

# The Importance of Sentinel Injuries in Protecting Children

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# Objectives

1. Identify that the younger the infant the more at risk they are for fatal non-accidental trauma.
2. Identify that the most common sentinel injury (in cases of child abuse) is a bruise.
3. Name three areas of the body where bruises raise concern for inflicted injury, in children under the age of four years.

# WARNING!

Disturbing photographs of abused children will be shown to illustrate key points.

## PLAN

Child abuse stats

Discuss sentinel injuries

Review child physical abuse

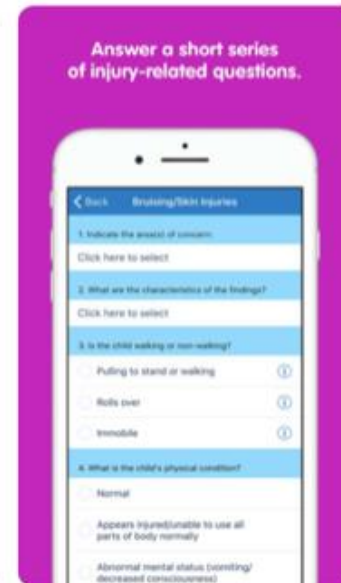
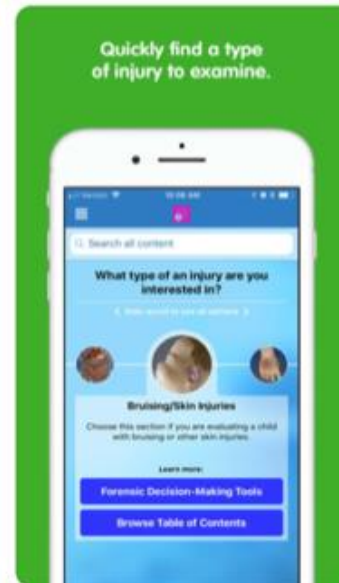
Resources

# New app: Child Protector



Child Protector  
Medical

OPEN



# Child Abuse and Neglect

At least one in four children have experienced child neglect or abuse (including physical, emotional, and sexual) at some point in their lives, and one in seven children experienced abuse or neglect in the last year.

Finkelhor D et al. Prevalence of childhood exposure to violence, crime, and abuse: Results from the National Survey of Children's Exposure to Violence. *JAMA Pediatr.* 2015;169(8), 746-754.

37.4% of all children experience a child protective services investigation by 18 years of age.

Kim H et al. Lifetime Prevalence of Investigating Child Maltreatment Among US Children. *Am J Public Health.* 2017;107(2)274-280.

# Child Abuse and Neglect

2016 National data: 676,000 children indicated as abused.

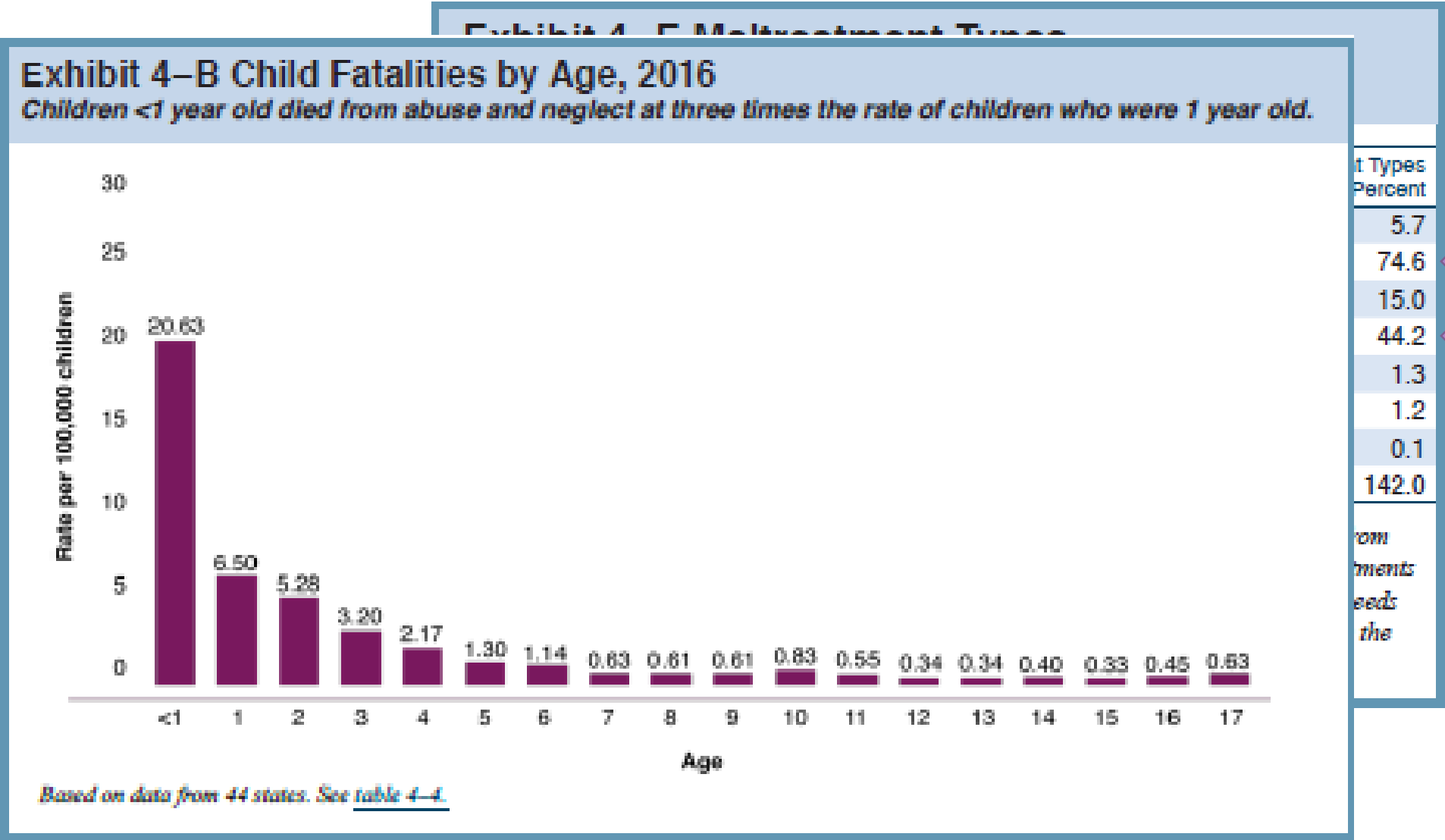
<https://www.acf.hhs.gov/cb/resource/child-maltreatment-2016>

# Mortality and Serious morbidity in child abuse

2016

- 1750 child fatalities in the past 6 years
- That's nearly 5 deaths a day
- Still under-reported if you include suicides that are child abuse deaths

<https://www.fda.gov/files/cb/cr...>



2016

## Exhibit 4–F Child Fatalities with Selected Caregiver Risk Factors, 2016

Caregiver Risk Factor	Reporting States	Child Fatalities from Reporting States	Child Fatalities With a Caregiver Risk Factor	Child Fatalities With a Caregiver Risk Factor Percent
Alcohol Abuse	27	896	51	5.7
Drug Abuse	31	1,120	169	15.1
Financial Problem	30	1,156	114	9.9
Inadequate Housing	32	852	71	7.5

*Data are from the Child File. For each caregiver risk factor, the analysis includes only those states that reported at least 1.0 percent of child victims' caregiver with the risk factor. States were excluded from these analyses if they were not able to differentiate between alcohol abuse and drug abuse caregiver risk factors and reported both risk factors for the same children in both caregiver risk factor categories. If a child was reported both with and without the caregiver risk factor, the child is counted once with the caregiver risk factor.*

Oregon 2016  
= 43% of all  
CPS cases

## Table 4–5 Child Fatalities by Relationship to Their Perpetrators, 2016

PERPETRATOR	Child Fatalities	Reported Relationships	Reported Relationships Percent
PARENT	-	-	-
Father	-	216	16.8
Father and Nonparent(s)	-	24	1.9
Mother	-	347	27.0
Mother and Nonparent(s)	-	137	10.7
Mother and Father	-	258	20.1
Mother, Father, and Nonparent	-	20	1.6
Total Parents	-	1,002	78.0

