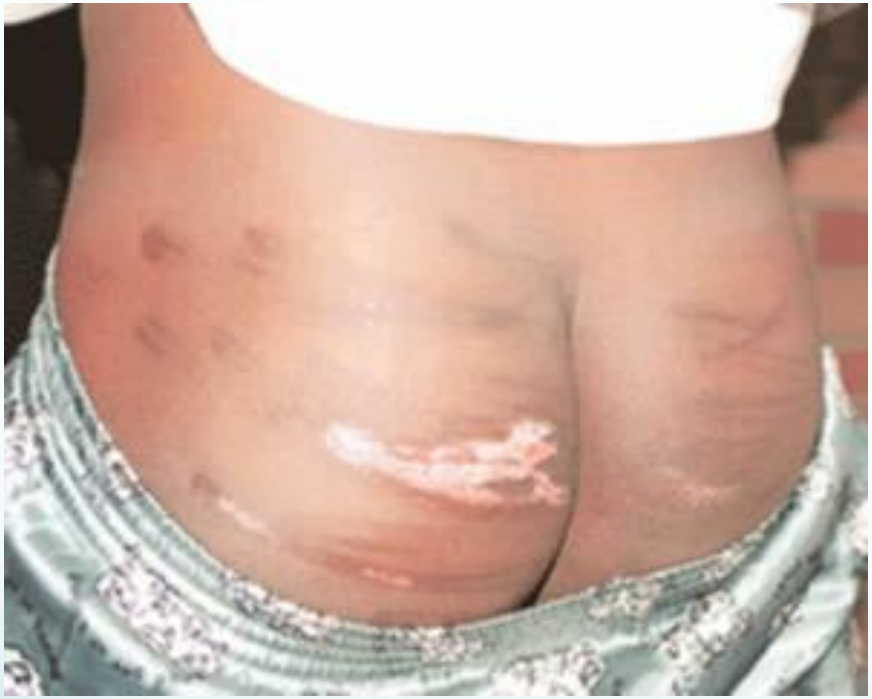


Torn frenulum upper lip

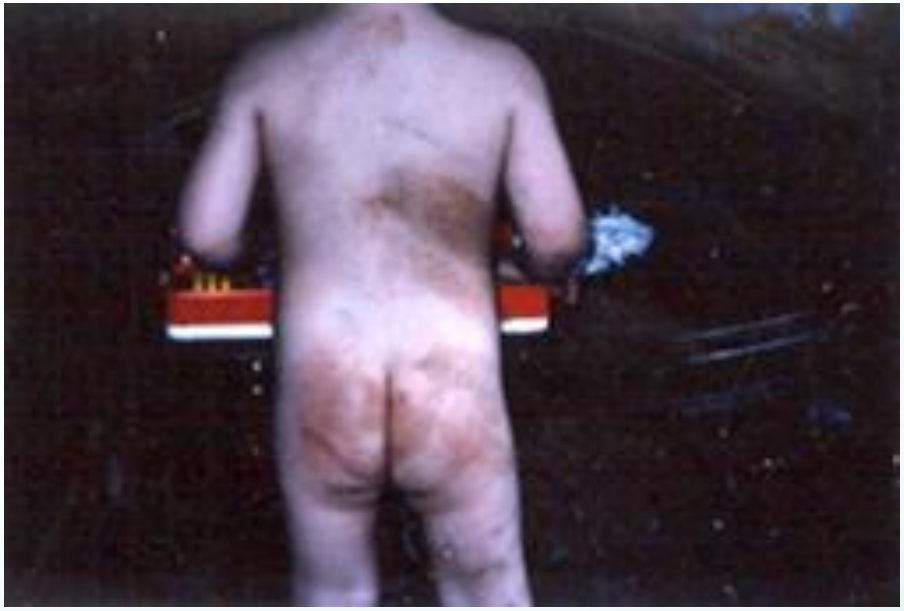


Lower lip puncture by teeth after being hit in the mouth. Note the bruise under the tongue

Buttocks / Back



Whip marks to buttocks



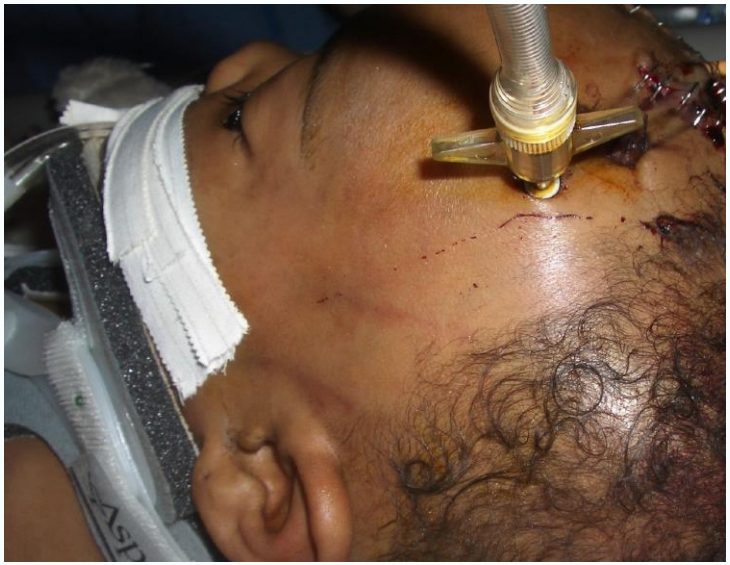
Paddle marks to back

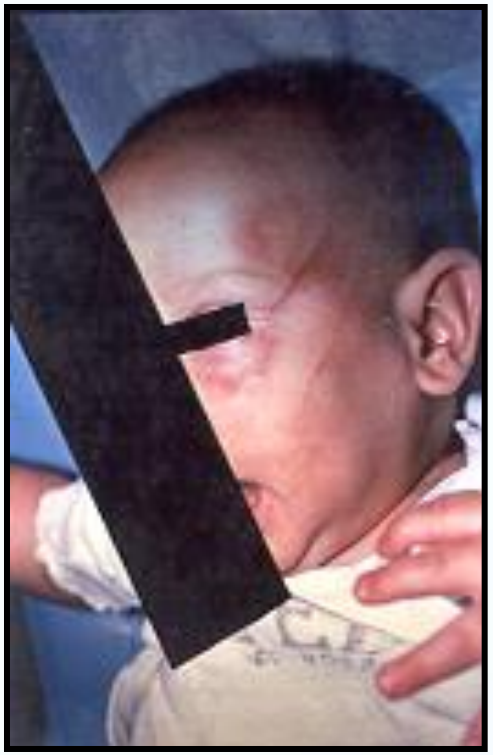
Genitalia / Inner Thigh

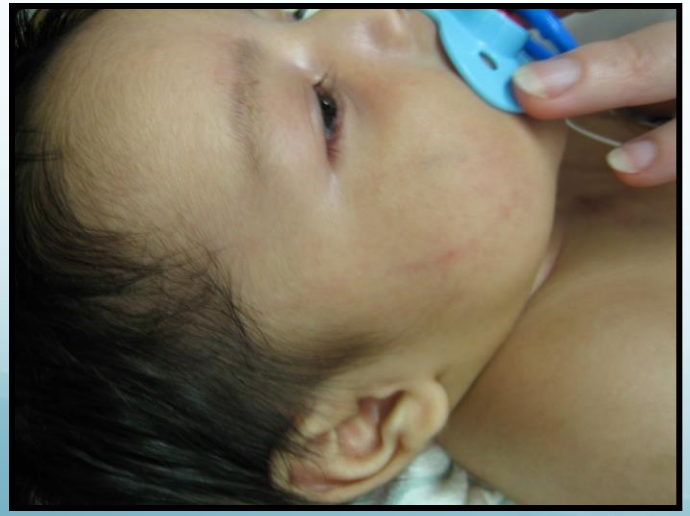
Pattern of Bruising

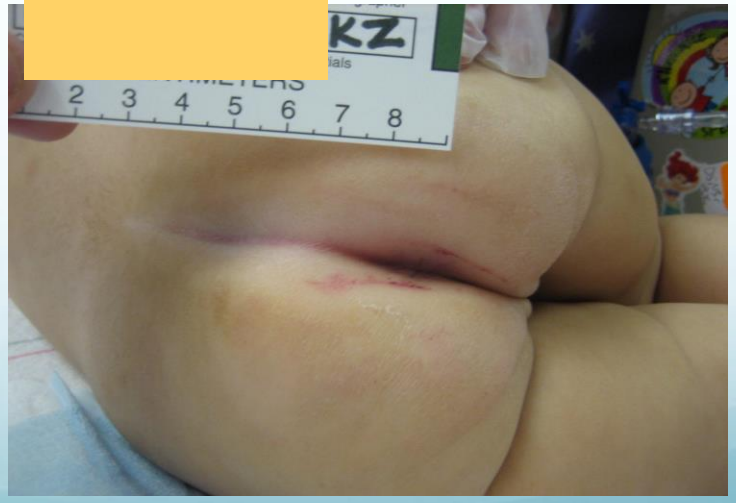
- Bruise pattern commonly mimics the object causing the injury
- High impact injuries
  - Negative image of the object used surrounded by a rim of petechiae where capillaries have been stretched and torn
- More forceful injuries
  - Positive image of the object when vessels are ruptured directly

Slap (outline of fingers)



