



# Warning Shot Across the Bow: Evaluation of Sentinel Injuries in Infants

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# Warning Shot



# Learning Objectives

- ▶ Learners will be able evaluate injuries in light of the child's age, developmental level, and reported mechanism of injury
- ▶ Learners will develop a treatment plan for sentinel injuries
- ▶ Learners will describe the potential consequences of sentinel injuries

# Conflict of Interest

- ▶ No disclosure

# Trauma Informed Disclosure

- ▶ This lectures involves pediatric injury and death with some graphic photographs which can be disturbing to some participants

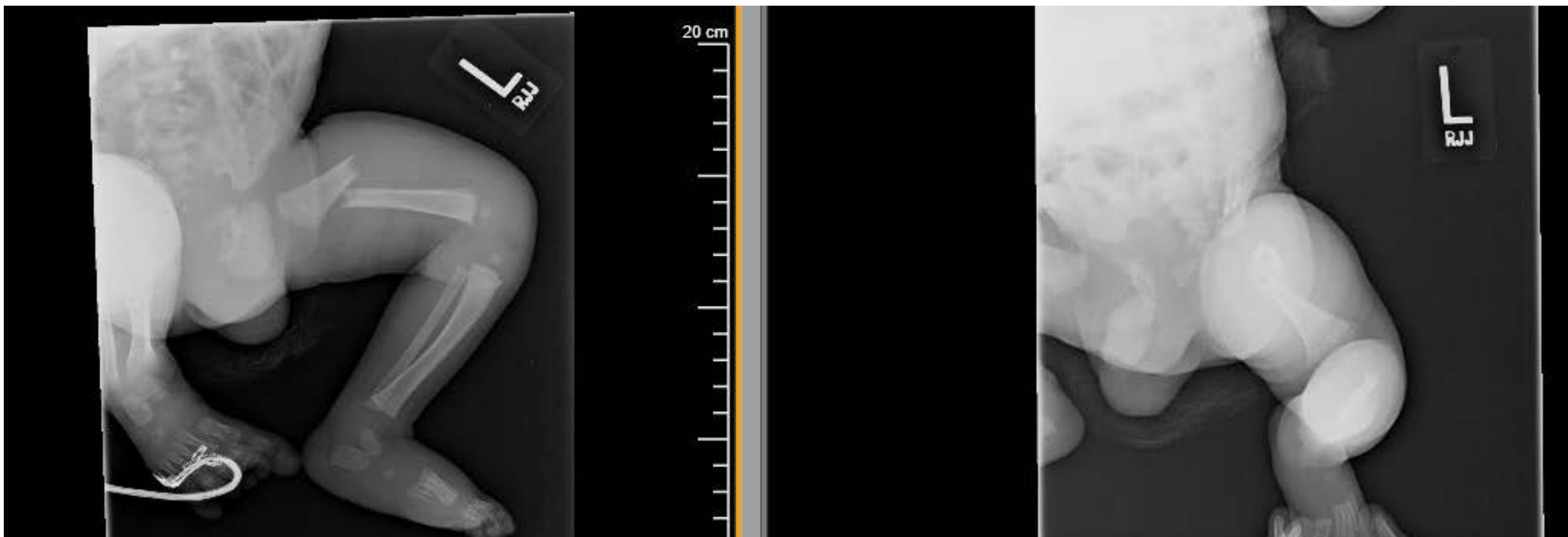
# Case Example

- ▶ 5 week old male presents with URI symptoms to his PCP on 2/15. Incidental finding of swelling and bruising of right digits 3 & 4
  - ▶ No trauma history provided, but he has been fussy
  - ▶ X-ray negative → referred to ortho
- ▶ Swelling of the left hand noted on 2/16 or 2/17
- ▶ 2/18 – presents to local ER with fever and URI symptoms
  - ▶ CXR negative
- ▶ Mom notes bleeding in the mouth on two separate occasions because he puts his hands in mouth

# Case Report

- ▶ 2/22 Dad states he was putting the child into a crib and dropped him. He grabbed him by his left leg to catch him.
- ▶ Family takes the child to a local ER where he is diagnosed with a left femur fracture
  - ▶ Transferred to CH