17% non-parent



# 10 Leading Causes of Death, United States 2016, All Races, Both Sexes

Rank	Age Groups				
	<1	1-4	5-9	10-14	15-24
1	Congenital Anomalies 4,816	Unintentional Injury 1,261	Unintentional Injury 787	Unintentional Injury 847	Unintentional Injury 13,895
2	Short Gestation 3,927	Congenital Anomalies 433	Malignant Neoplasms 449	Suicide 436	Suicide 5,723
3	SIDS 1,500	Malignant Neoplasms 377	Congenital Anomalies 203	Malignant Neoplasms 431	Homicide 5,172
4	Maternal Pregnancy Comp. 1,402	Homicide 339	Homicide 139	Homicide 147	Malignant Neoplasms 1,431
5	Unintentional Injury 1,219	Heart Disease 118	Heart Disease 77	Congenital Anomalies 146	Heart Disease 949
6	Placenta Cord Membranes 841	Influenza & Pneumonia 103	Chronic Low. Respiratory Disease 68	Heart Disease 111	Congenital Anomalies 388
7	Bacterial Sepsis 583	Septicemia 70	Influenza & Pneumonia 48	Chronic Low. Respiratory Disease 75	Diabetes Mellitus 211
8	Respiratory Distress 488	Perinatal Period 60	Septicemia 40	Cerebro-vascular 50	Chronic Low. Respiratory Disease 206
9	Circulatory System Disease 460	Cerebro-vascular 55	Cerebro-vascular 38	Influenza & Pneumonia 39	Influenza & Pneumonia 189
10	Neonatal Hemorrhage 398	Chronic Low. Respiratory Disease 51	Benign Neoplasms 31	Septicemia 31	Complicated Pregnancy 184

By: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention

# Morbidity

NSCAW researchers found that, at some point during the 3 years following a maltreatment investigation, 28 percent of children had a chronic health condition (Administration for Children and Families, Office of Planning, Research and Evaluation, 2007)

[https://www.childwelfare.gov/pubPDFs/long\\_term\\_consequences.pdf](https://www.childwelfare.gov/pubPDFs/long_term_consequences.pdf)

Annually there are 1200 seriously head injured children and 80 deaths from abuse.

<https://www.aap.org/en-us/about-the-aap/aap-press-room/aap-press-room-media-center/Pages/Abusive-Head-Trauma-Fact-Sheet.aspx>

The mortality rate for children with abusive head trauma ranges up to 35.7%. Among survivors, 42% – 96% suffer long-term neurologic morbidity. Both mortality and survivor neurologic outcome are worse in abusive head trauma compared with accidental TBI.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3437227/>

# The long shadow of aces

American Psychological Association 2017

About half of all children in the United States will experience some kind of adversity.

One third of all mental disorders are attributable to ACEs, worldwide.

Children who experience threat:

- Information processing biases resulting in the rapid identification of anger

- Heightened emotional reactivity to negative cues that might signal threat

- Generalization of threat responses to a wide range of stimuli (poor emotional regulation)

Children who experience deprivation (including poverty):

- Experience persistent deficits in cognitive functioning, including executive functioning

- Extreme over pruning of synaptic connections and branching

- Pervasive deficits in working memory, inhibitory control, and cognitive flexibility

# Morbidity

Adverse Childhood Experiences: graded relationship between the number of ACEs and each adult health risk behaviors and diseases.

Smoking, obesity, attempted suicide, drug use, >50 sexual partners and alcoholism

Ischemic heart disease, cancer, chronic lung disease and liver disease

Felitti and Anda. *Am J Prev Med.* 1998;14(4):245-58

# AAP The Evaluation of Suspected Child Physical Abuse

by Christian and committee on CAN, 2015

Previous sentinel injuries, defined as inflicted injuries that are minor and recognized by physicians or parents before the recognition that the child has been abused, are common in abused infants but rare in those not abused.<sup>54</sup> For example, previous sentinel injuries are identified in 25% of abused infants and in one-third of those with AHT.<sup>54,55</sup> The majority of sentinel injuries are bruises, intraoral injuries, including frena tears, or fractures.<sup>57-60</sup>

# Sentinel injuries: Recognizing the symptoms of the canary in the coal mine before it's too late.

Who might see a sentinel injury?

*Parent*

*Caregiver*

*Medical provider*

*Other family members*

Types of injuries:

*Bruises in infants*

*Intra-oral injury*

*Ear injury*

*Subconjunctival hemorrhage*

*Nursemaid's elbow (in an infant)*

2017. Antoinette Laskey, MD, Child Abuse Summit PDX.

# Additional injuries in young infants with concern for abuse and apparently isolated bruises.

*J of Pediatr* 2014;165:383-8, by Harper et al.

2890 children (children < 10 yrs seen in 20 centers for concern of child abuse)

*57.7% had apparently isolated bruises at presentation*

*Neuro-imaging identified new injury in 27.4%*

*Skeletal survey identified new injury in 23.3%*

*Abdominal injury identified in 2.7%*

*Overall, 50% had at least one additional injury*

70% had bleeding disorder testing, no disorders were found

***50% had high likelihood of abuse.***

# Sentinel injuries

## Bruises are TRAUMA

April 2017- *International Journal of Child Abuse and Neglect*

“History, injury and psychosocial risk factor commonalities among cases of fatal and near-fatal physical child abuse”

- Small study of 20 children < 4years old.
- Median age=7.5 months
- 95% with traumatic brain injury
- 90% with bruises
- Of cases with available prior medical records, 64% had prior atypical bruising.



# Prior opportunities to identify abuse in children with abusive head trauma.

*International Journal of Child Abuse and Neglect.* 2016;60:36-45. Letson, et al.

Multicenter study

232 children with AHT

*31% (73) had a total of 120 prior opportunities for diagnosis.*

25% in medical setting

Most common complaint was vomiting but for 12% it was bruising.

6% in CPS setting

*10% died.*

*Median age was 5.4 months*

# Sentinel Injuries Precede Abusive Head Trauma in Infants.

2009 *Pediatric Academic Societies Meeting*. Baltimore, MD by Sheets et al.

100 children with discharge diagnosis of abusive head trauma

*30% had a history of sentinel injury*

Bruise was most common

*Average of one month before the head injury*

*97% before 6 months of age*

*60% before 2 months of age*

# Risk factors for recurrent injuries in victims of suspected non-accidental trauma: a retrospective cohort study.

2014, *BMC Pediatrics* by Deans et al.

1361 children with suspected NAT

*26% had a recurrent NAT event within 1 year*

*40% within 2 years*

*Risk factors:*

Rural

Young age (<30 months)

Fewer injuries (1 or 2 detected)

# Barriers and facilitators to detecting child abuse and neglect in general emergency departments.

*Annals of Emergency Medicine, 2015 by Tiyyagura et al.*

29 interviews at 3 emergency depts.

## Barriers:

*Believing the caregiver*

*Failure to recognize a child's condition could be due to CAN*

*Challenges of working in ED such as lack of on-going contact with family*

*Provider biases*

*Factors associated with reporting*

*Negative outcomes such as testifying in court*

*Lack of follow up on reported cases*

## Facilitators

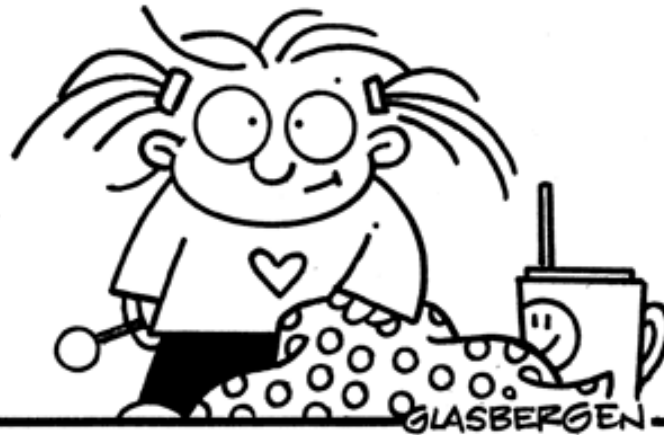
*Real time discussion with peers*

*Belief that it is better to report when suspicious*



© 2009 by Randy Glasbergen. [www.glasbergen.com](http://www.glasbergen.com)

## ***GUINNESS BOOK OF WORLD RECORDS***



**April 17, 2009 – Amelia Ann Ashton asked her  
mother 53,297,518 questions in 15 minutes.**

# Think about child abuse...

## Box 2

### Six B's: high-risk chief complaints

- Bruises
- Breaks
- Bonks (head injuries)
- Burns
- Bites
- Baby blues (excessive crying, poor feeding)

Leetch and Woolridge, 2013;31:853-873. *Emerg Med Clin N Am.* Emergency Department Evaluation of Child Abuse.