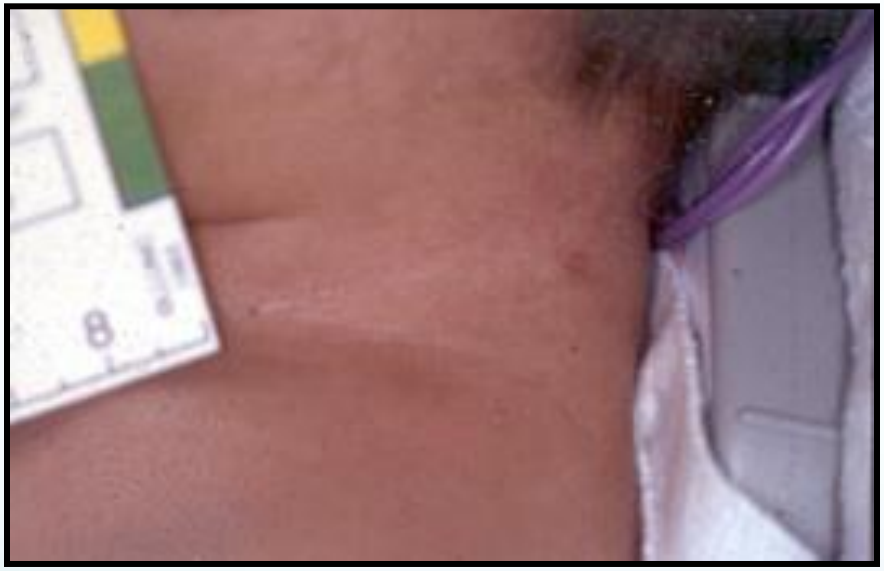




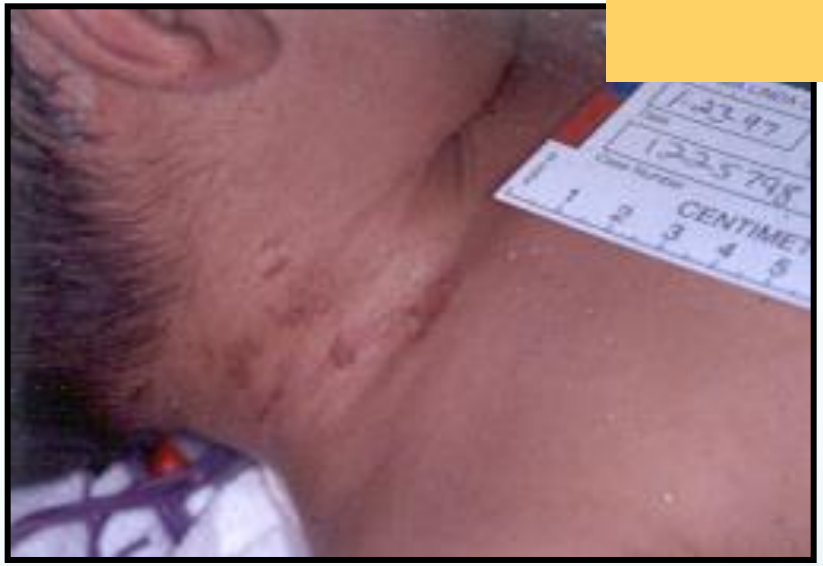


Spanking

Typical strangulation marks



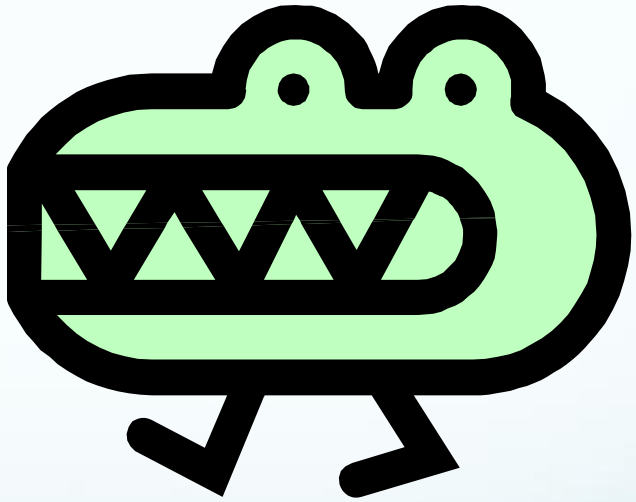
Mark left by thumb



Marks left by other nails

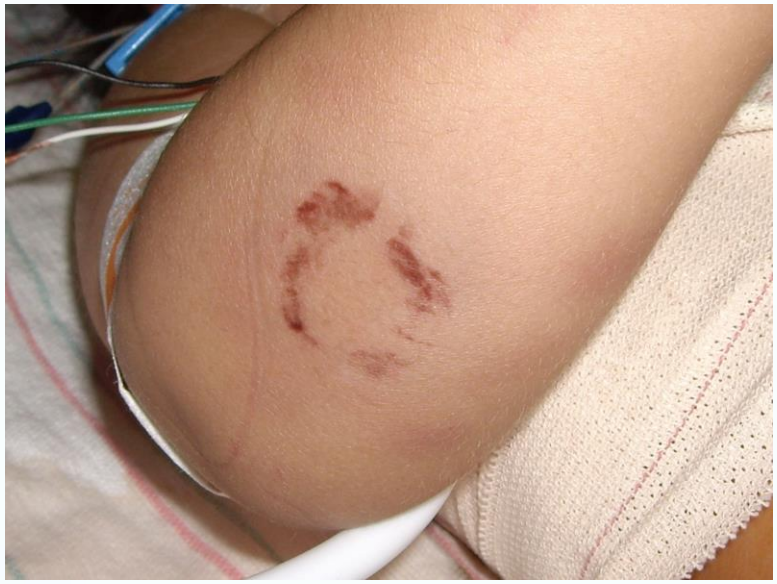
Bite marks

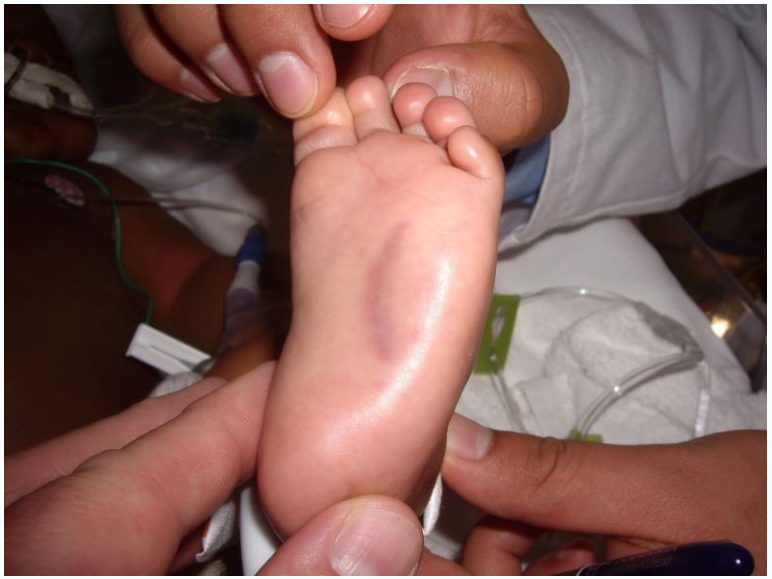
- Bites - manifestation of uncontrolled, primitive behavior
- Location:
  - Head and neck 42%
  - Trunk 29%
  - Limbs 24%
  - Breast/genitals 5%

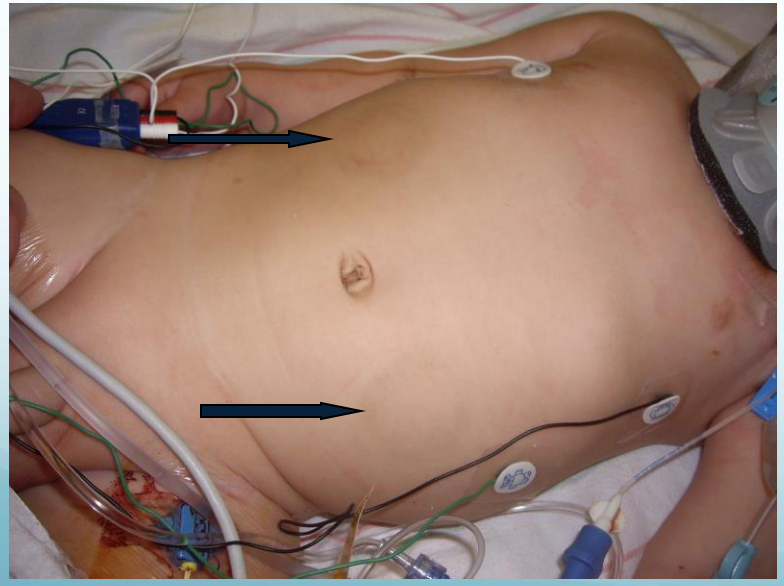


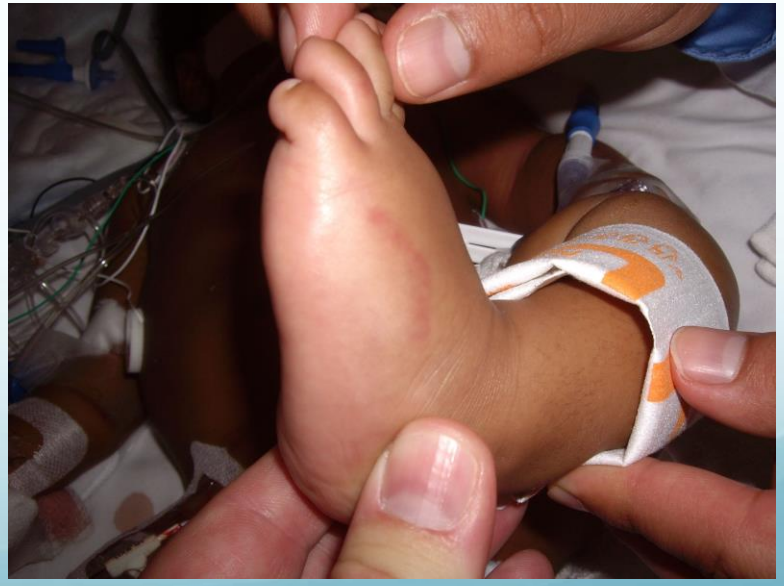
- Size:
  - Canine to canine >3 cms typically indicates an adult