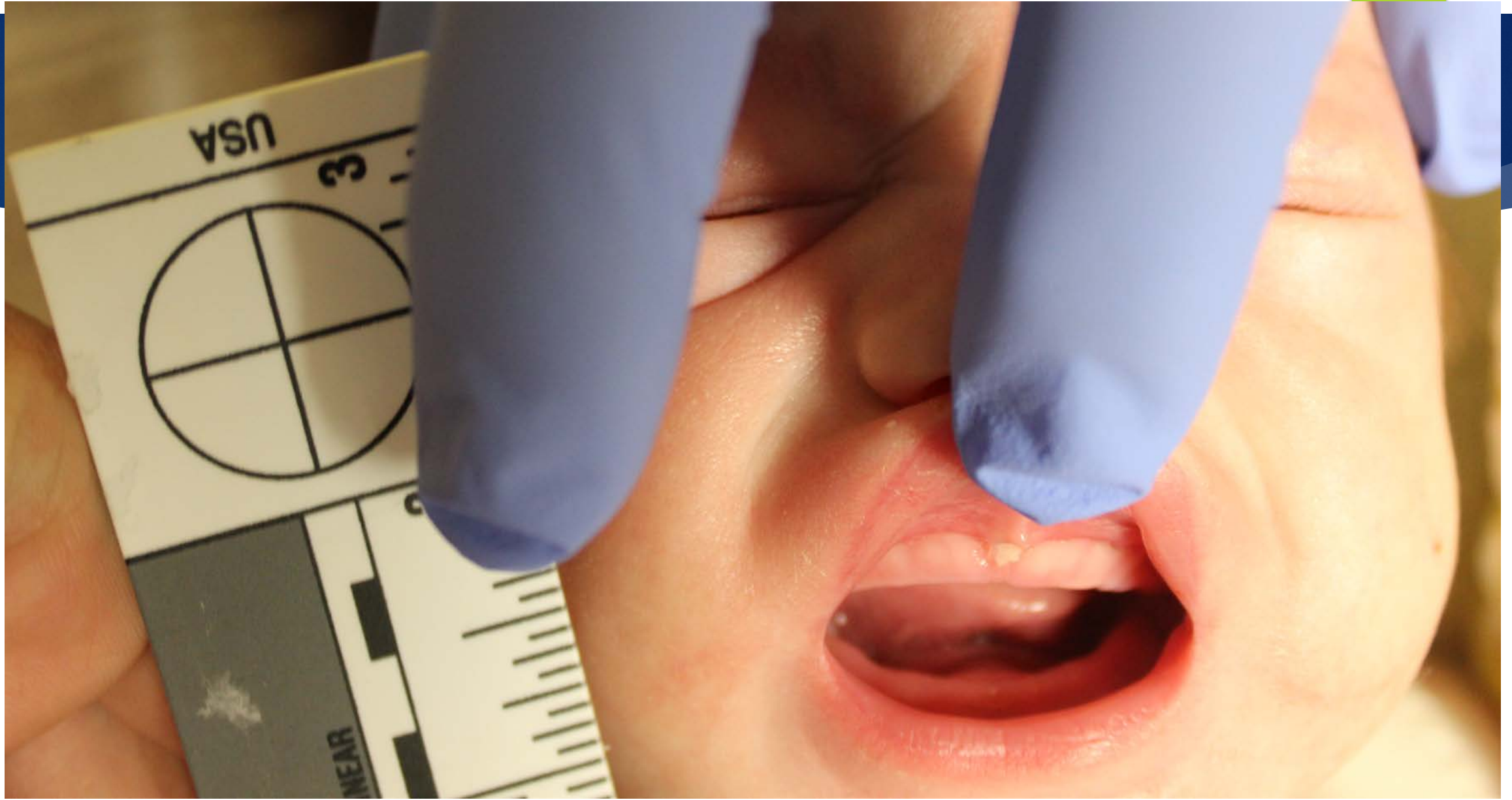
# Femur X-Rays From OSF

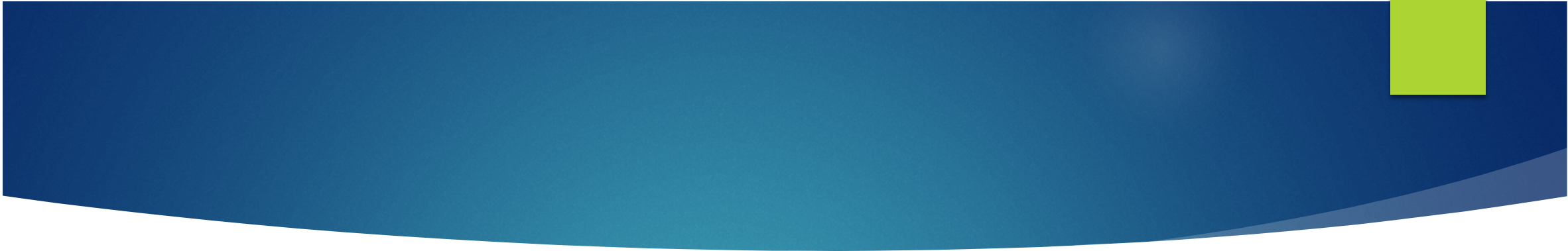


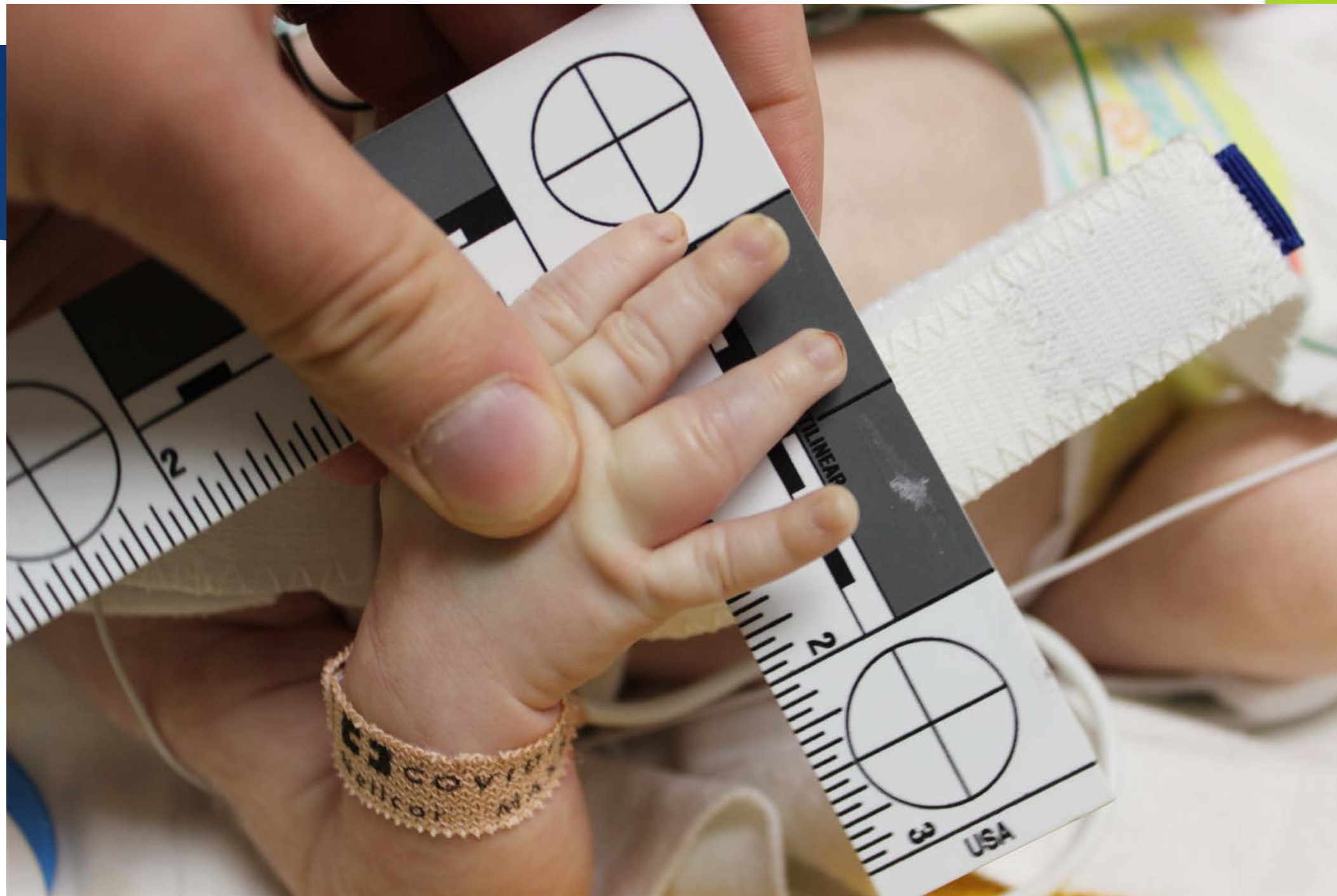


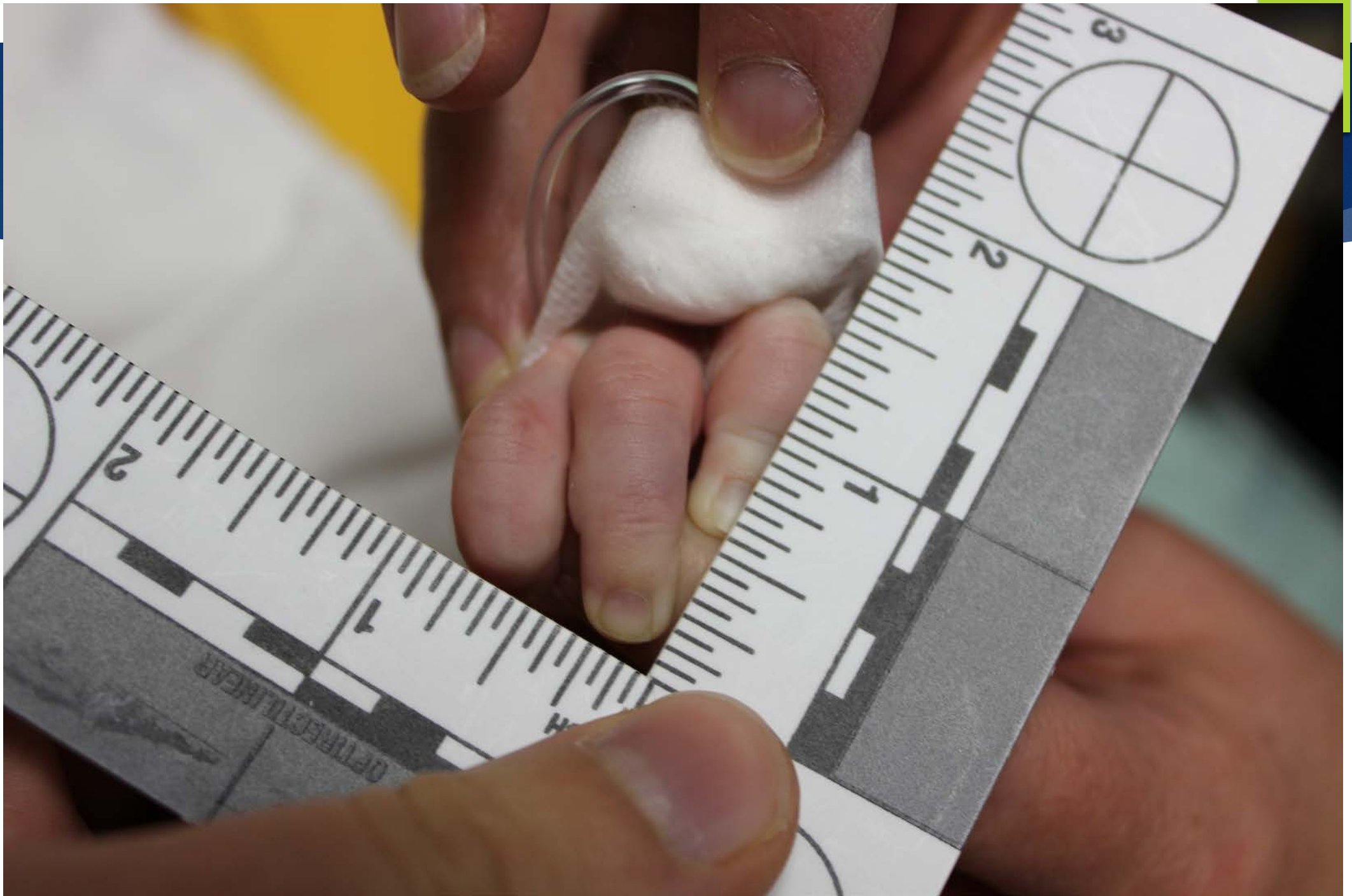