BRUISES



# Bruising characteristics discriminating physical child abuse from accidental trauma.

2010 *Pediatrics*. Pierce et al.

Children ages 0-48 months admitted to PICU for trauma

*42 victims of physical abuse*

*53 victims of accidental trauma*

*71 (of 95) had bruising*

Bruises associated with abuse were:

Torso	}	< 4 years of age
Ear		
Neck		

Any bruising in a child <4 months of age

# Dr. Mary Clyde-Pierce (2015)

## **“Got skin? Examine it!”**

“Bruises are injuries” think TRAUMA.

Non-cruising infant-age matters

Age less than or equal to 4 years, get child undressed and examine!

Focus on high risk chief complaints:

BRUE/ALTE

Vomiting

Rolled off the couch/bed.

Social risks:

MCP: attributions of child; discipline practices; new paramours

Also: DV; substance abuse; criminality; mental illness

**“get a social work consult if bleeding disorder is ruled out EVEN if other NAT work up is negative”**

# Dr Pierce

## Incidental bruising

### Characteristics

- Child developmentally capable of causing the bruise (**NMB** no go)
- Occur after mobility starts
- 9 months of age and above, prevalence rates go up for bruising
- Typically no definitive associated bruise history, but often there is a speculated cause
- Always over bony prominent areas; Never over "soft" areas or protected areas

## Typical or Accidental bruising

### Characteristics

- Clear and discrete trauma hx that matches the location of the discrete impact
- **"One and Done"**
- Bony prominent areas
- NOT multi-planar
- NOT over soft tissue areas
- NOT bilateral
- NOT clustered
- NOT patterned (no geometric shapes like loop marks or hand slaps)

### Regions

- Forehead-Head
- Zygoma
- Chin
- Knees
- Elbows
- Shin
- Spine
- **FHZC<sup>3</sup>KES<sup>2</sup>**

# Dr Pierce

## Atypical bruising Physical Assault

### Characteristics

- May or may not offer a history to explain the findings
- Often the bruise is "2<sup>nd</sup> fiddle" to the reason for presentation
- Grab or "box" ears, face, neck (jaw line) with choking, shoulder, arms, chest
- Hit or slap the side of the head
- Punch in the eye or mouth or stomach
- Kick in the stomach or back
- Spank the buttocks and upper legs
- Bilateral injuries to eyes, ears, cheeks, jaw: **Yikes!**
- Ear, eyes (sclera, eyelids), jaw line, buccal check, frenulum, neck, upper chest, shoulder bruising: **Double yikes!**

