Dangerous Homes? What injuries should make you worry about abuse after household “accidents”

Learning Objectives

• When a household fall is offered as an explanation for an injury, list reasons to suspect abuse based upon the story and the injury
• Describe what injuries are expected in various household fall scenarios

Outline

• Perspective of falls
  – What are short household falls
  – Developmental Perspective
• Expected injuries in household falls involving pre-mobile infants
• Expected injuries in household falls involving mobile infants and toddlers
• Key points
Key Points
- Serious injuries result from severe forces
- Serious injury resulting from household fall forces deserve special attention
- Short household falls are usually benign
- Falls are the most common true and false histories when children are injured
- Skull fractures can result from short household falls or abuse; delay in seeking care is usually seen in both!
- Teamwork between investigators and medical is critical!

Distance of a “Short Fall”
- Researchers have used a wide spectrum of distances
- This presentation focuses on household falls which usually are < 4 feet
- Distance – of the head? Of the body? Of the feet? No standard approach.
- Since the head is most often injured, fall distance usually means the distance that the head fell!

Accident or Not?
- Falls are the most common true history to explain injuries in infants/young children
- Falls are the most common false history to explain injuries in infants/young children
- A clear history of a fall does not distinguish between accidental and abusive injuries!
Considerations

• How do we know if the injury is abuse or accident (or something else)?
• History – is the injury EXPECTED given the story?
• Severe injuries result from severe forces. Are the injuries EXPECTED?
• Developmentally, could the child do what is described?
• Are there occult (hidden) injuries or a history of sentinel injury (bruise or other “trivial” injury before the infant could pull to a stand and take steps)?

Accident or Abuse?

• Science – many research articles have been published on this topic
• Experience – unintentional injury (commonly called “accidents”) is often witnessed
• Expected injuries from unintentional events are well-understood

Falls

• Developmental perspective of falls
  – Infancy
    • Pre-mobile 0-7 months of age
    • Mobile 7-12 months of age
  – Toddlers
  – Preschoolers
  – School age children
  
  Focus of today

  Not the focus
Young Pre-Mobile Infants

- Pre-mobile infants (not yet cruising)
  - Falls off of elevated surfaces such as couch, bed, changing table
  - Falls from arms of caregivers
  - Falls in arms of falling caregivers
  - Falls in baby equipment
  - Rarely injured by a sibling
  - Unusual – dropped by caregiver (common false history)

Gross Motor Development

Child Development Resource

- **Milestone Moments**
- Publication of the CDC and the AAP to help parents and others detect developmental delays
Fall From Sofa or Bed

- Expected Injury
  - No injury - majority
  - Soft tissue swelling on the forehead (goose egg)
  - Bruise on forehead
  - Rarely a skull fracture
  - Very rarely a compression fracture of the femur if the infant lands on knee (rare injury in very heavy infants)

Falls in Well Children

- 2001 Warrington – Survey of parents < 6 mo
  - Most kids who fall don’t seek care
  - The only serious injuries resulted from serious accidents
- Haney et al. Survey study of well children < 5 y/o (Pediatr Emer Care 2010;26:914-918)
  - 19.6% of children had a fall by 6 months of age per parent report
  - Only 5% of the children had any injury beyond swelling or a bruise. There were no serious injuries
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Definition of Sentinel Injury

• Sentinel injury –
  – Visible/detectable injury in a pre-cruising infant detected by a parent and suspicious for abuse
• Example: 6-month old infant with abusive head trauma
  – healing rib fractures (not sentinel injuries)
  – history of an unexplained cheek bruise at 2 months of age

Summary of Findings

• Sentinel injuries preceded more severe abuse in 27.5% of abused infants
• Medical providers were reportedly aware of the sentinel injury in 42% of cases
• “Prevention window” between sentinel injury and more severe abuse ranged from 1 day to 7.3 months
• Apparently trivial injuries (other than a scratch) in young infants should raise a concern about abuse
Isolated Bruising – Is It Abuse?

- Isolated bruising in pre-cruising infants evaluated for abuse
  - < 6 months old evaluated for abuse
  - 50% have other serious injury identified on skeletal survey, neuroimaging or abdominal injury screening
  - 70% were screened for bleeding disorders and none identified
  - Always consider alternative hypotheses to abuse!
  - Bruising can be the first injury from abuse!
  - Remember that the lack of other injuries on skeletal survey and other tests does not rule out abuse!