# Case Report

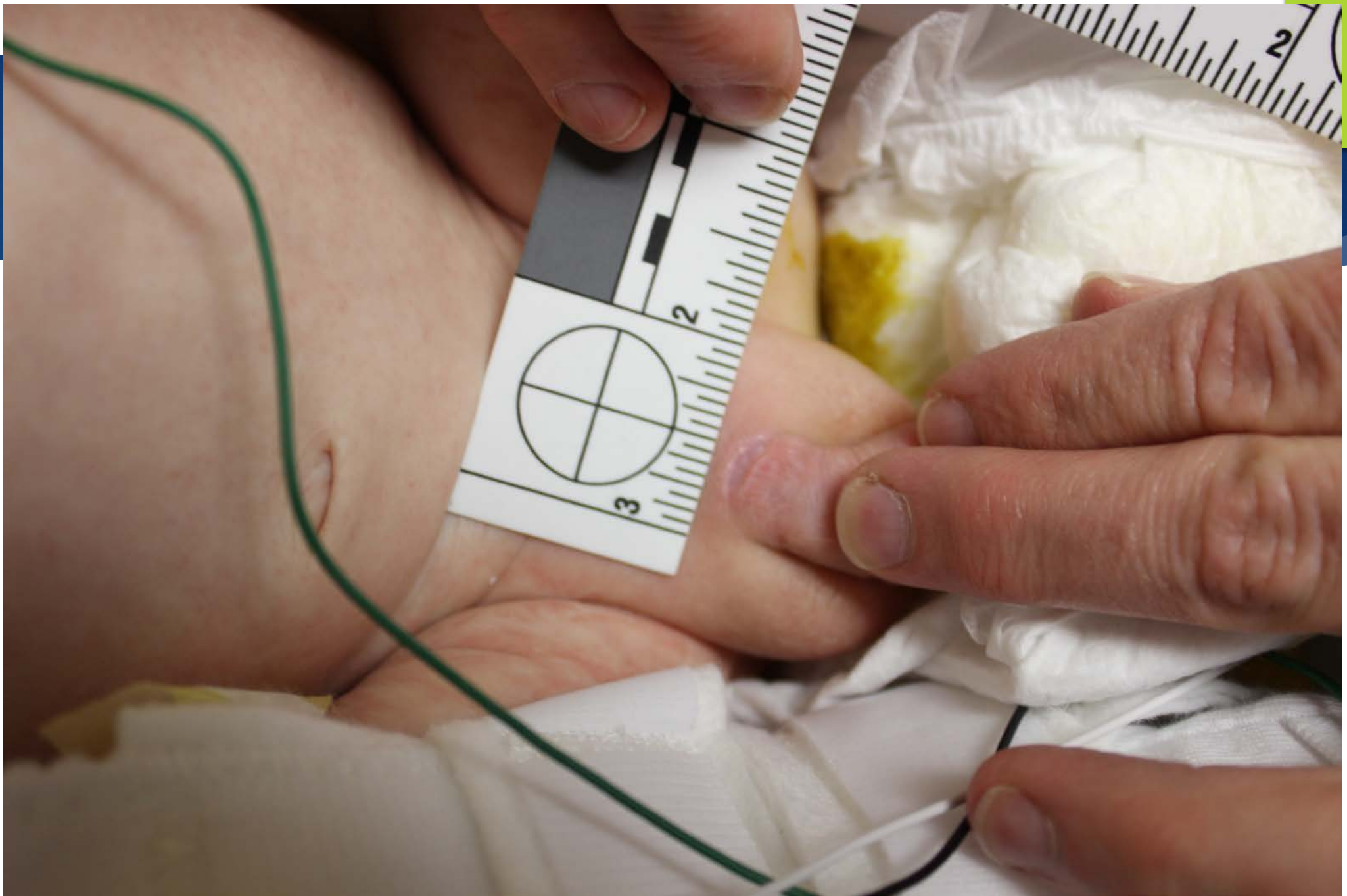
- ▶ Transferred to CH
  - ▶ Child Abuse Work Up
    - ▶ Skeletal Survey
    - ▶ HCT – negative
    - ▶ Trauma Labs
      - ▶ AST/ALT 161/137
      - ▶ WBCS 20K
      - ▶ Plts: 735K