Image from Kosair Children's Hospital, Louisville

Ann & Robert H. Lurie  
Children's Hospital of Chicago

## BRUISING RULES

Torso Ears Neck  
4 years & under

OR ANY BRUISING ON AN INFANT  
4 MONTHS OR YOUNGER

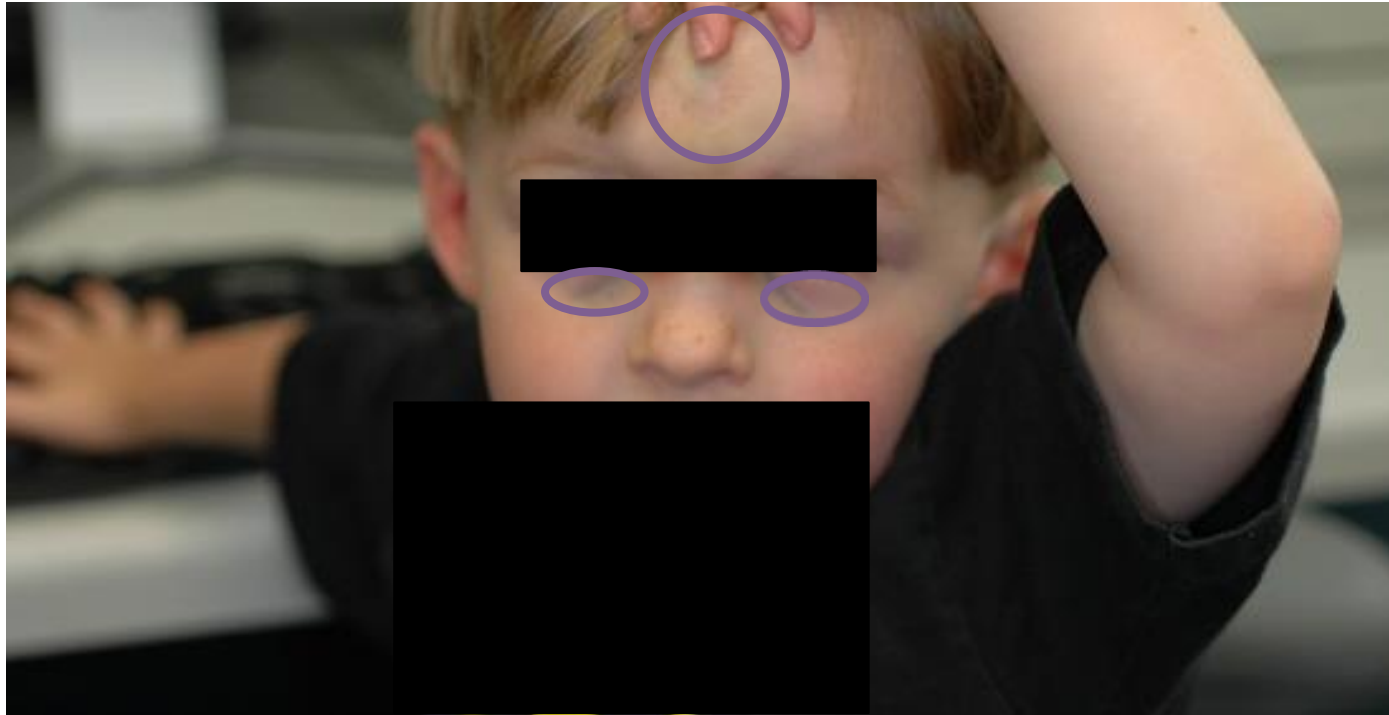




# Bruises



Beware: forehead bump with migration



# TEN-4-FACES



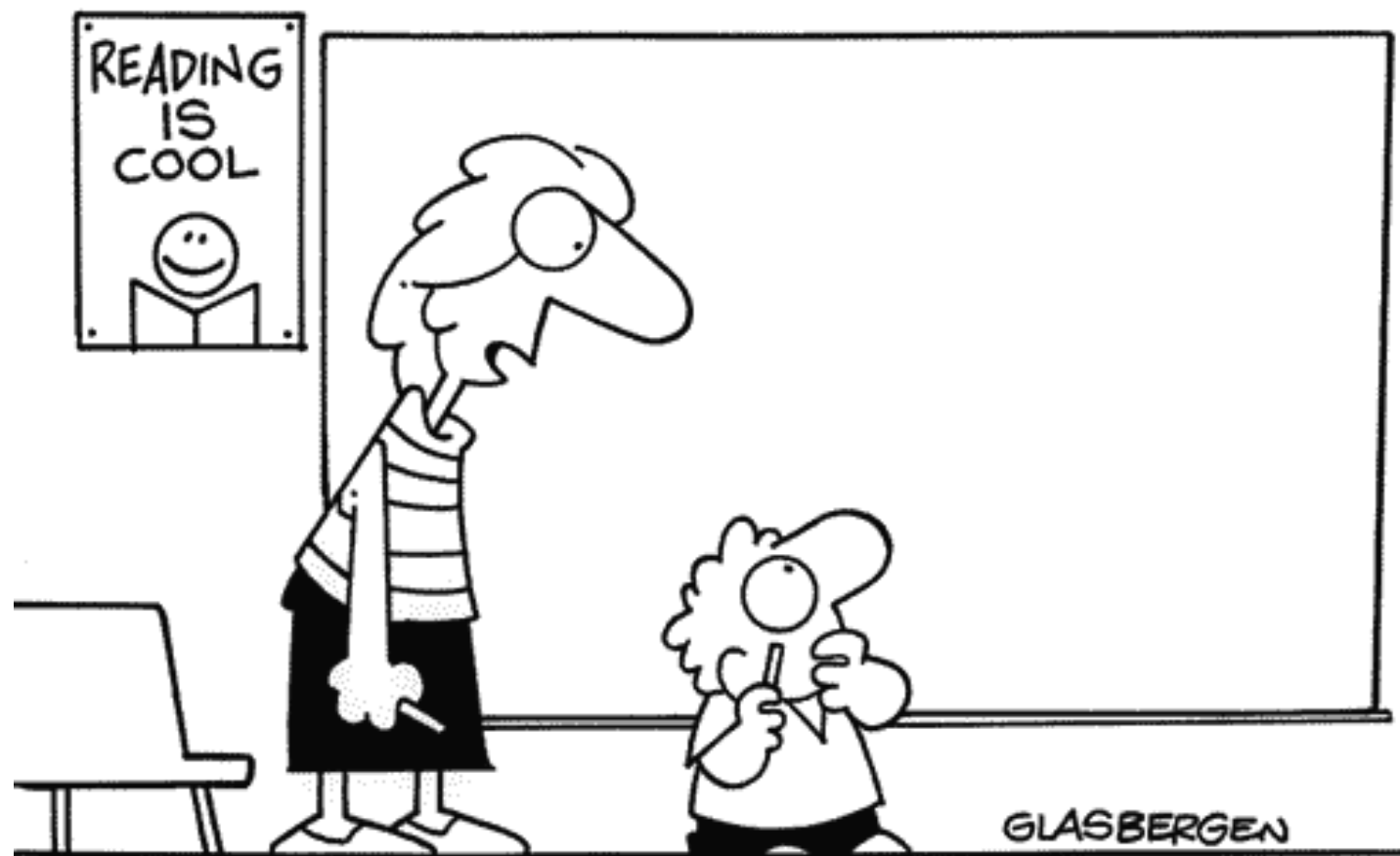
# TEN-4-FACES





# TEN-4-FACES





**“There aren’t any icons to click. It’s a chalk board.”**

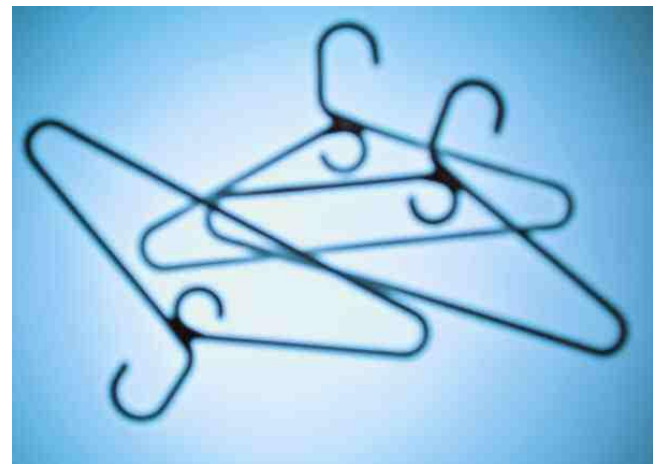
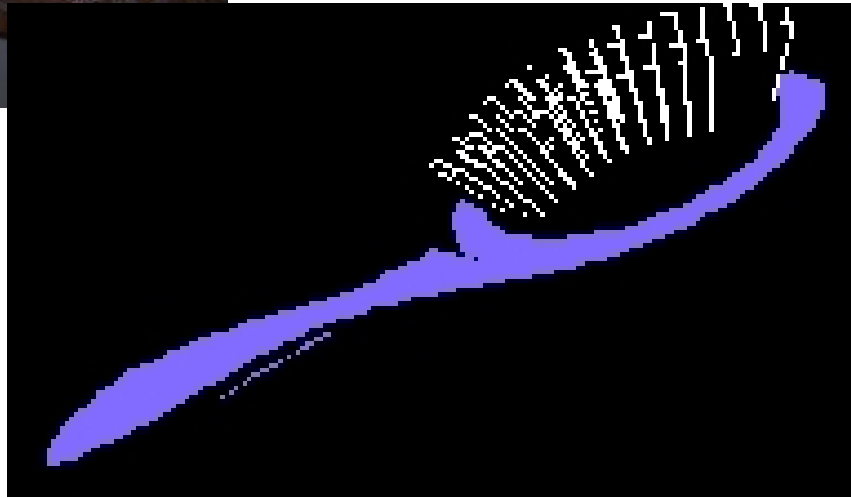
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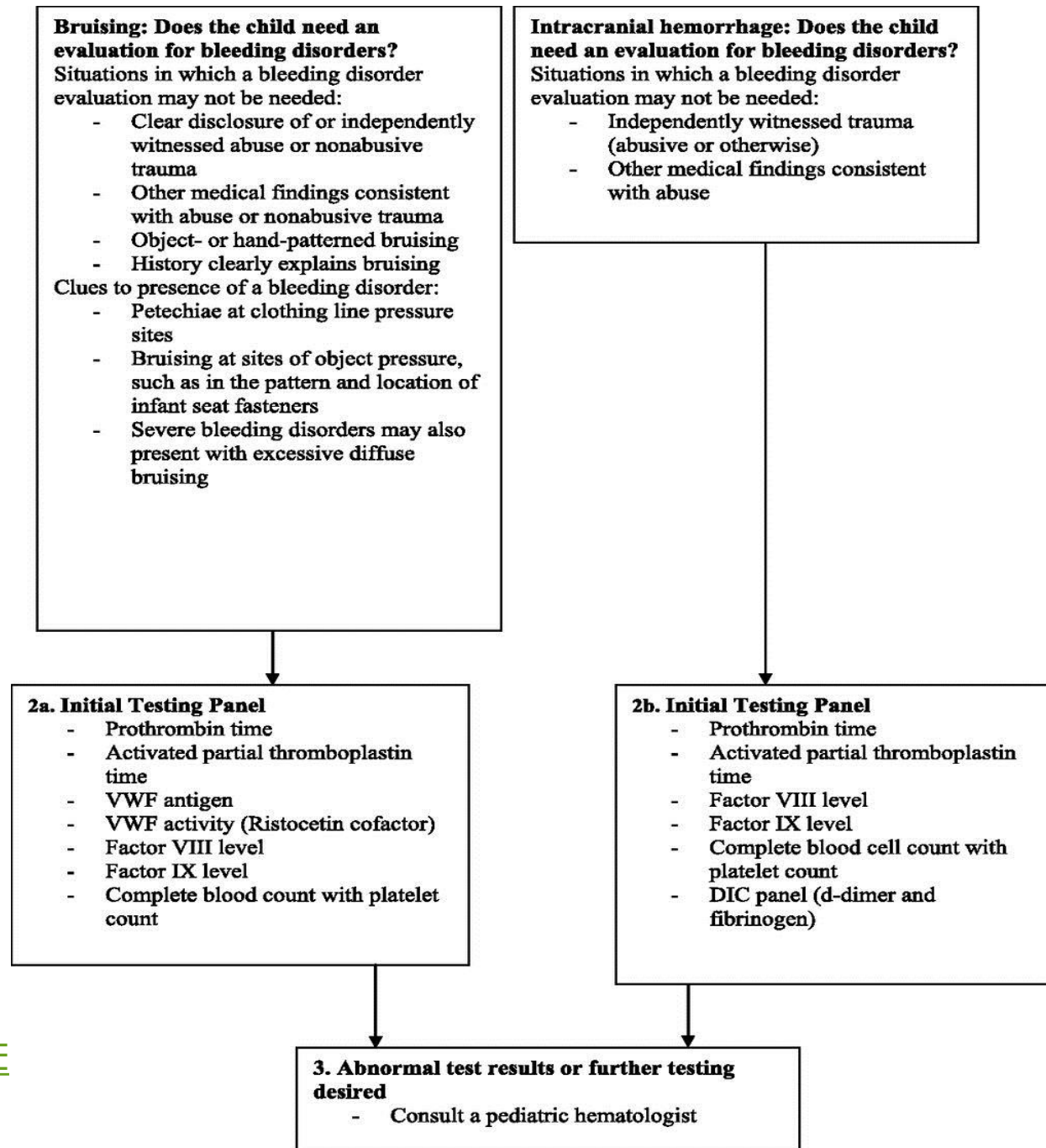




# TEN-4-FACES



# Bleeding Disorder Evaluation



Pediatrics  
April 2013, VOLUME  
131/ ISSUE 4

# Patterns



# Patterns



AAP



# Patterns



# Think about child abuse...

Child maltreatment is a public health problem with lifelong health consequences for survivors and their families.