Bites





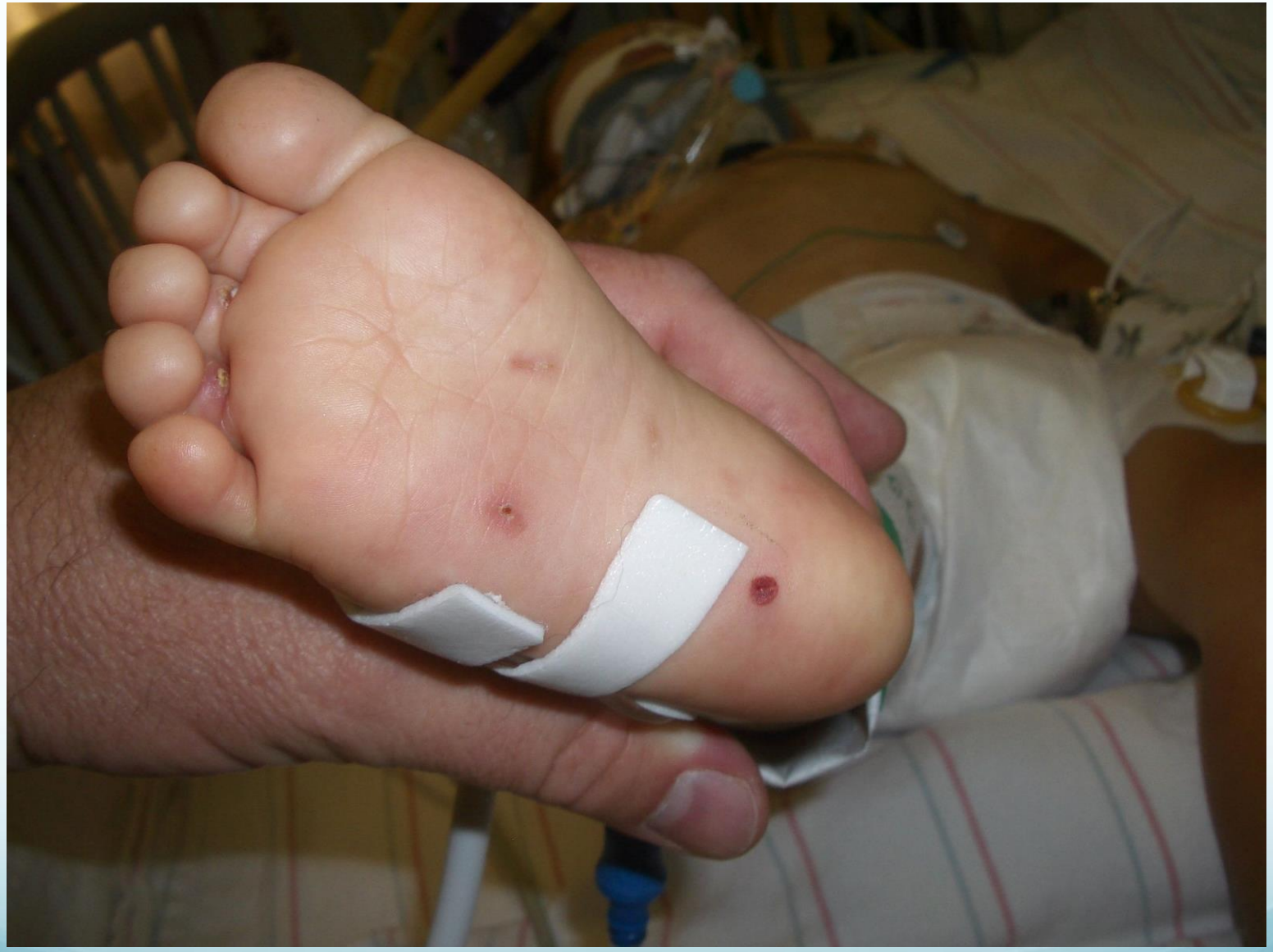




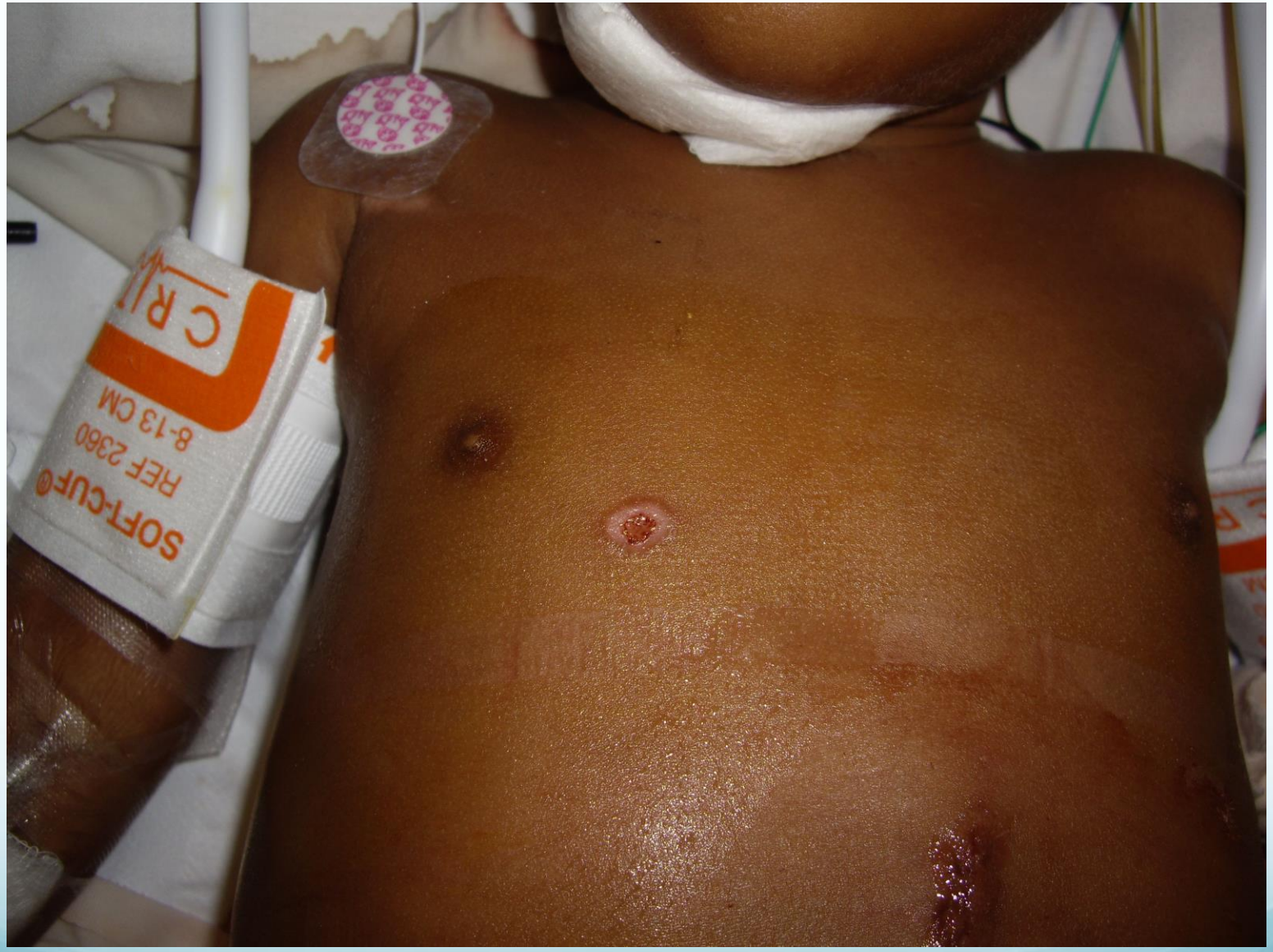
Burns

- 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

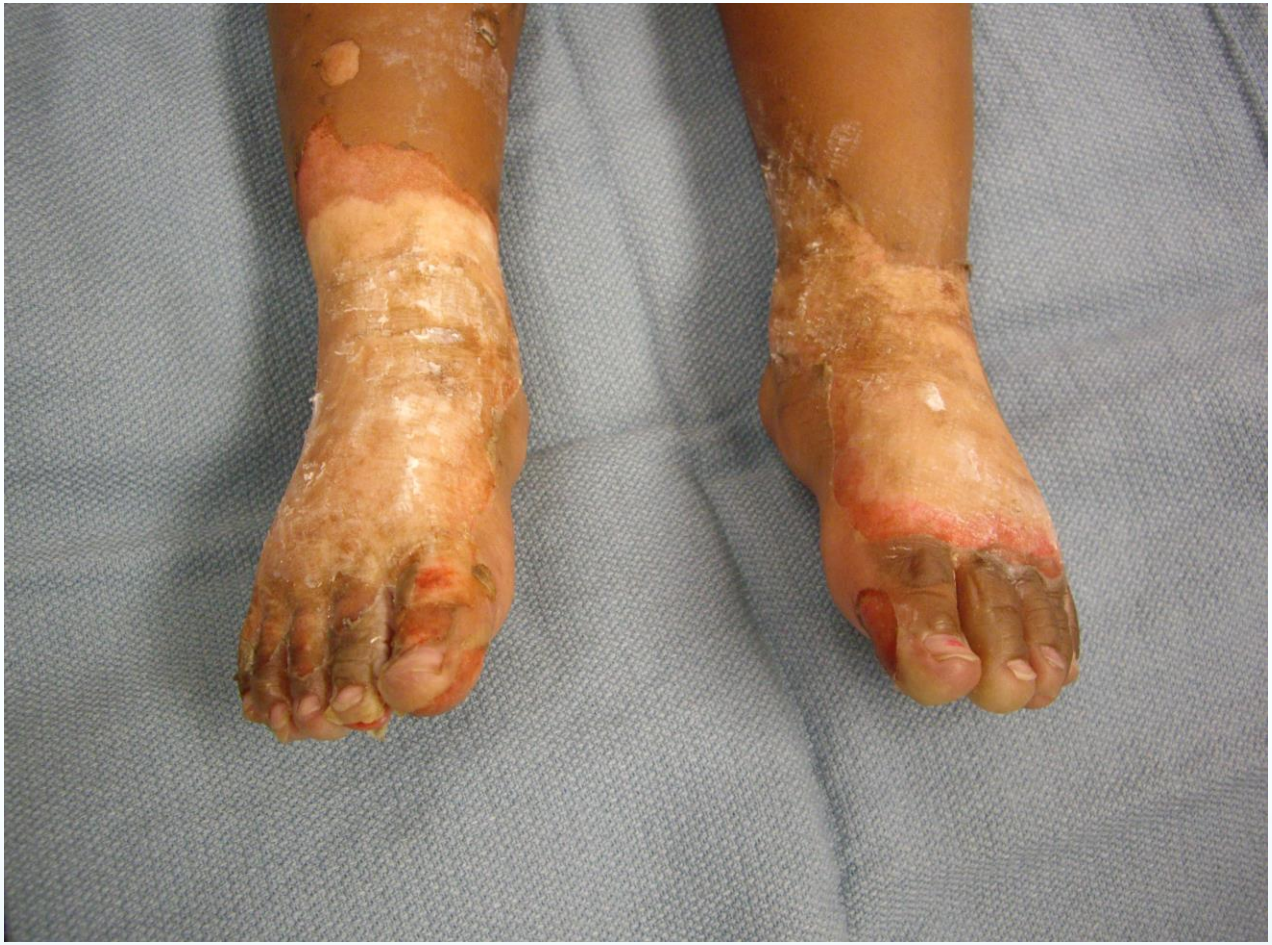
Contact Burn



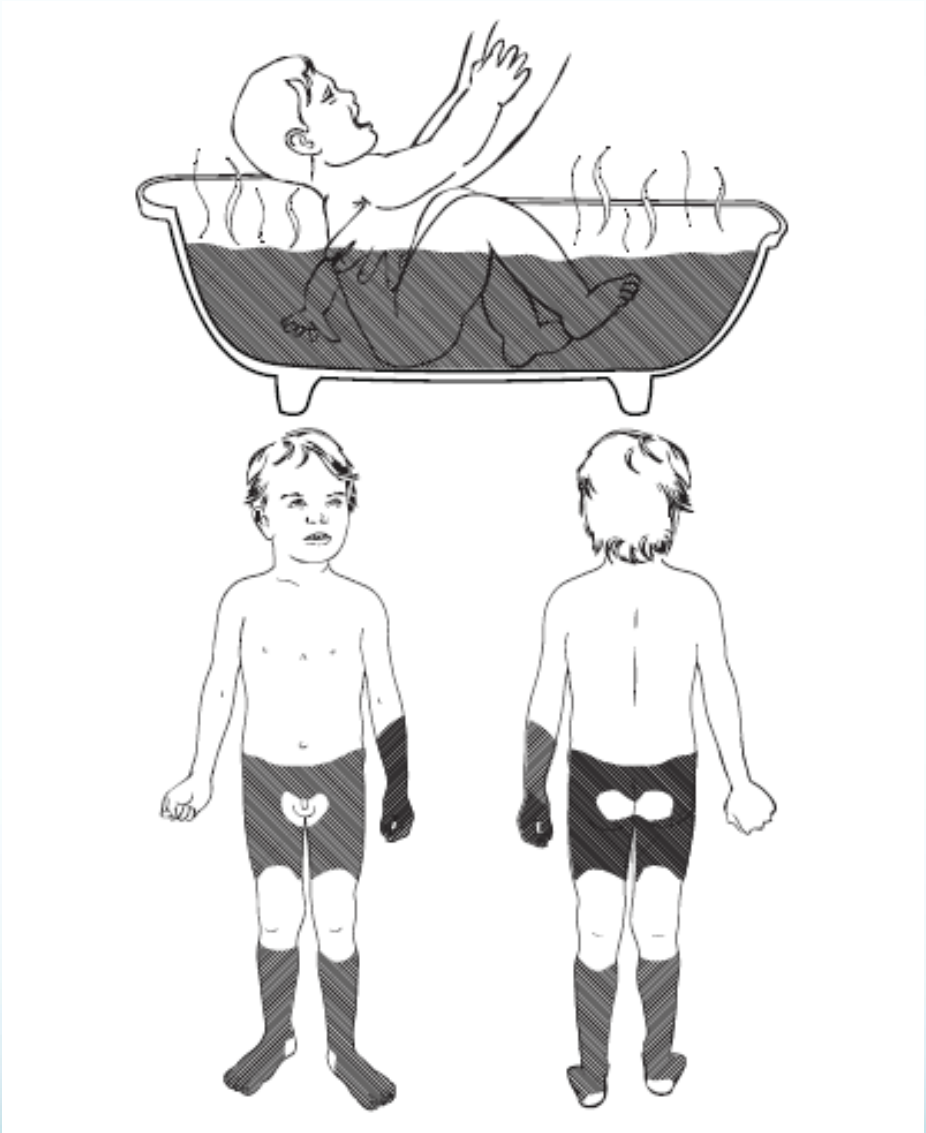
Cigarette burns to foot - different stages of healing



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