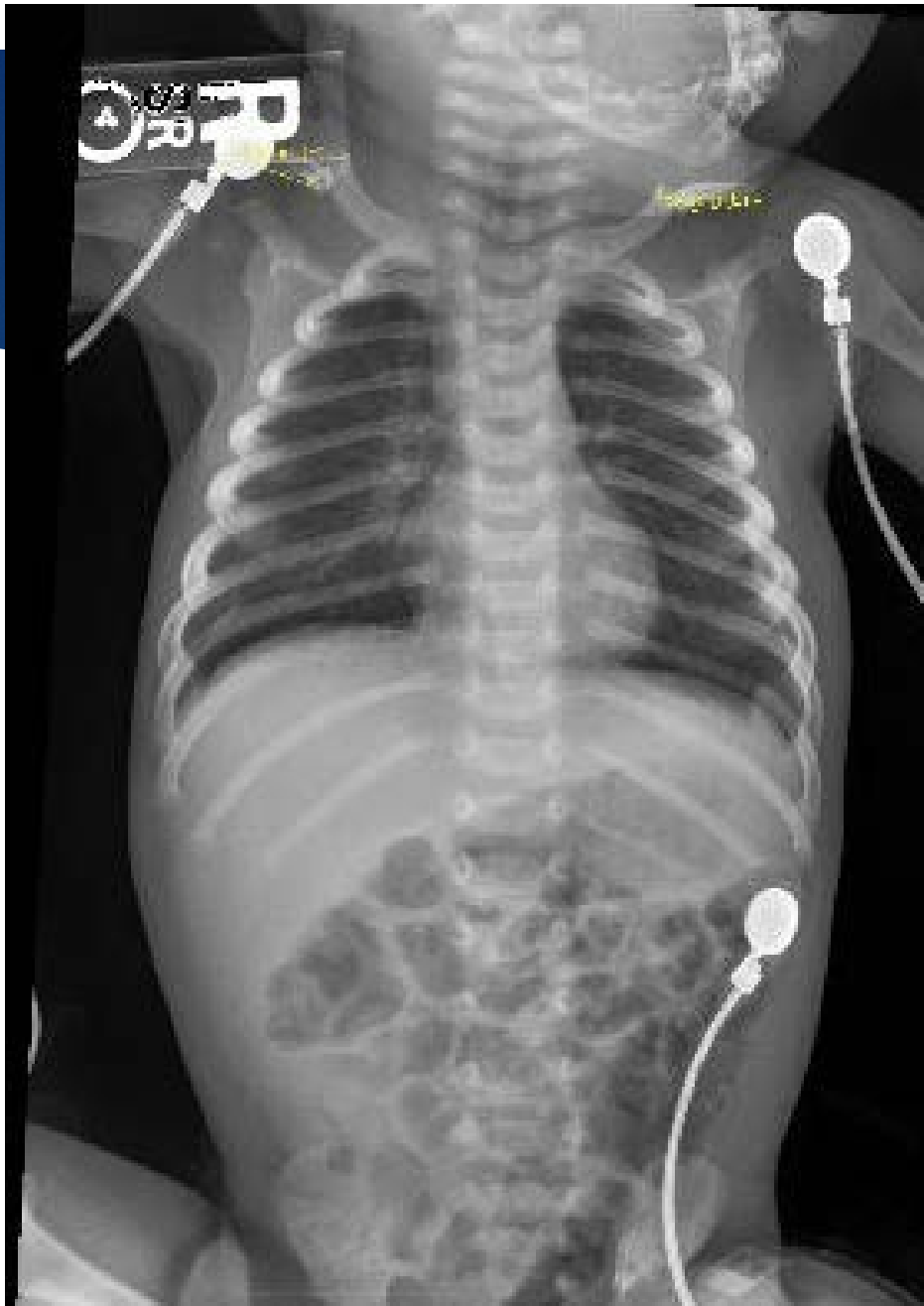


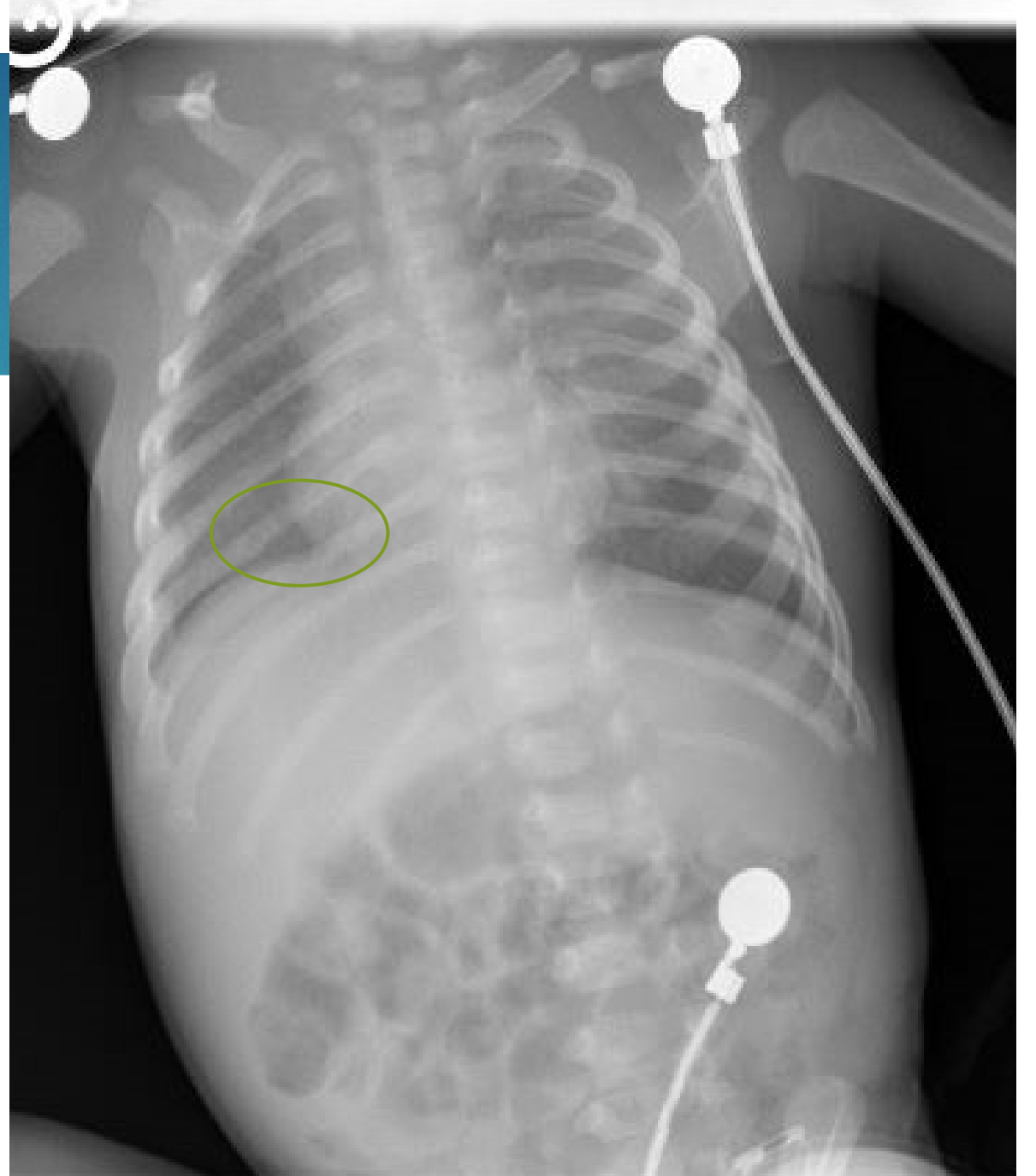
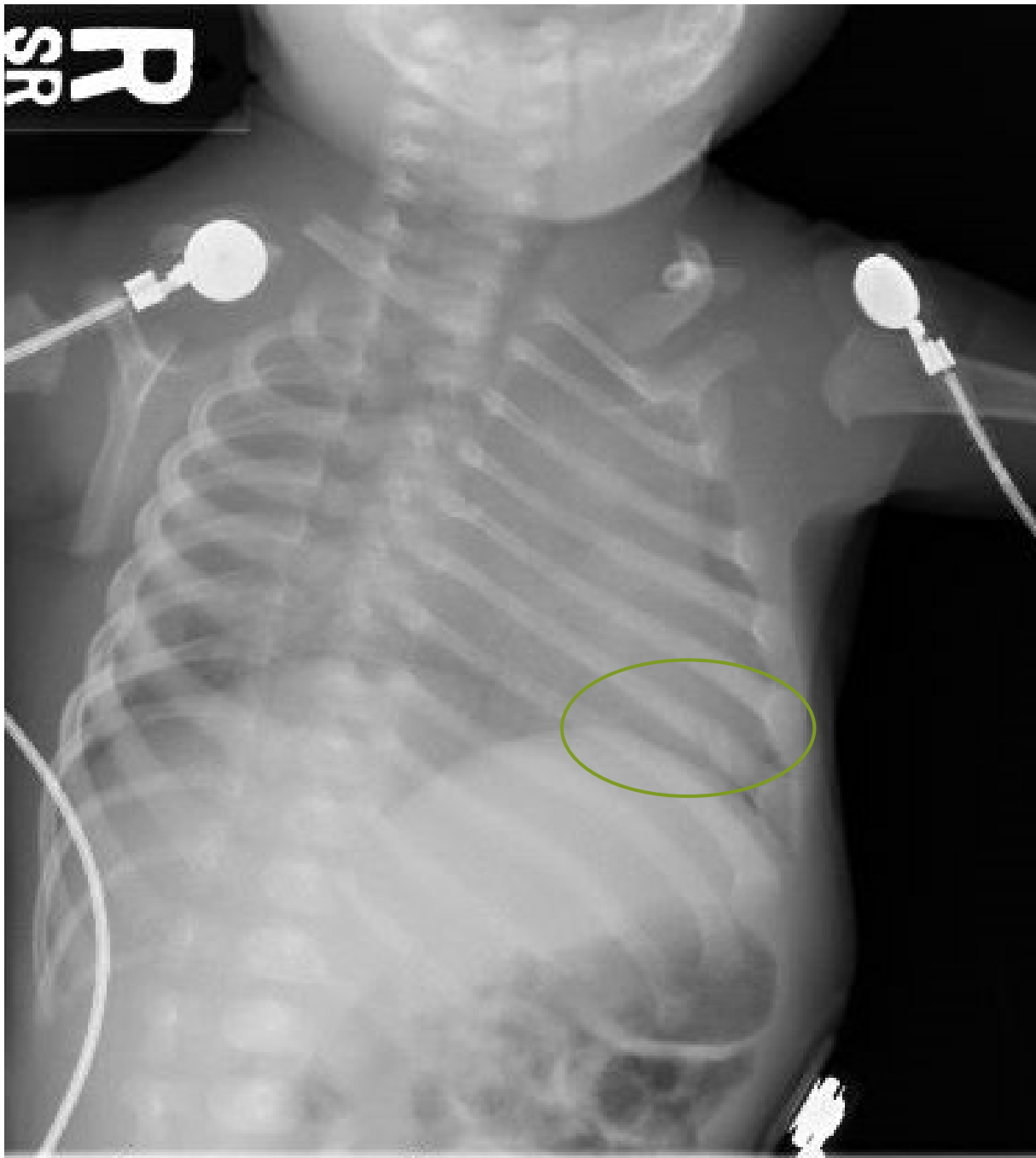