Histories that raise concern for abuse:

- No explanation or vague explanation given for a significant injury

- Denial of trauma in a child with an obvious injury

- An important detail changes over time in a substantive way

- Explanation inconsistent with child's developmental level/ability

- Explanation inconsistent with the pattern or severity of the injury

- Unexplained or unexpected delay in seeking care

- Different witnesses provide markedly different explanations

# The Evaluation

**TABLE 1** Factors and Characteristics That Place a Child at Risk for Maltreatment

Child	Parent	Environment (Community and Society)
Emotional/behavioral difficulties	Low self-esteem	Social isolation
Chronic illness	Poor impulse control	Poverty
Physical disabilities	Substance abuse/alcohol abuse	Unemployment
Developmental disabilities	Young maternal or paternal age	Low educational achievement
Preterm birth	Parent abused as a child	Single parent
Unwanted child	Depression or other mental illness	Nonbiologically related male living in the home
Unplanned pregnancy	Poor knowledge of child development or unrealistic expectations for child Negative perception of normal child behavior	Family or intimate partner violence

Reproduced with permission from Flaherty et al.<sup>34</sup>

# Fractures

Fractures concerning for abuse:

Non-ambulatory infants (without a clear history of trauma or known bone fragility)

Multiple fractures

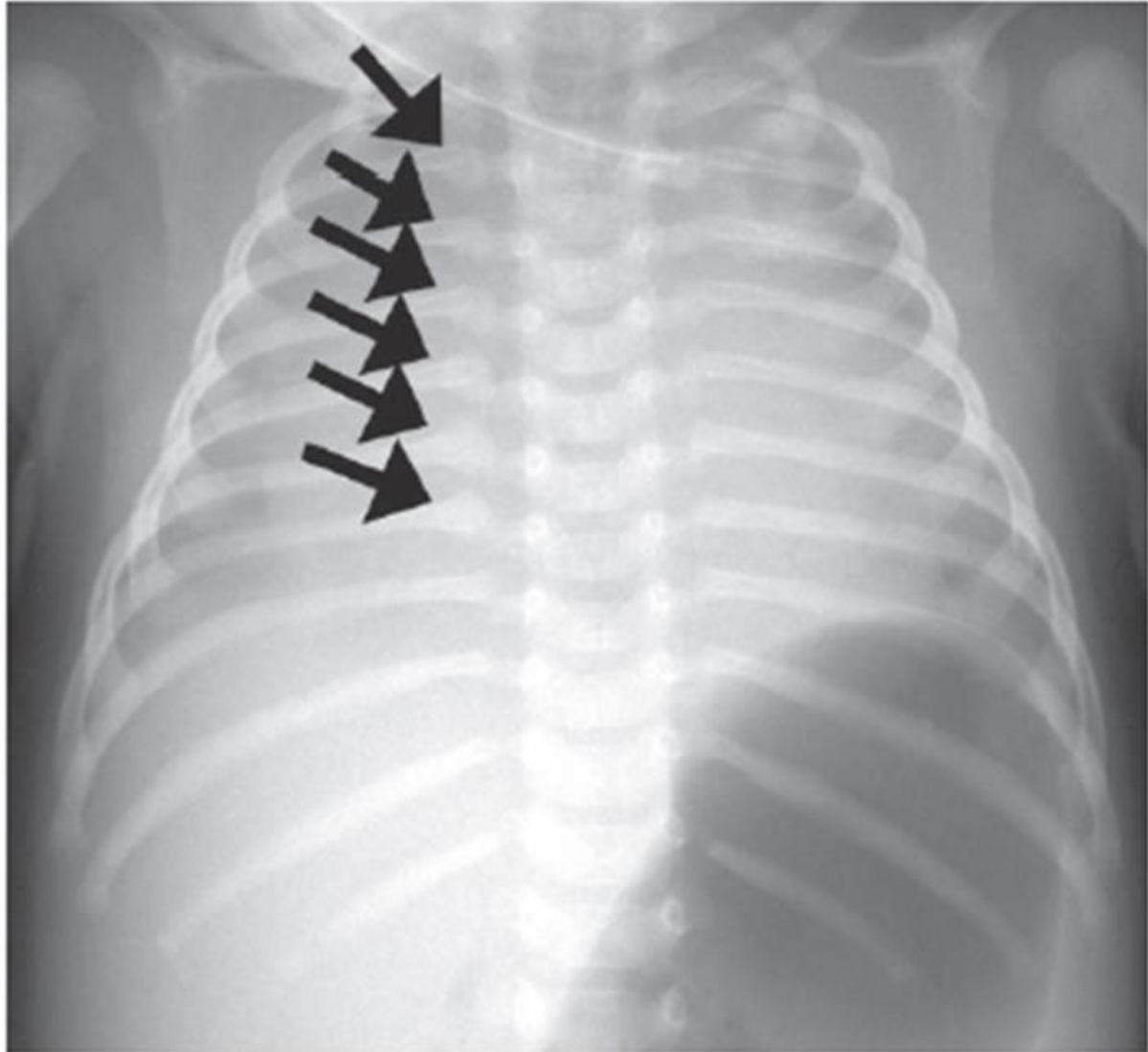
Rib fractures

*Just this fx noted in children less than 3 years old is associated with 95% positive predictive value for NAT.*

CPR rarely causes rib fx, usually anterior.



# Rib fractures



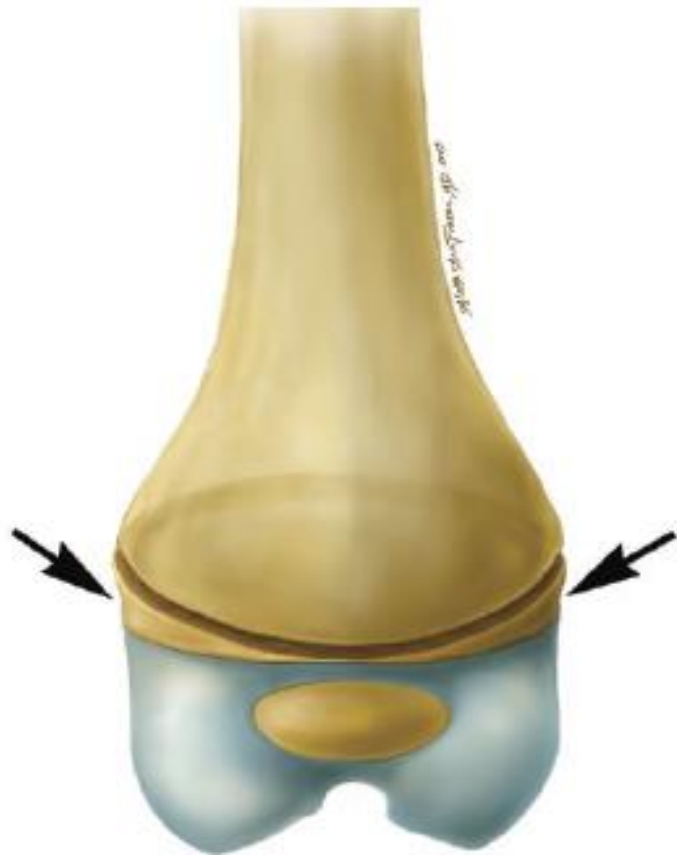
# Fractures concerning for abuse cont'd

Infants and toddlers with midshaft humerus or femur fractures

*Particularly under the age of 15 months.*

Unusual fractures such as scapula, CML, vertebral, sternum

History of trauma does not explain the fracture.