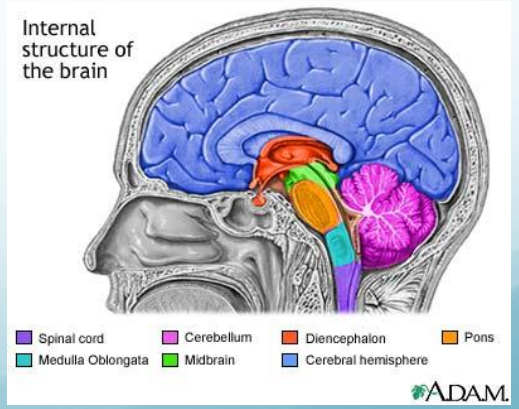
Missed Abusive Head Trauma

- 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

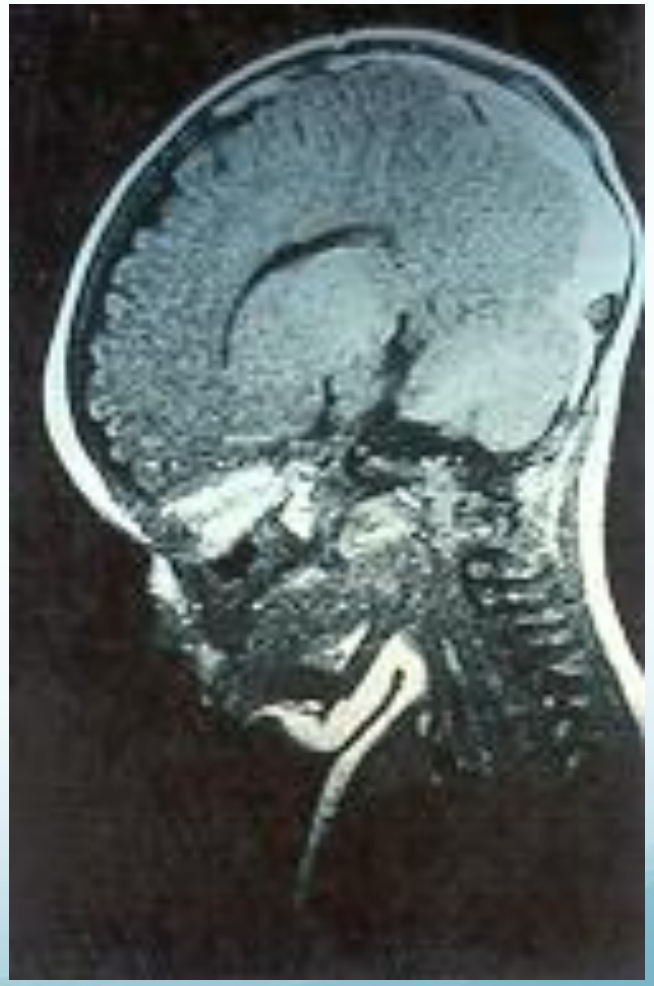
Etiology of the brain injury

- 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 ↑ vasoreactivity damaged axons
  - Cerebral edema
  - Diffuse axonal injury
  - Traumatic axonal injury