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# Case Report: Primary Skeletal Survey

- ▶ Fractures
  - ▶ Left clavicle
  - ▶ Right clavicle
  - ▶ Right 7<sup>th</sup> rib
  - ▶ Left 7<sup>th</sup> rib
  - ▶ Left femur mid diaphysis
  - ▶ Metaphyseal corner right femur

# Case Report

- ▶ Placed in a Pavlik Harness by Peds Ortho
- ▶ Discharged into a foster home
- ▶ Ongoing investigation with DHS and law enforcement
- ▶ Follow up skeletal survey and outpatient appointment at CAC

# Case Report: Follow Up Skeletal Survey

## ▶ Fractures: Right Side

- ▶ 5<sup>th</sup> Rib
- ▶ 6<sup>th</sup> Rib
- ▶ 7<sup>th</sup> Rib
- ▶ 9<sup>th</sup> Rib
- ▶ ? 10<sup>th</sup> and 12<sup>th</sup> Ribs
- ▶ Clavicle
- ▶ Femur
- ▶ Proximal Phalanx 2<sup>nd</sup> digit hand

## ▶ Fractures: Left Side

- ▶ 6<sup>th</sup> Rib
- ▶ 7<sup>th</sup> Rib
- ▶ 8<sup>th</sup> Rib
- ▶ 10<sup>th</sup> Rib
- ▶ 11<sup>th</sup> Rib
- ▶ Clavicle
- ▶ Femur
- ▶ 1<sup>st</sup> metatarsal bone
- ▶ Proximal Phalanx 3<sup>rd</sup> digit hand

# Sentinel Injuries

- ▶ “A sentinel injury was defined as 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

- ▶ What We Know?
- ▶ Why We Care?

# Potential Sentinel Injuries

- ▶ Must Be Visible to the Caregiver
  - ▶ Bruising
  - ▶ Intraoral Injury
  - ▶ Burns
  - ▶ Radial Head Subluxation
  - ▶ Subconjunctival Hemorrhages

Axiom

“ Kids that don't  
cruise, shouldn't  
bruise ”



Study	Age or Stage of Motor Development	% with Bruises
Robertson et al (1982) N=100	2wk-2mo 3-9mo	3.3 (included abrasions) 0.1
Mortimer and Freeman (1983) N= 620	<1y	0.9
Wedgwood (1990) N=24	Pre-cruisers	0
Carpenter (1999) N= 177	Pre-crawlers	3.9
Sugar et al (1999) N=930	Pre-cruisers 0-2mo 3-5mo 6-8mo	2.2 0.04 0.7 5.6
Labbe and Caouette N=1467	0-8mo	1.2
Kemp et al (2015) N=328	Premobile • Not rolling • Rolling	6.7 1.3 10.9

## Factors Affecting the Development and Appearance of a Bruise

Properties of the impacting object or surface

Force of impact

Duration of impact

Properties of the body region impacted:

- Vascularization of the tissue bed
- Tightness of the skin and connective tissue support
- Presence or absence of tissue planes
- Presence of underlying bone

Quantity of blood extravasated

Distance of hemorrhage below the surface of the skin

Age and health status of the injured individual including:

- Medications
- Statue of coagulation system
- State of the immunological system (required to breakdown extravasated blood)

Color of skin

Prior injury

# Bruises: Fact vs Fiction

Myth	Fact
Infants bruise easily	<ul style="list-style-type: none"><li>• Bruises are rare</li><li>• There is no evidence to support this</li></ul>
Different colored bruises are different ages	<ul style="list-style-type: none"><li>• Two bruises caused by a single event may be different colors and may change color at different rates</li></ul>
Presence of abrasions and/or swelling at the site of a bruise indicates it is acute	<ul style="list-style-type: none"><li>• Only assessed in one study, but not a reliable indicator of injury age</li></ul>
The age of bruises can be determined by color	<ul style="list-style-type: none"><li>• Extensive research documents that color is not a reliable way to determine the age of bruises</li><li>• Only consistent color indicator is that yellow has not been reported in bruises less than 18 hrs old</li></ul>

# Epidemiology

- ▶ Sentinel Injury Prevalence: Unknown
  - ▶ Caregivers may not seek medical attention for the injuries
  - ▶ Medical professionals may not document perceived minor injuries
- ▶ Seminal Study → Sheets
  - ▶ 27.5% of child evaluated by a hospital CPT with a diagnosis of PAB had a previous history of a sentinel injury described by a parent
  - ▶ None of the children with low or no concern for child abuse had a history of a sentinel injury
- ▶ Further studies demonstrated similar associations

# Epidemiology

- ▶ Infants
  - ▶ Highest rates of maltreatment
    - ▶ 24.2 per 1,000 infants
    - ▶ 9.2 per 1,000 children
- ▶ Risk Factors
  - ▶ Crying peaks in early infancy → Trigger
  - ▶ Young parental age
  - ▶ Mental Health Disorders
  - ▶ Substance Abuse Disorders
  - ▶ Low Socioeconomic Status
  - ▶ Domestic Violence



Say It Louder For People In The Back...

**CHILD ABUSE HAPPENS IN  
ALL GEOGRAPHIC,  
ETHNIC, AND  
SOCIOECONOMIC  
SETTINGS**

# Clinical Presentation

- ▶ Identified during medical history OR incidental exam finding
- ▶ Full Skin Exam
- ▶ Bruising is the most common presentation for child physical abuse and sentinel injuries

# History

- ▶ Complete History:
  - ▶ Bruising
  - ▶ “Red spots” of the whites of the eyes
  - ▶ Bleeding from the nose or mouth
- ▶ Injury timeline, presentation, and any known associated trauma
- ▶ Complete medical, birth, family, developmental, and social history



# Development Milestones...In Brief

- ▶ 2 Months: Head Up 45°
- ▶ 4 Months: Roll Over and Sit with Support
- ▶ 6 Months: Sit Without Support
- ▶ 9 Months: Cruise
- ▶ 12 Months: Walk



# Red Flags

- ▶ Changing history
- ▶ Lack of a plausible history
- ▶ Inappropriate delay in seeking care
- ▶ History that is inconsistent with the developmental level
- ▶ History that is inconsistent with the injury severity