**Figure 3.** Diagram depicts the discoid metaphyseal fracture fragment (arrows).

# The Evaluation

**TABLE 2** Indications for Obtaining a Skeletal Survey

---

All children <2 y with obvious abusive injuries

All children <2 y with any suspicious injury, including

Bruises or other skin injuries in nonambulatory infants;

Oral injuries in nonambulatory infants; and

Injuries not consistent with the history provided

Infants with unexplained, unexpected sudden death (consult with medical examiner/coroner first)

Infants and young toddlers with unexplained intracranial injuries, including hemorrhage and hypoxic-ischemic injury

Infants and siblings <2 y and household contacts of an abused child

Twins of abused infants and toddlers

---

# Fractures

## Serum:

Calcium, phosphorus, alkaline phosphatase, 25-hydroxyvitamin D and PTH.  
Consider-vitamin C, copper, and ceruloplasmin, if abnormal X-rays.  
Consider-skin biopsy or DNA analysis for Osteogenesis Imperfecta.

## Imaging:

Skeletal survey

*Repeat in 2 weeks for high risk cases*

*Can use bone scintigraphy to complement skeletal survey.*

# Fractures

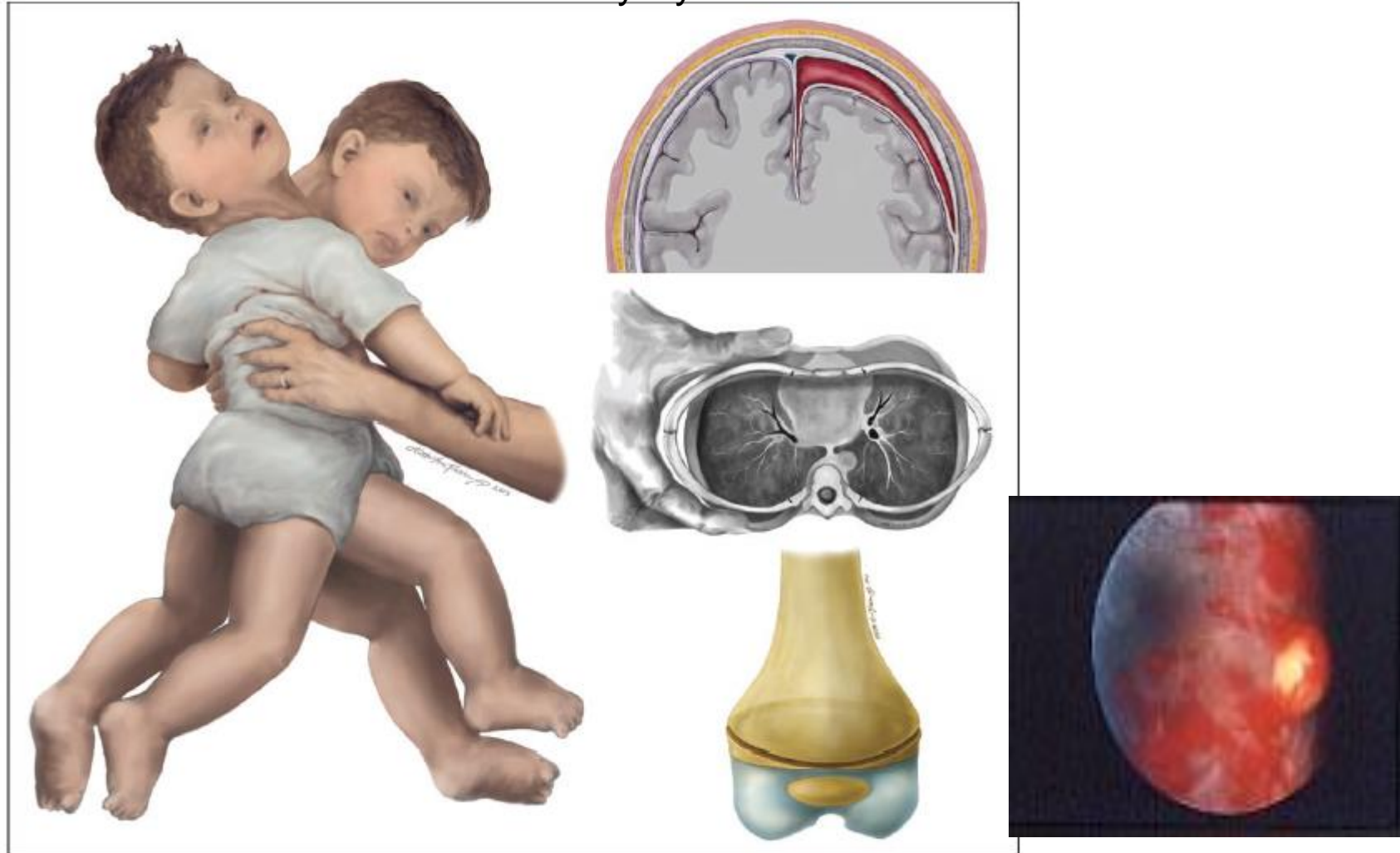




**“Can I get my milk from an unopened container? I just saw a documentary on Munchausen by proxy syndrome and, well...you’re not exactly the most stable person I know.”**



## Shaken Baby Syndrome



**Figure 1.** Violent shaking and squeezing of an infant may result in subdural hemorrhage (top right diagram) and shear-type brain injury, rib fracture (middle right diagram), and metaphyseal fracture (lower right diagram). These injuries are fully described and illustrated in subsequent sections.



# The Evaluation-head injury

## Head trauma

All infants and children with suspected AHT require CT, MRI or both.

*Symptomatic children-CT of the head*

*MRI-all children with abnormal CT's, asymptomatic infants with non-cranial abusive injuries and for f/u of trauma.*

*U/S for macrocephaly, ok but-if positive get MRI. DO not use in emergency setting.*

Think of ophthalmology exam for retinal hemorrhages.

*Not necessary if exam and neuro-imaging are negative.*

CBC w/plts, PT/INR/aPTT, Factors VIII and IX, fibrinogen, and d-dimer.