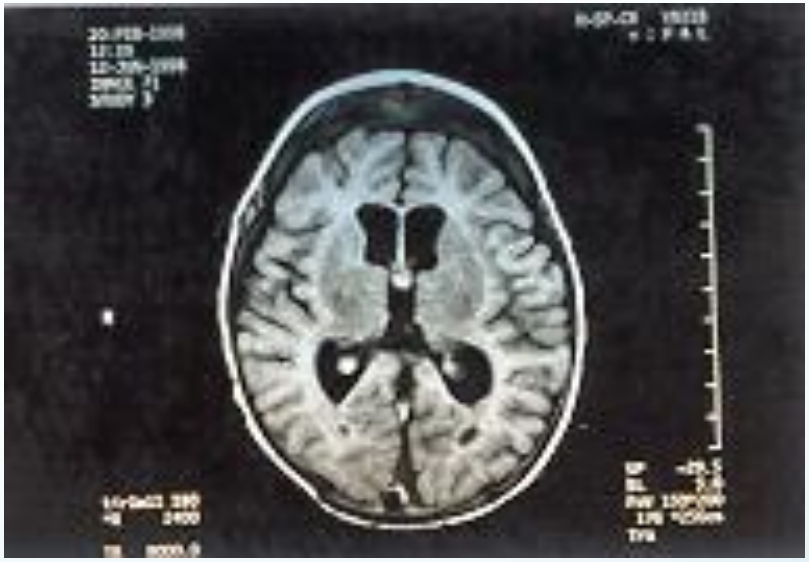
Presentation of AHT

- 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

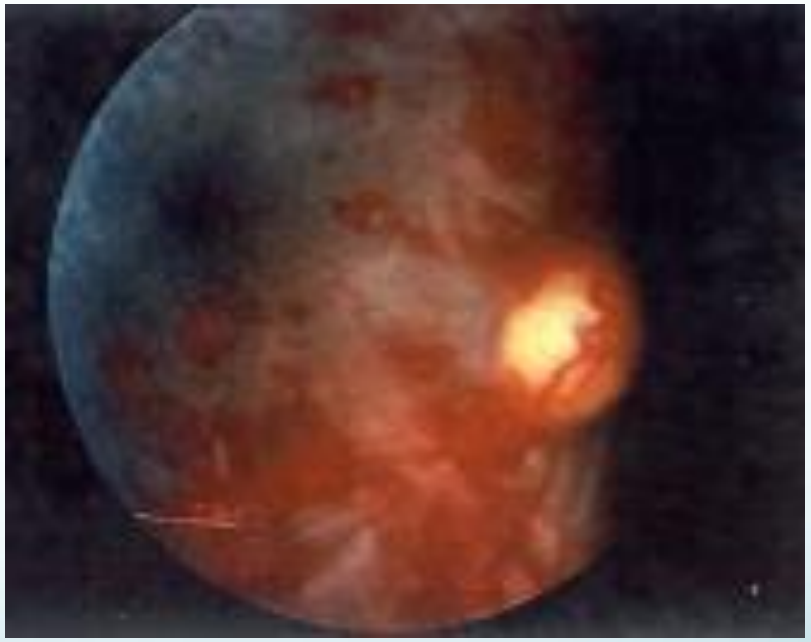
- Occur in 19-37% of newborns
  - Generally gone in 8 - 21 days, occasionally last 4 - 6 weeks
  - Head MRI of neonates with RH found 0% with ICH
- Have been reported after
  - CPR (9 of 117 pts: 2 prolonged CPR, 4 NAT, 1 HTN, 1 MVA, 1 drowning)
  - ECMO (13%, mostly neonates)
  - Meningitis, aneurysms,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

Retinal Hemorrhages and Accidental Head Injury

- Christian etal. *(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 etal. *(ADJC)* 50 kids <2 yr. Well documented accidental head injury. NO retinal hemorrhages.
- Johnson etal. *(Neurosurgery)* 140 children with accidental head injury. Only 2 with RH (after side impact MVA).
- Elder etal. *(J Ped Child Health)* 25 children with accidental head injury. No RH.
- Buys etal. *(Opthalmology)* 79 head injured children. 75 accidental - NO RH. 3 NAT all with RH's. 1 indeterminate.
- Duhaime etal. *(Pediatrics)* 100 consecutive head injuries. 10 pts with RH. 9 due to abuse. 1 due to MVA,
- Betz etal. *(Forensic Sci Internat)* looked at area of hemorrhage and mechanism. Accidental = 1.1 - 3.3% surface area. NAT = 19 - 73%.

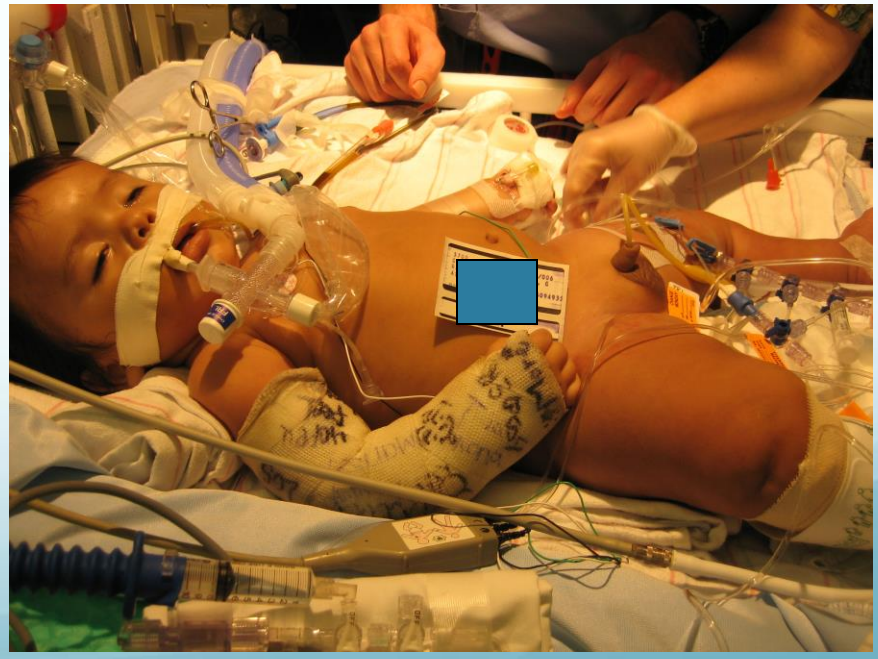
Retinal Hemorrhages

- 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

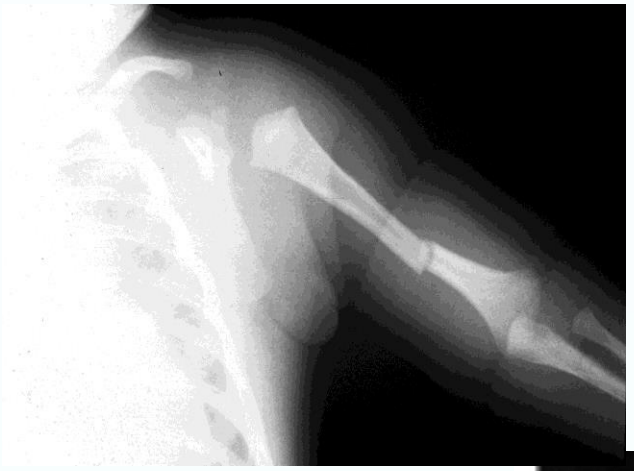
- 25 - 50% of children with documented NAT will have fx's
- The younger the patient with a fx, the higher the probability of abuse

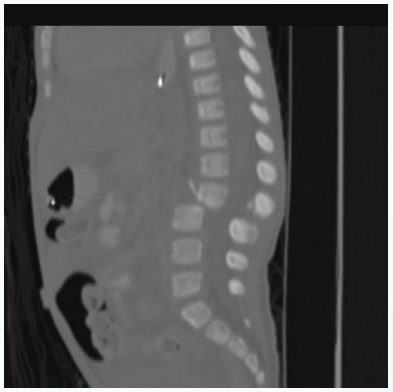


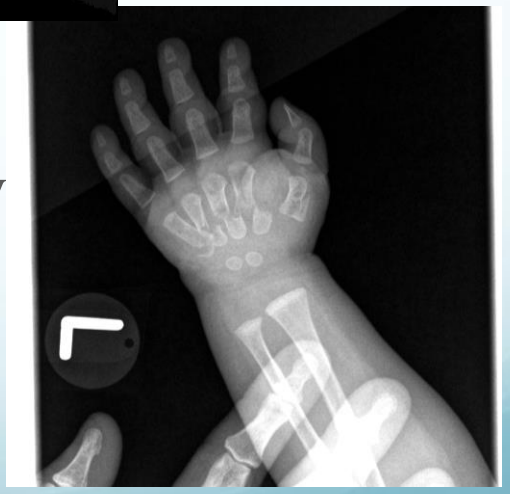
10 m/o with head injury after a broken arm that wasn't reported to CPS