# Common Suspicious Histories for Bruising

- ▶ Unknown or No History
- ▶ Easy Bruising or Bleeding
- ▶ Normal Care and Handling
- ▶ Short Household Falls
- ▶ Inflicted By Another Child or Pet
- ▶ Self-Inflicted Injury

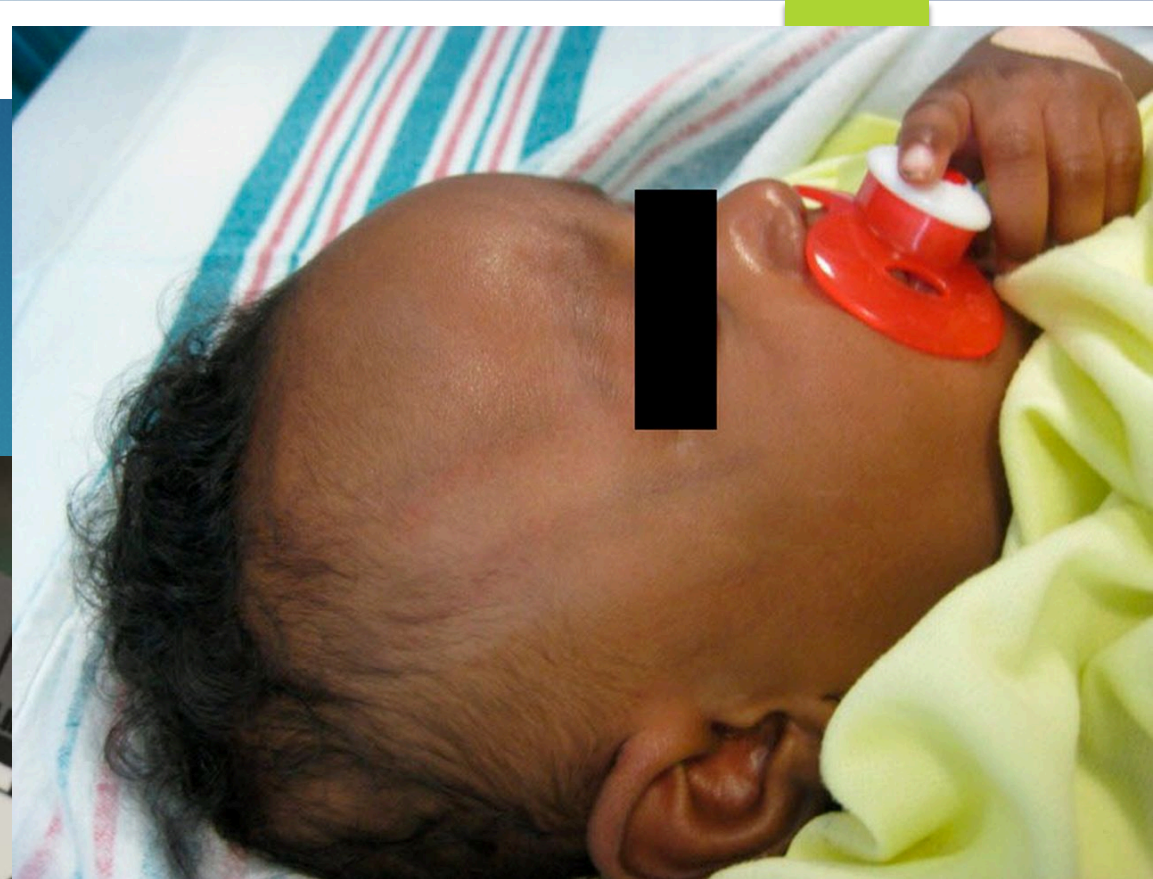
# Examination

- ▶ Full Skin Exam
- ▶ Special Attention
  - ▶ Intraoral exam
  - ▶ Pinna
  - ▶ Scalp
  - ▶ Anogenital
  - ▶ Hands
  - ▶ Feet
- ▶ Document and Photograph if Possible



# Cutaneous Medical Mimics

- ▶ Hemangiomas
- ▶ Dermal Melanosis
- ▶ Nevus of Ota
- ▶ Nevus of Ito
- ▶ Incontinentia Pigmenti
- ▶ Urticaria Pigmentosa
- ▶ Erythema Multiforme
- ▶ Allergic Contact Dermatitis
- ▶ Panniculitis
- ▶ Coining/Spooning
- ▶ Cupping
- ▶ Phytophotodermatitis
- ▶ Beloque Dermatitis
- ▶ Topical Application of Chemicals
- ▶ Ink/Dye Staining
- ▶ Henoch Schonlein Purpura
- ▶ Ehlers Danlos Syndrome
- ▶ Striae Disease
- ▶ Coagulation Disorder
- ▶ Hemophilia
- ▶ Von Willebrand Disease
- ▶ Vitamin K Deficiency
- ▶ Platelet Disorders
- ▶ Hemolytic Uremic Syndrome
- ▶ Meningitis and DIC
- ▶ Neuroblastoma
- ▶ ALL
- ▶ Maculae Cerulae
- ▶ Valsalva Effect
- ▶ Trauma: Accidental vs Iatrogenic



# Subconjunctival Hemorrhages

- ▶ Concern for asphyxiation or a direct blow
  - ▶ Substantia propria is robust in children
    - ▶ Straining with constipation, coughing or vomiting are NOT common with a young infant, even with coagulopathy
  - ▶ Child Abuse Mimics
    - ▶ Birth Trauma
    - ▶ Pertussis



<http://champprogram.com/question/3a.shtml>



# Intraoral Injuries

- ▶ Intraoral injuries are not consistent with routine care and handling





# Management

- ▶ Head CT or MRI in infants <6 months or abnormal neurological exam
  - ▶ Dilated eye exam if imaging is abnormal
  - ▶ No clinical place for head ultrasound
- ▶ Initial skeletal survey for children younger than 2 years old with a follow up skeletal survey in 2 weeks.
- ▶ Lab studies for abdominal injury
  - ▶ AST/ALT Greater than 80 → Abdominal CT
- ▶ Mandatory Reporting
- ▶ May evaluate for mimics, but should not delay the work up

# Abusive Head Trauma

- ▶ 1972 Dr. Caffey Describes “Shaken Baby Syndrome”
  - ▶ Intracranial and intraocular bleeding with no external signs of injury caused by vigorous shaking of infants

# Epidemiology

- ▶ Prevalence
  - ▶ Unknown
- ▶ Typically more severe cases are identified
  - ▶ 14-30/100,000 depending on the study
- ▶ Median Age of Victims
  - ▶ 2.2-5.9 months