*Review newborn screen*

*Consider urine organic acids to screen for GA1.*

# Cont'd

Six findings associated with abusive head trauma

- Rib fractures

- Retinal hemorrhages

- Long bone fractures

- Head/neck bruising

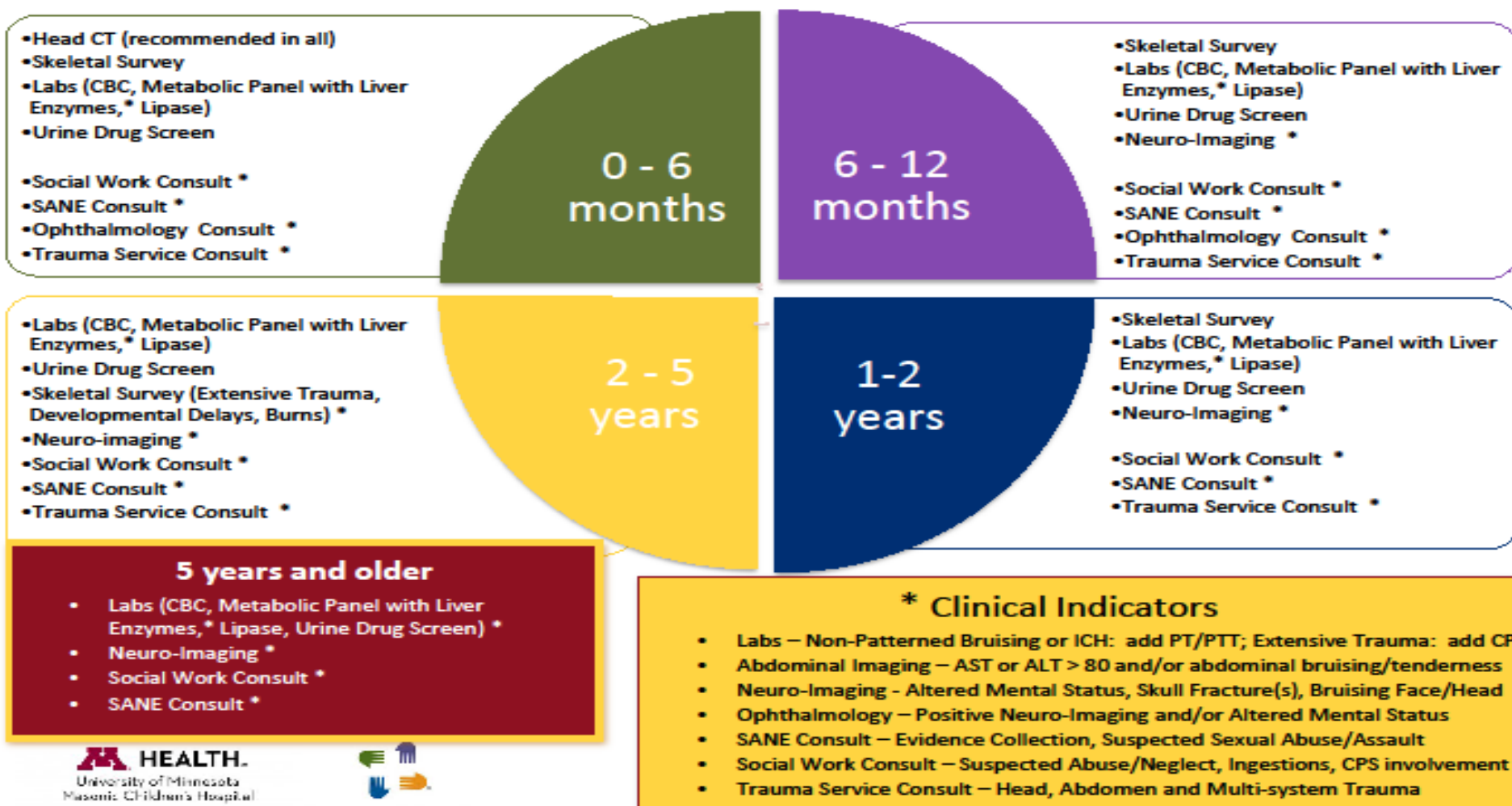
- Apnea

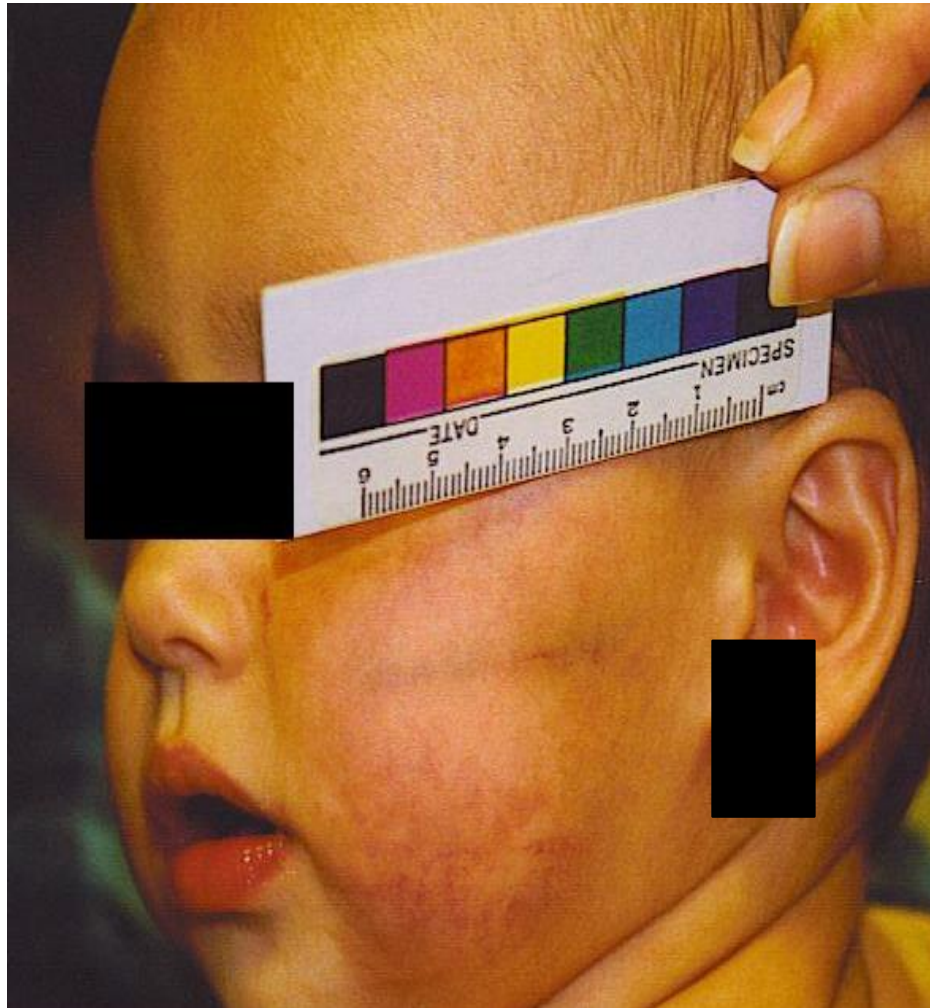
- Seizures

When 3 or more are present, PPV approaches 100% for AHT

## CENTER FOR SAFE AND HEALTHY CHILDREN

### Assessment for Physical Abuse







# BURNS



# The Evaluation-abdomen

Abdominal injury=second leading cause of mortality in physical abuse.

- Get liver and pancreatic enzymes

- Get UA

- Consider CT with IV contrast

- Skeletal survey in children < 2 years

# Oral injuries and occult harm in children evaluated for abuse

2017. Arch Dis Child. Dorfman, MV et al.

2890 child abuse consultations in 20 US cities < 120 months old.

3.3% had oral injuries (96 children)

*43% of those had frenulum injuries*

*84% got skeletal surveys*

25% showed occult fractures

*75% had neuroimaging*

38% had injuries

*41% had retinal exams*

24% had retinal hemorrhages

# Continued

70% of the children seen with oral injury had a high level of concern for child abuse.

Of children < 6 months of age with oral injury, 88% had a high level of concern for child abuse

Of children 6-12 months of age, 80% had a HLOC for child abuse

Of children 1-3 years of age, 64% had a HLOC for child abuse

Of children > 3 years of age, 80% had a HLOC for child abuse





Detecting and Reporting Child Abuse, Idaho's Invisible Children; are they your children?  
[http://www2.state.id.us/phd1/hp\\_detecting-child-abuse.pdf](http://www2.state.id.us/phd1/hp_detecting-child-abuse.pdf)

# Subconjunctival hemorrhages



# Strangulation: manual or ligature

Potentially lethal features: but can die w/o any of these:

- Loss of consciousness

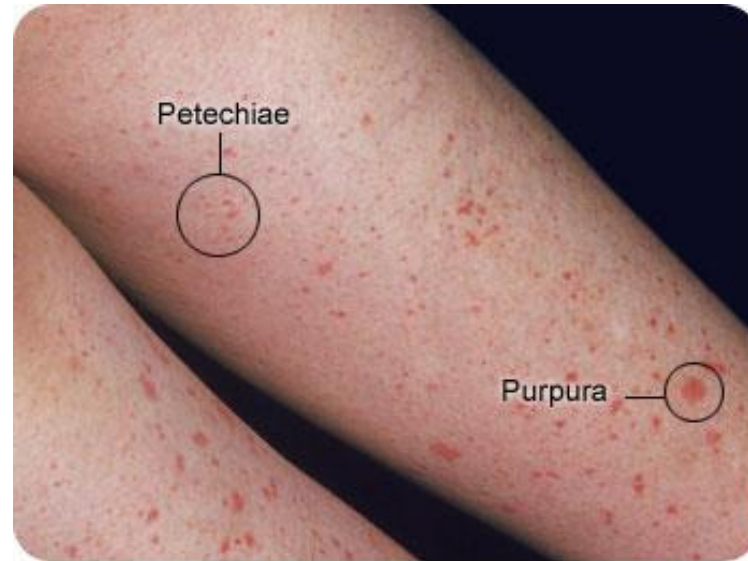
- Bladder or bowel incontinence

  - 5% of survivors*

  - 60% of fatalities (vs. 14% of controls)*

- Facial petechiae

# Petechiae



# Strangulation

## Evaluation:

*Pulse oximetry*

*Chest films*

*Soft tissue films of neck*

*CT/CTA of neck recommended for:*

*Conscious victims with history of:*

*Loss of consciousness*

*Or petechiae (suggesting force was applied for 15-30 seconds or longer)*

*Consider pharyngoscopy or laryngobronchoscopy with symptoms*

## Admit for observation:

*Loss of consciousness*

*Evidence of vascular obstruction with facial or conjunctival petechiae*

*Symptoms of soft tissue injury to the neck*

*Under the influence*

# Missed opportunities to diagnose child physical abuse.

2014, 30(11):771-776, *Pediatric Emergency Care* by Thorpe et al.