Highly Suspicious Fractures

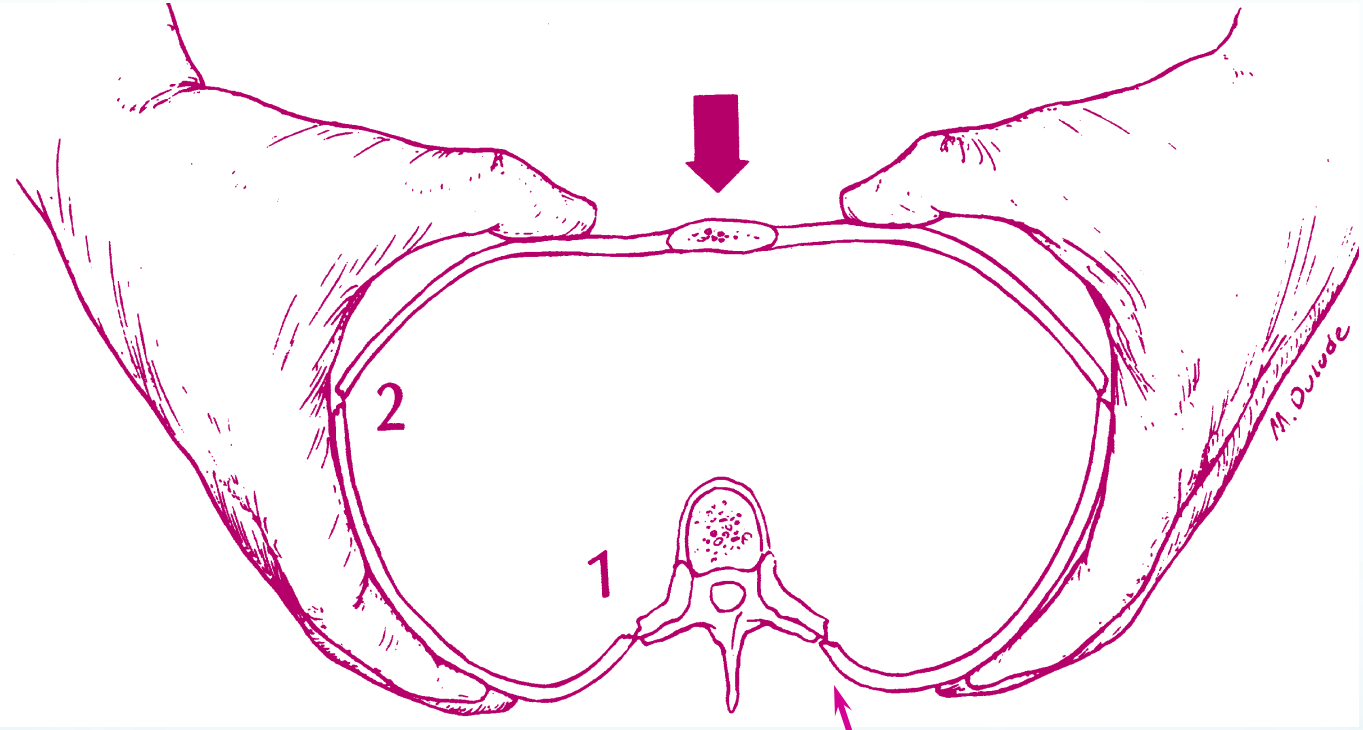
- Posterior rib fx
- Metaphyseal fx
- Scapular fx
- Vertebral fx
- Sternal fx
- Hands and feet - especially if non-ambulatory
- Midshaft humerus in < 3 yr
- Femur fx in any non-ambulatory child







Mechanism of Posterior Rib Fx's



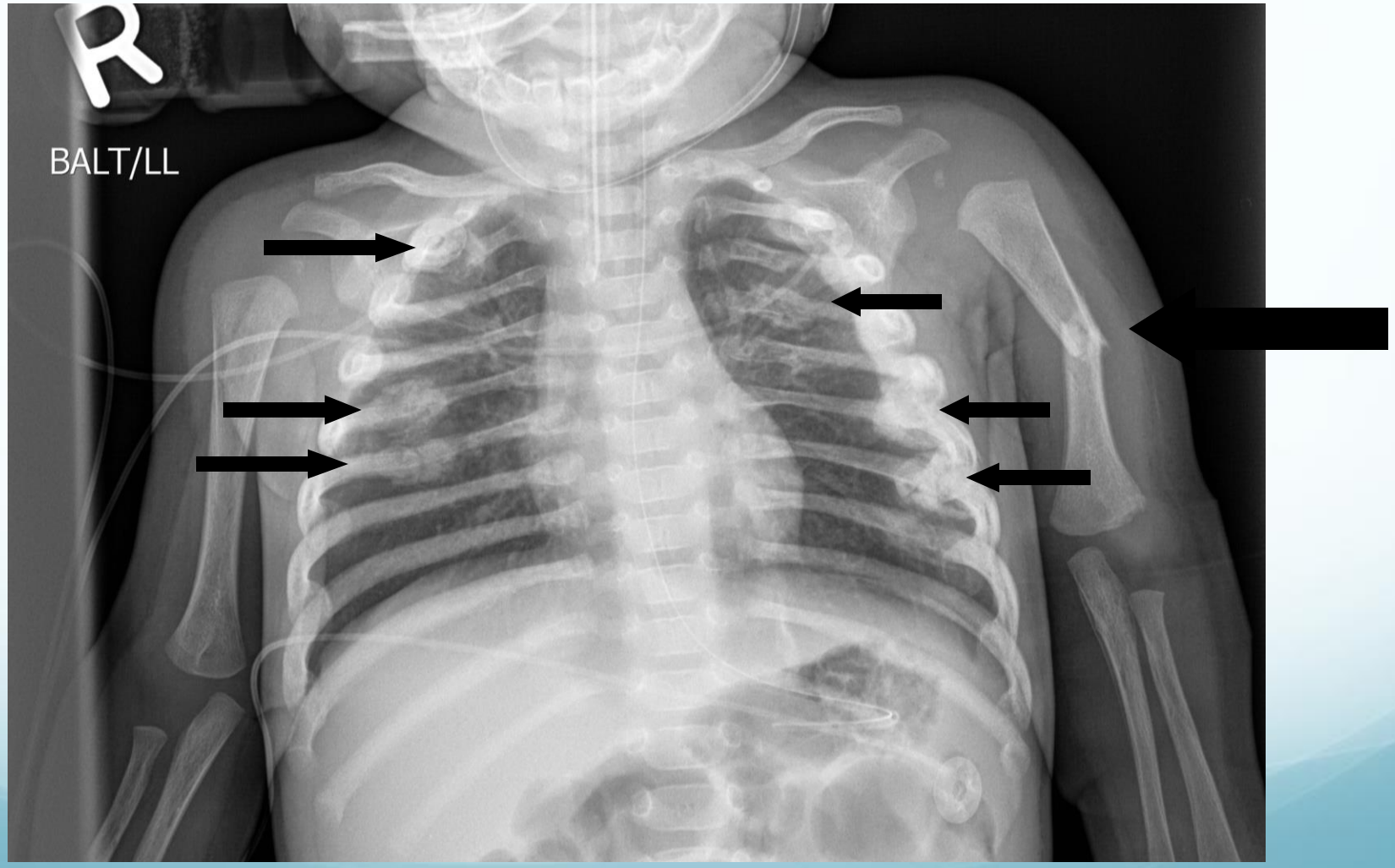
1 posterior

2 lateral

transverse process of adjacent vertebrae is the fulcrum

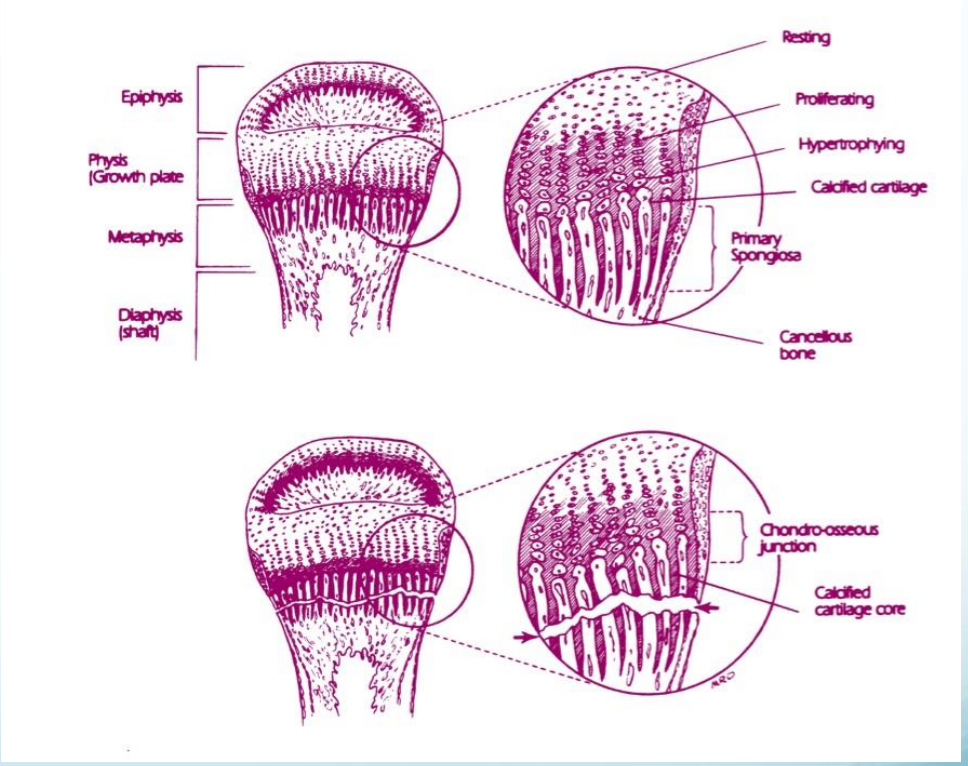
Note: post rib fx's are NOT seen after CPR

Multiple Rib Fractures (and a humerus fx)