# Epidemiology

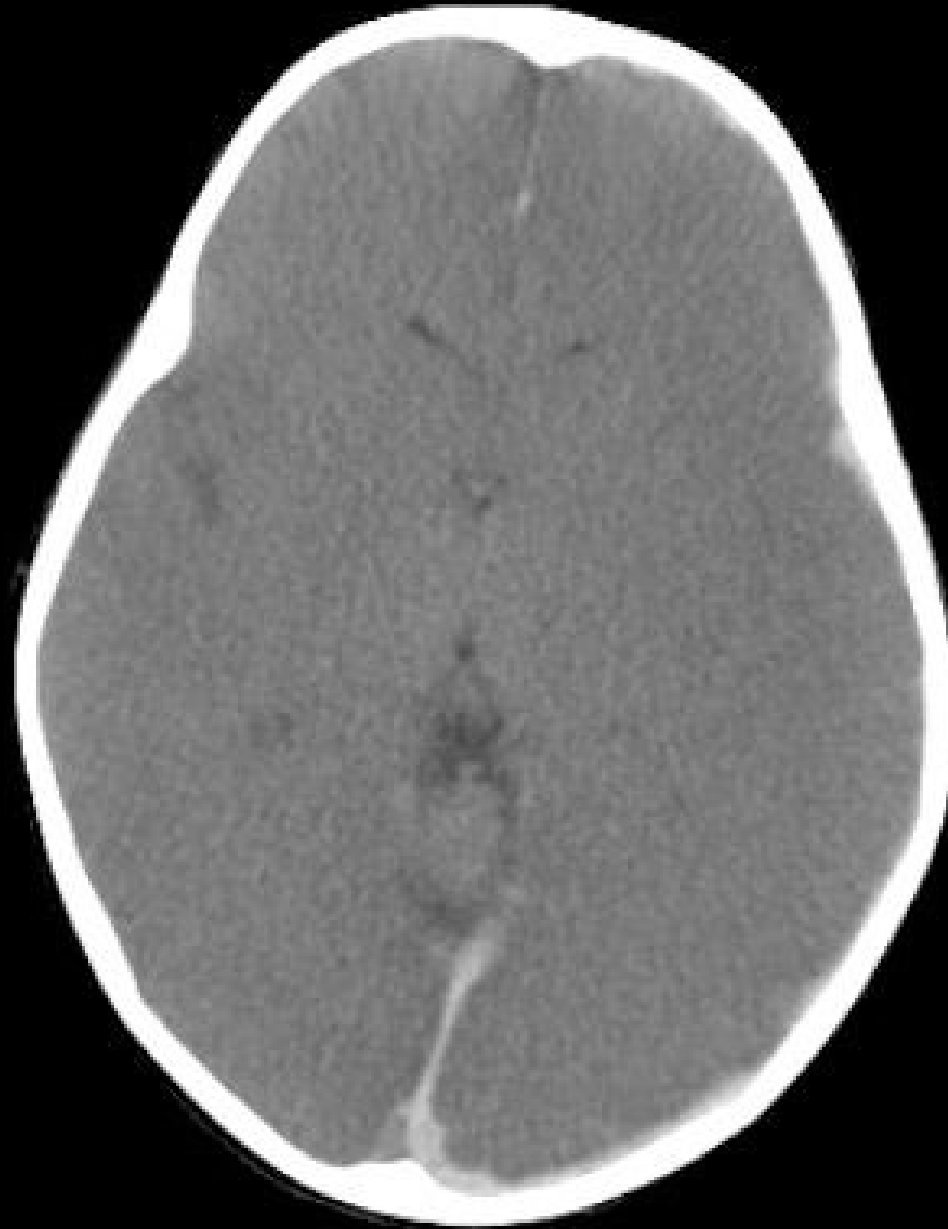
- ▶ Phone Survey By Zolotar et al
  - ▶ 1% of mothers in North Carolina with children less than 2 yo shake their children
- ▶ 31% of children had seen a physician with symptoms concerning for head trauma and the diagnosis was missed before AHT was diagnosed

# Clinical presentation

▶ Range of Symptoms





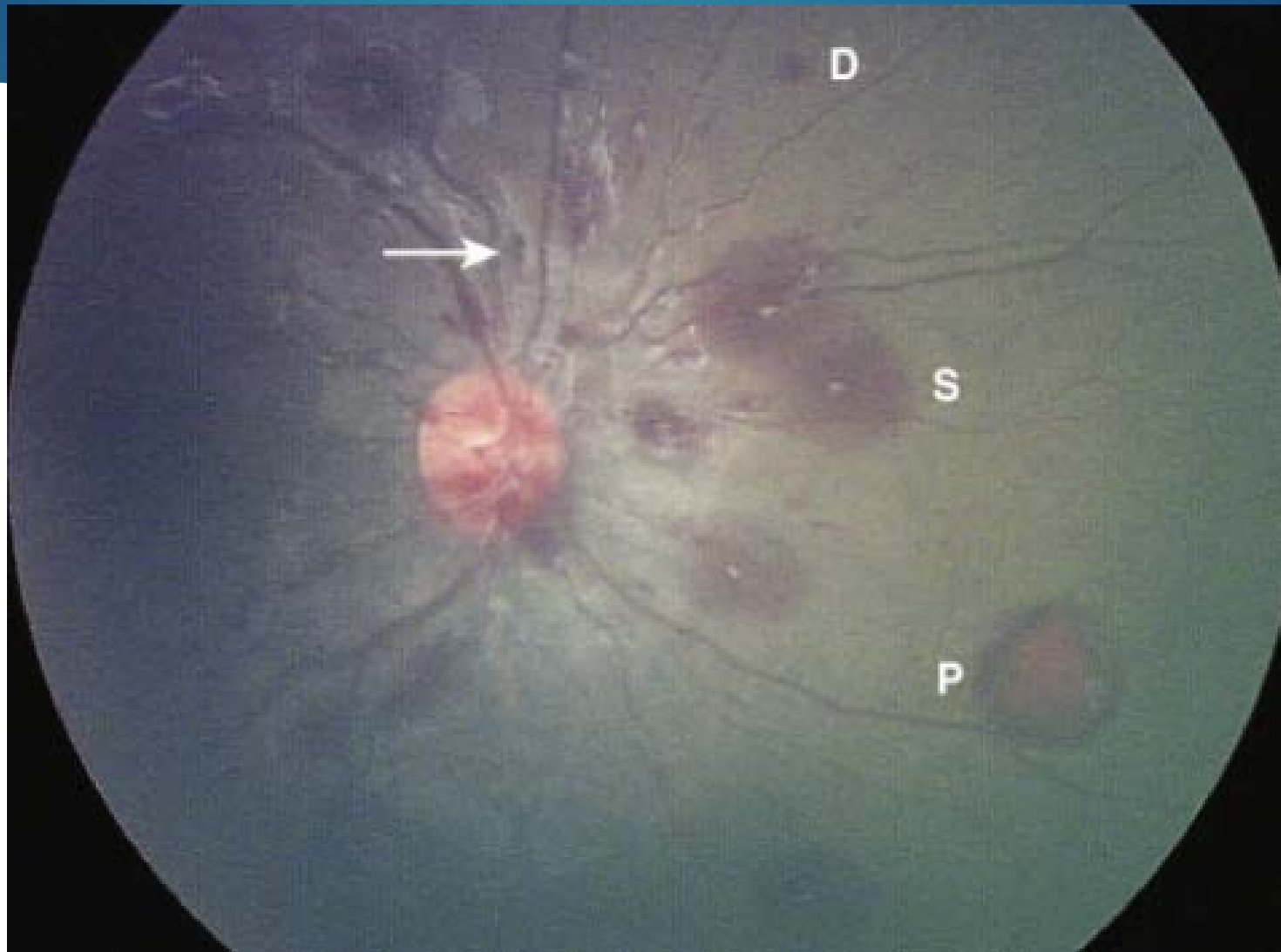


# Retinal Hemorrhages

- ▶ May be associated with AHT
  - ▶ Unilateral vs bilateral
  - ▶ Size and distribution may vary
  - ▶ Classic: Extensive multilayer RH, TNTC, extending to the ora serrata
    - ▶ High Specificity
    - ▶ Vitreoretinal traction
- ▶ Diagnostic Evaluation



# Retinal Hemorrhages



# Associated Signs/Symptoms

- ▶ Retinal Hemorrhages
- ▶ Long Bone Fractures
- ▶ Rib Fractures
- ▶ Bruising
- ▶ Seizures
- ▶ Apnea
- ▶ Other
  - ▶ Skull Fracture
  - ▶ Subgaleal Hematoma
  - ▶ Abdominal Injury
  - ▶ Oropharyngeal Injury