1466 children had a skeletal survey for concern of abuse.

100 had healing fractures.

*77 children diagnosed as abused.*

*Of those 32% had a previous visit where abuse could have been diagnosed.*

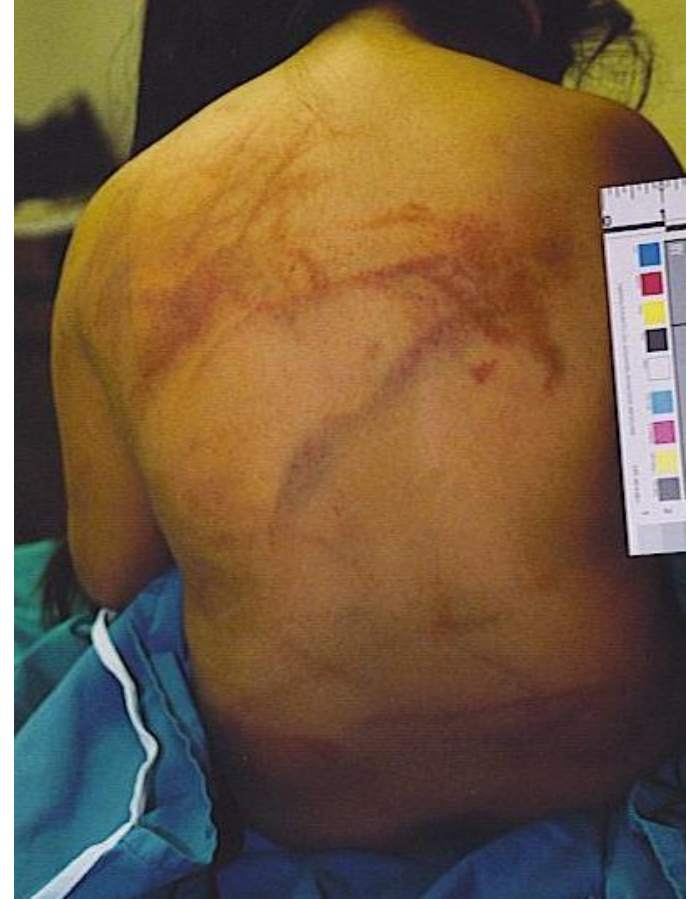
*Mean age 3.9 months.*

*90% of these children were admitted.*

*10% of them died.*

61% of the healing fractures were rib fractures followed by lower extremity (40%) and upper extremity (30%) and skull (25%).









# Pittsburg Infant Brain Injury Score

Berger, et al. 2016

- ✓ Abnormal skin exam (2 pts)
- ✓ Age  $\geq$  3 months (1 pt)
- ✓ Head circumference  $>$  85<sup>th</sup> percentile (1 pt)
- ✓ Hemoglobin  $<$  11.2 (1 pt)

1040 infants with temp  $<$  38.3° C

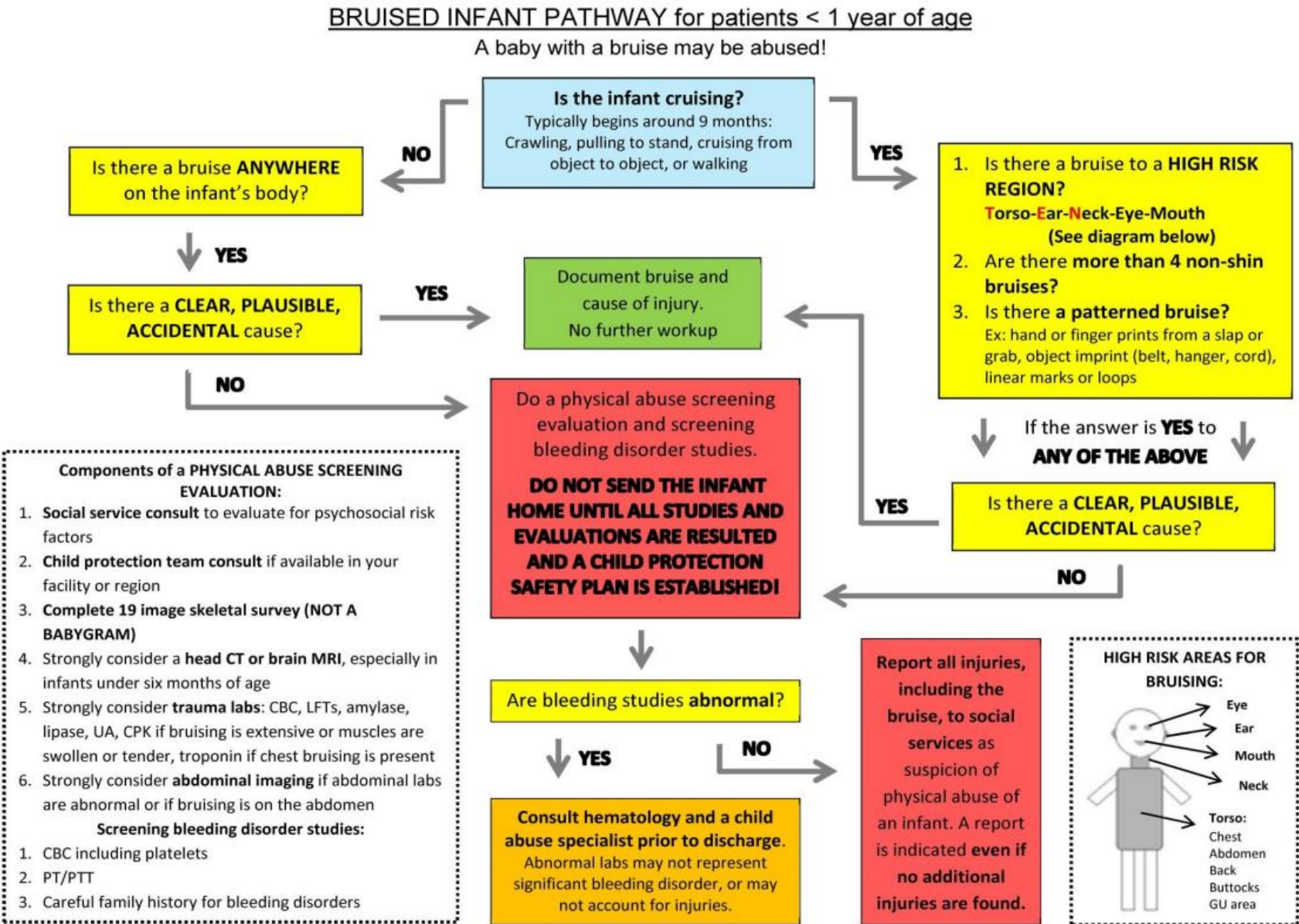
214 cases and 826 controls

No history of trauma

A symptom associated with having a brain abnormality

**A score of 2** showed a sensitivity and specificity for having abnormal neuroimaging was 93.3% and 53%. Implementation analysis needed before integration to clinical practice.

Mary Clyde Pierce, MD  
Lurie Children's Hospital, Chicago



# Excellent resources:

Leetch and Woolridge, 2013;31:853-873. *Emerg Med Clin N Am.* **Emergency Department Evaluation of Child Abuse.**

Christianson, CW and the Committee on CAN. *PEDIATRICS*. Volume 135, number 5, May 2015. **The Evaluation of Suspected Child Physical Abuse.**

Tiyyagura G, Beucher M, and Bechtel K, 2017;14(7):1-28. *Pediatric Emergency Medicine Practice.* **Nonaccidental Injury in Pediatric Patients: Detection, Evaluation, and Treatment.**

# Bruising studies

2015. *Arch Dis Child*. Kemp et al. **Patterns of bruising in preschool children-a longitudinal study.**

3523 bruises

*2.2% of children who could not roll over.*

*Ears, neck, buttocks, genitalia and hands were rarely bruised.*

1999. *Arch Pediatr Adolesc Med*. Sugar et al. **Bruises in infants and toddlers-those who don't cruise rarely bruise.**

973 children < 36 months old

*21% with bruises*

0.6% in children less than 6 months

1.7% in children less than 9 months

Goes up to 18% in cruisers and 52% of walkers.

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