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Skull Fractures: Expect Delay in Seeking Care

- Unlike most serious injuries, skull fractures often present several days after the fall
- Child cries but then is fine after the fall
- Several days later (often during a bath) a “boggy” or “squishy” area on the head is noted
- Care is sought
Skull Fractures

• Simple:
  – Linear
  – Parietal (side of head)
  – Accidental or abuse

Point of impact
Fracture
Origin of fracture line

Blue area is In-bended skull.

Modified from Carole Jenny, MD

Unexpected Skull Fractures

• Complex (everything except simple):
  – Depressed
  – Diastatic
  – Comminuted
  – Stellate or branching
  – Multiple

• Front and back of skull (Occipital and frontal) require more force than the side. Unusual in short falls

Modified from Carole Jenny, MD
Fractures: Specificity for abuse*

• **High Specificity:**
  - Classic Metaphyseal Lesion (CML) - commonly called "bucket handle or corner fractures"
  - Rib - especially posterior
  - Scapula (shoulder blade)
  - Sternum (breast bone)

• **Moderate Specificity:**
  - Vertebral body
  - Digits
  - Complex skull fx

• **Low Specificity:**
  - Clavicle (collar bone)
  - Long bone shaft
  - Linear skull fx
  - Supracondylar fracture

* All can be caused by abuse even if the specificity is low!

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What does specificity mean?

• Nothing when confronted with an individual case
• Low specificity = Most are not caused by abuse but there is no way to apply this to an individual patient
• High specificity fractures = rarely seen in settings other than abuse
• However, even specific fractures can rarely occur from "accidents"

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Fracture Specificity

• Interesting
• Not useful in individual cases
• Details of fall are critical in determining if injuries are consistent
• Multi-disciplinary team response is often critical to making the determination
• Re-consult medical if new history or details emerge – need medical input to determine if injury is explained
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Rare – femur fracture from short fall

- The only long bone fracture that is rarely seen, but not unexpected, in infant falls from sofa or bed
- Must have high suspicion of abuse when a long bone fracture reportedly resulted from bed/sofa fall

Axial Loading (Compression forces)

- Fall onto the knee
- Compressive force along the length of the femur
- Causes buckling of the metaphysis
- Buckle or torus fracture

2009 Haney Pediatr Emerg Care 25(12):841
INVESTIGATORS PLAY A KEY ROLE

A little more information about fractures (broken bones)

Symptoms of Long Bone Fxs

- Swelling to extremity
- Pain to extremity
- Decreased movement
- Often no bruising
- General fussiness
- No symptoms – rare!

Bruising and Fractures

- Short household falls can result in a bruise, particularly over a bony prominence
- Short household falls can result in a fracture (broken bone) rarely
- The presence or absence of bruising does not help differentiate accident from abuse. 25% of fractures in either case are associated with bruising
Higher force falls

- Falls from caregiver arms, changing table, kitchen counter, table
- Long bone fractures still rare
- Young children tend to injure the head
- Fall onto the top of the head (vertex) can result in bilateral skull fractures!

Summary: Short Falls & Skull Fractures

- Uncommon but not unexpected
- Even a fall from a sofa onto a carpeted floor can result in a skull fracture
- Simple, linear, parietal (side of head) – but these are also seen in abuse
- Complex fractures are unexpected – crossing suture line, depressed, comminuted (bone chips)

Depressed Skull Fractures: Get the details!

- Depressed skull fractures can rarely result from unusual accidental falls
- Require much more force than typical household falls
- But... Striking the edge/corner of an object “concentrates” the forces
Case Examples

• Case involving the fall onto the corner of the table
• Case involving the fall onto the wrought iron table leg (in salon)

FALLS FROM CAREGIVER ARMS

Stair falls in caregiver arms

• Considered complex falls
• Injury is more likely in complex falls
• However, such falls are commonly provided as false history in child abuse cases
• Lower extremity fractures can occur (buckle most common followed by spiral)

Child abuse was not considered in all cases:
Pennock et al. J Child Orthop. 2014;8:77
Mobility of infant can result in higher force falls which are more likely to result in bruising and sometimes fracture.