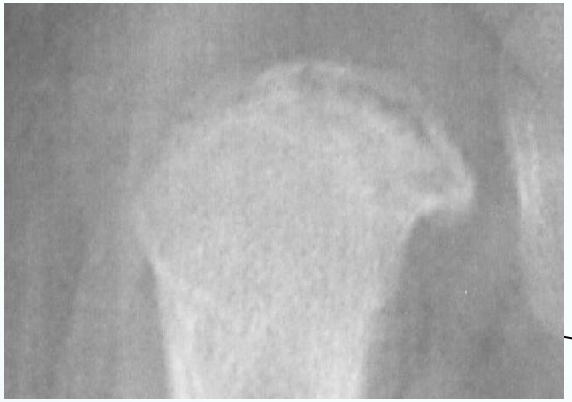


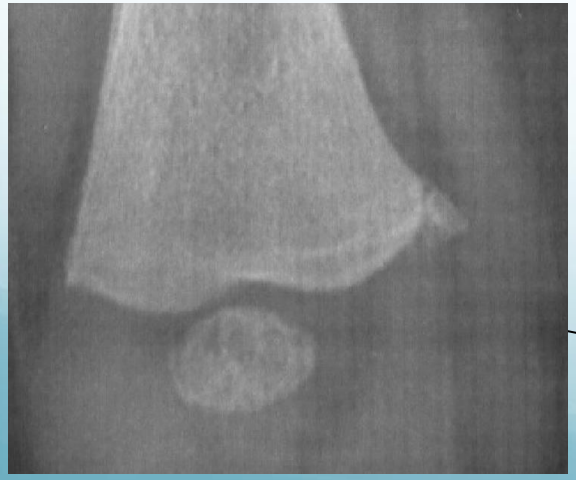
Metaphyseal Fracture

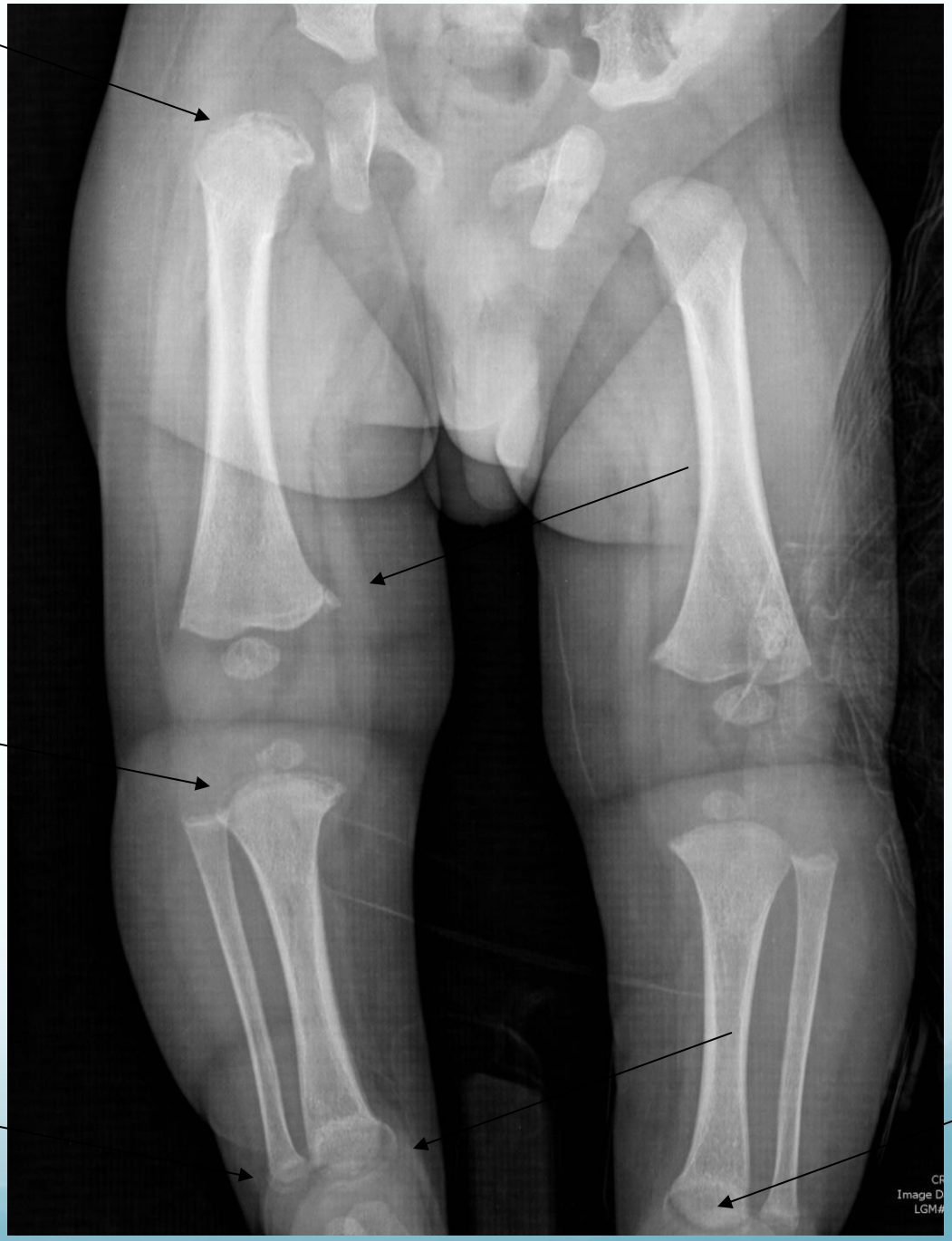
- Also called….
  - Corner fracture
  - Bucket handle fx
- Etiology
  - Flailing while being shaken
  - Twisting and torquing the extremity while pulling or yanking



Multiple Metaphyseal Fractures

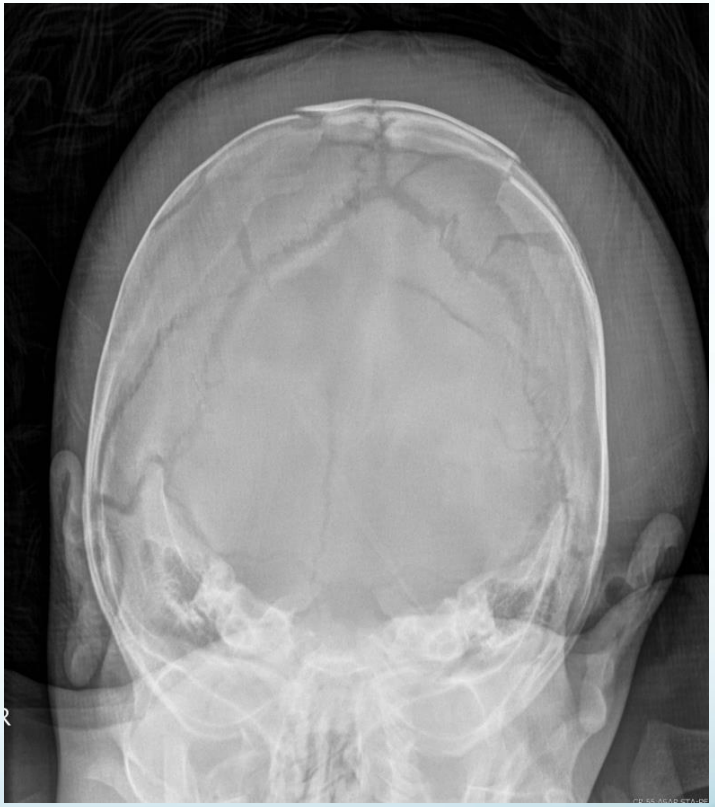






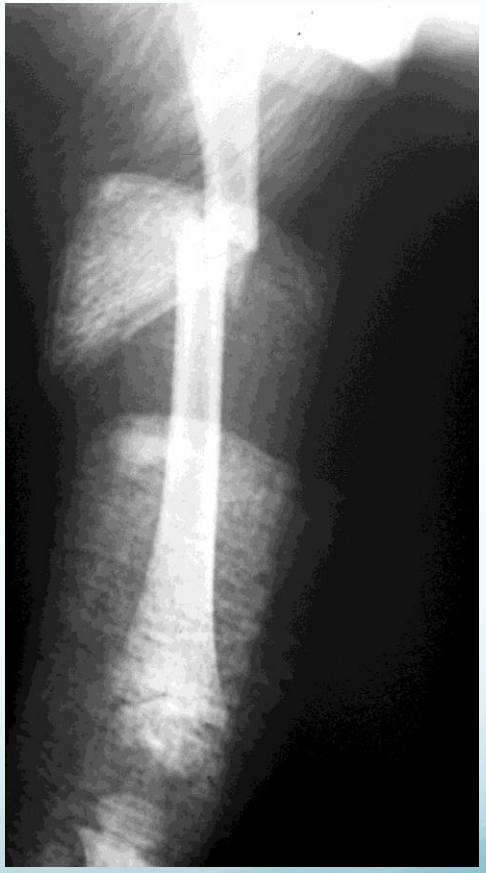
Moderately Suspicious Fractures

- 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

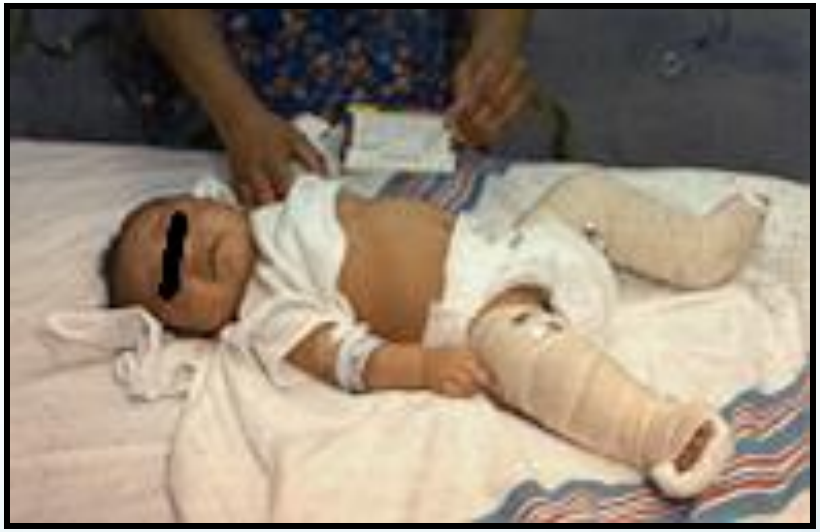
- Common in abuse, but also frequently accidental