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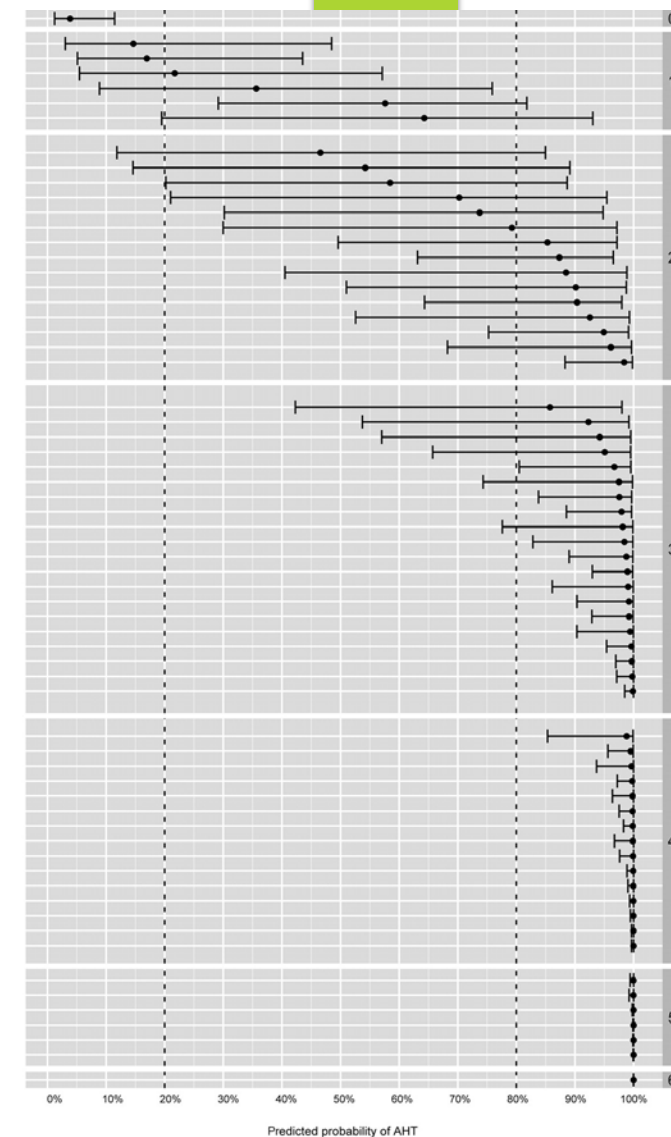
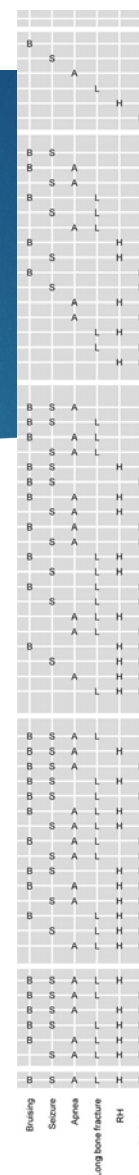
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Article

## Estimating the Probability of Abusive Head Trauma: A Pooled Analysis

Sabine Ann Maguire, Alison Mary Kemp, Rebecca Caroline Lumb and Daniel Mark Farewell

Pediatrics September 2011, 128 (3) e550-e564; DOI: <https://doi.org/10.1542/peds.2010-2949>



# Abdominal Injuries

- ▶ Second most common cause of death after AHT
  - ▶ Mortality rate of 40-50%
- ▶ Bowel injury is more common with abusive injuries than accidental
  - ▶ Small bowel injuries associated with abuse
  - ▶ Colonic injuries associated with accidental injuries
- ▶ Majority present with no history; presenting with abdominal pain, vomiting (potentially bilious), distension, nonspecific crying and fussiness
  - ▶ Most commonly injured structures include:
    - ▶ Small Bowel (typically duodenum and proximal jejunum)
    - ▶ Left Lobe of the Liver
    - ▶ Pancreas

# Other Considerations

- ▶ Siblings of index child should be evaluated and/or forensically interviewed
  - ▶ Siblings under 2 years old → consider skeletal survey
  - ▶ All preverbal children need a full exam
- ▶ Multiples at highest risk

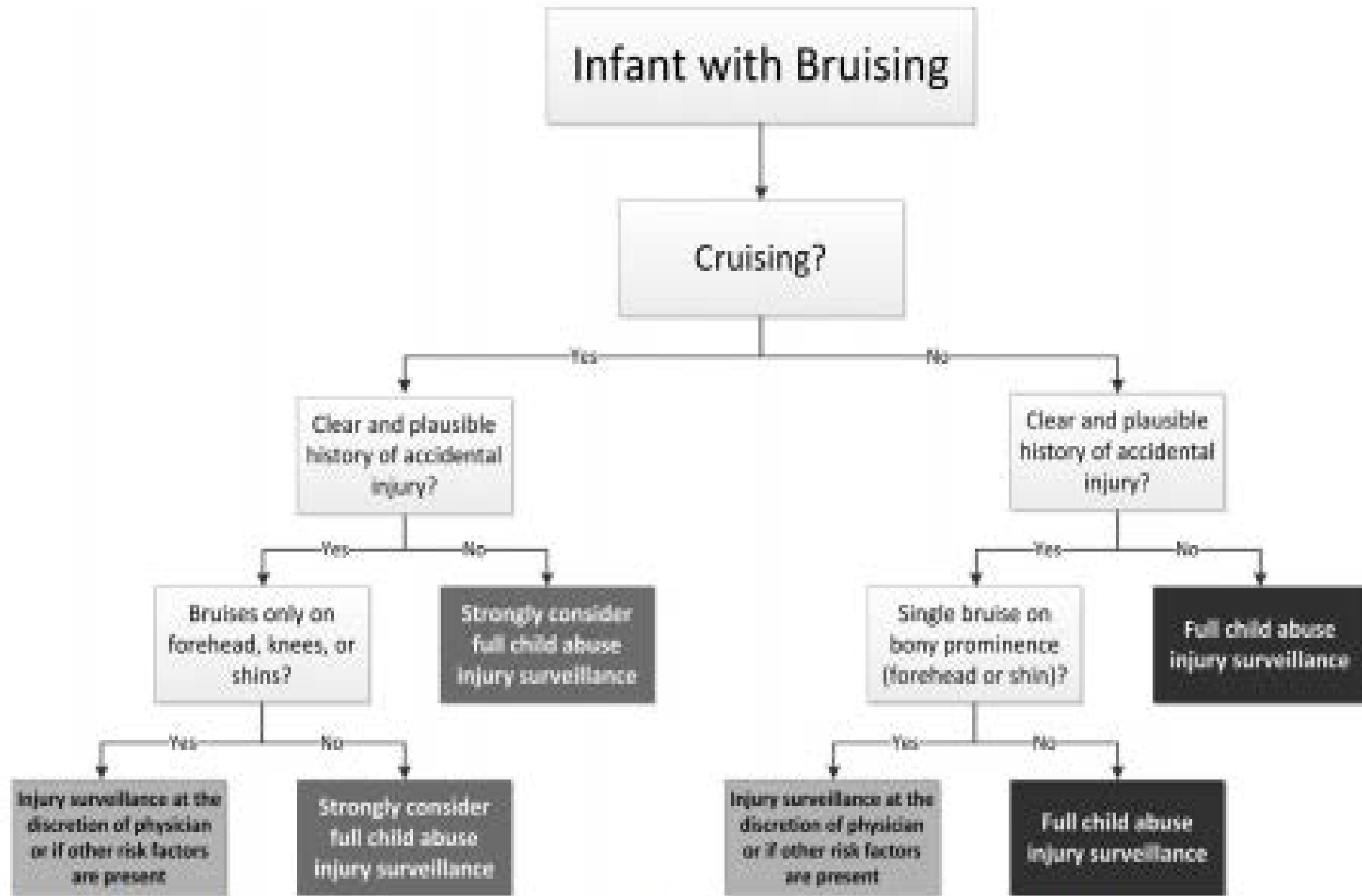


Fig. 10. Algorithm to guide management of a precruising infant with bruising.

# Warning Shot Across The Bow

- ▶ The Chance To Save A Child's Life

# References

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