- Single long bone fx's
- Simple linear skull fx's
- Mid clavicle fx's

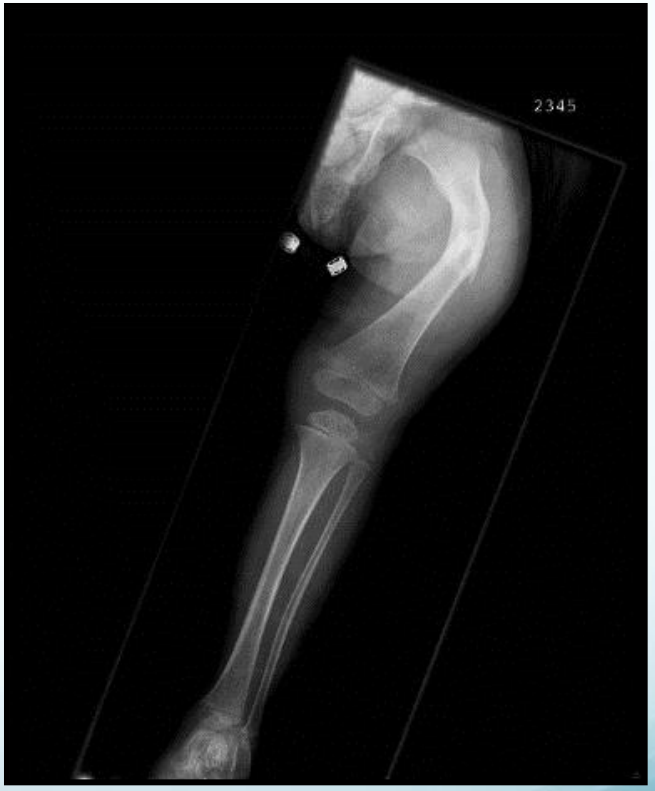
Femur fractures

- 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

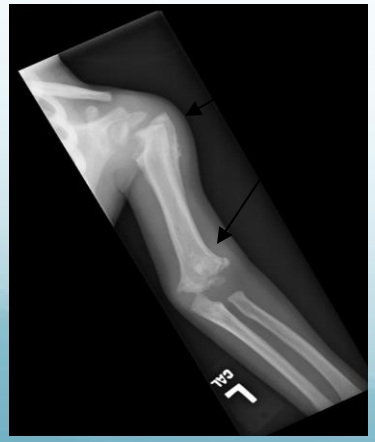
- Accidental fracture
- Osteogenesis imperfecta
- Metabolic bone disease (eg Rickets)
- Birth trauma

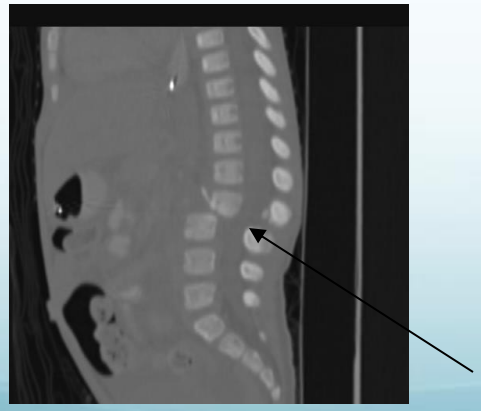


Skeletal survey: X-rays of the bones

- 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.

Fuhrman and Zimmerman, Pediatric Critical Care, Elsevier 2016

Transport Management

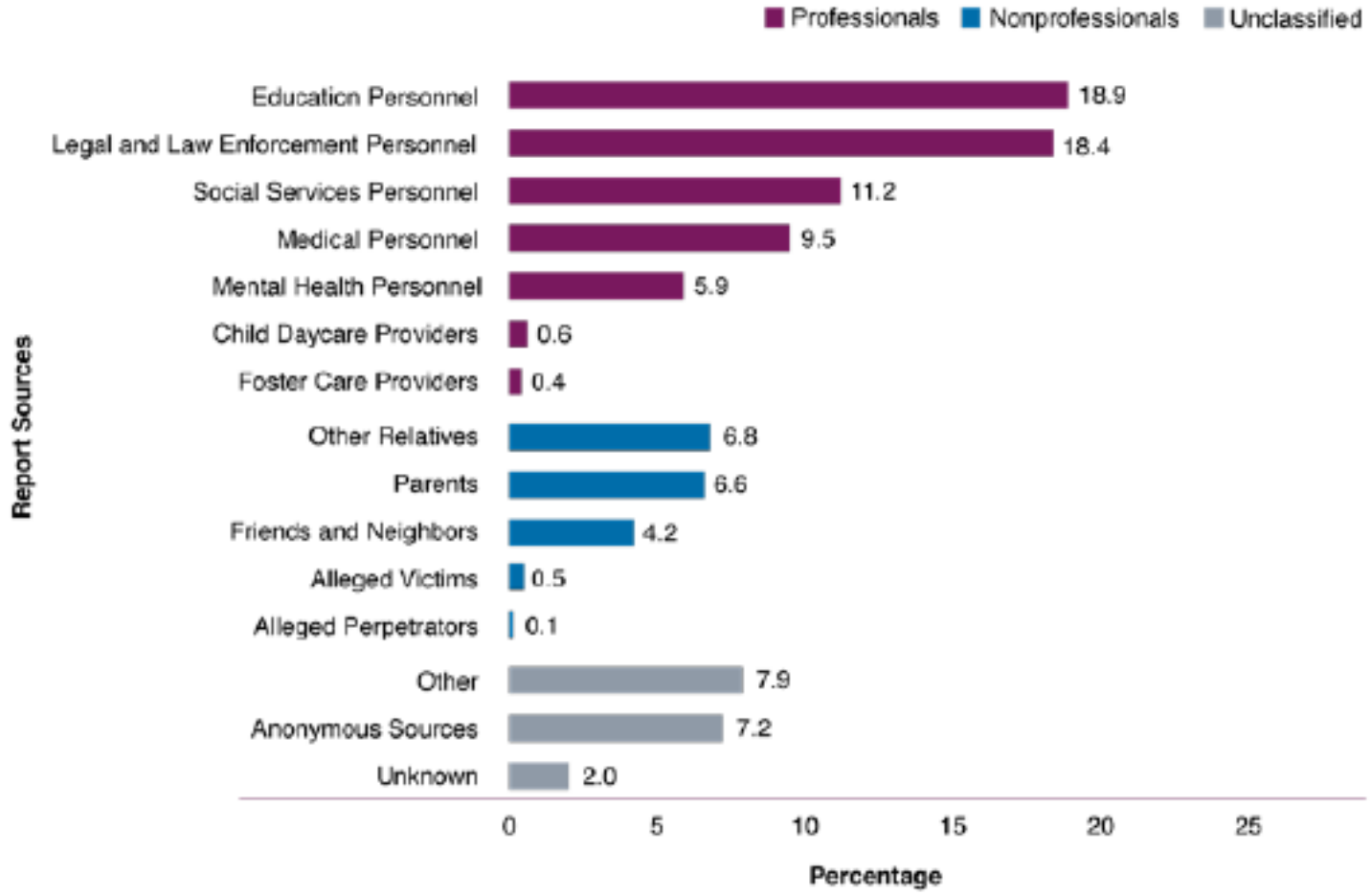
- ABCDE trauma evaluation on suspicion of NAT
- Neuroprotective measures
- Placement in spine precautions
- Activation of trauma protocol
  - Transport to ED
- Obtain/repeat necessary CT scans
- Prepare for OR
- CPS notification
- Accurate documentation

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



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

Fuhrman and Zimmerman, Pediatric Critical Care, Elsevier 2016

Organ Donation

Box 122.3

Key Groups Needed for Tissue Procurement

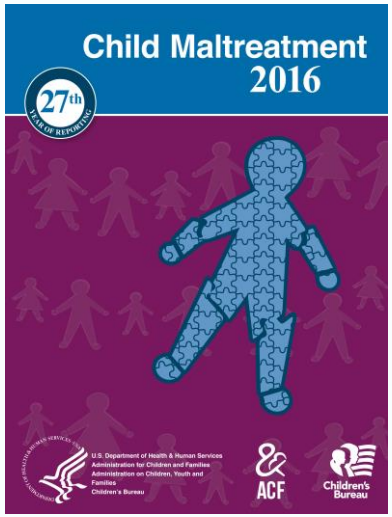
Pediatrician representing family's request
Organ procurement organization representative
Medical examiner's office
District attorney's office

Fuhrman and Zimmerman, Pediatric Critical Care, Elsevier 2016

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



kidsdata.org
A Program of Lucile Packard Foundation for Children's Health

SAFE KIDS WORLDWIDE™

California Department of Public Health
CDPH

ChildStats.gov
FORUM ON CHILD AND FAMILY STATISTICS

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People.™
Injury Prevention & Control

Questions?