FALLS INVOLVING MOBILE CHILDREN

Mobility = Injury

- Mobile infants/toddlers
  - Falls from standing/crawling height
  - Falls from elevated surfaces
- Complex Falls
  - Falls down stairs
  - Falls in arms of falling caregivers
  - Falls in baby equipment

WHEN MOBILE CHILDREN FALL
Expected Injuries – Falls from Standing Height – Walk or Run

- Usually no injury
- Bruise – primarily over bony prominences
- Fall onto outstretched hand (FOOSH) – buckle fractures of radius, ulna; clavicle
- Slip/trip and fall – sometimes a toddler fracture or rarely < 3 y/o a femur fracture
- Fall onto elbow – supracondylar fracture
- History is the key! All can be either from abusive or accidental means!

Location of Bruises

- Toddlers/preschoolers fall a lot!
- Usually no bruise
- If bruising – over bony prominences (forehead, knees, shins)
- Be very suspicious if most bruises are on the face or on soft parts of the body!
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**Falls - The Story**

- Detailed enough that you could re-create it
- How far, in what position, onto what surface
- How did the child behave before and after the incident
- Developmentally, what could the child do before the incident?
- What symptoms would be expected given the injury? Did the child display these symptoms?
- What did the caregiver do after the incident? To help or to resuscitate?
- Who witnessed the incident?

**Kirschner’s “Dirty Dozen”**

- Sibling blamed for injury
- Incident happened when alone with mother’s boyfriend
- Help is first sought from a relative or neighbor
SEVERE HEAD INJURIES IN SHORT HOUSEHOLD FALLS?

Witnessed Short Falls

- 5 studies*
- Total of 802 children with witnessed short falls
  - Most occurring in hospital
  - From bed, chair, crib, parents' arms
- 8 skull fractures (< 1%)
- No neurological abnormalities or deaths


Subdural hemorrhages from short falls are...

- Unusual
- Usually small and at site of impact
- Usually do not cause symptoms
- More severe injuries are usually associated with greater heights, a fall backwards onto the occiput or more complicated fall (such as a fall in baby equipment)
Falls: Summary and Conclusions

• Short falls (<5 ft) can uncommonly cause cranial injuries
  – Skull fractures most commonly
  – Epidural hemorrhage
  – Subarachnoid hemorrhage
  – Localized subdural hemorrhage
• Brain injury beyond a concussion are rare
• Injuries are often clinically silent or minimally symptomatic, resolve without long-term problems
• Short falls are rarely lethal
  – Frequency of ~0.5 per million
  – Most are from expanding mass lesions (large, surgical EDH, SDH)

Complex falls – falls with caregivers or baby equipment

COMPLEX FALLS = INCREASED RISK OF INJURY

Complex Falls – Increased Risk

• Tend to be more severe
• Includes:
  – Fall in baby equipment
  – Fall of caregiver and infant
  – Caregiver or furniture falls onto infant
• Falls in baby equipment
  – Additional weight/inertia of the object
  – Injuries tend to be worse when infant not strapped into equipment
HIGHER FORCE FALLS AND MOBILE CHILDREN

Falls Down Stairs
- One big fall then a series of short falls
- Many are not injured
- Head/neck is most common body location of injury
- Rarely more than one body region injured
- Rarely any injury to the trunk; no visceral injury
- Serious injury is unexpected

Studies did not systematically evaluate/screen for abuse:
Svanstrom Scand J Soc Med. 1974;2:113
Joffe and Ludwig Pediatrics. 1988;82:457

Falls from Bunk Beds
- National Electronic Injury Surveillance System database study
- Typical age 4 y/o
- Head and face most common site of injury. Visceral (abdominal organ) injury is not expected
- Rarely fatal unless there is a mass-effect intracranial hemorrhage

2008 D'Souza – Pediatrics;121:e1696
Other Complex Falls

• Falls from shopping carts:
• Falls in walkers:
  – Reider Pediatr (1986;78:488)
• Playground falls
• Bathtub falls

Falls - Straddle

• Common injury in boys and girls
• May present with bruising and/or bleeding
• Usually in children out of diapers; usually child can report what happened
• There should be a clear history
• Hymenal/vaginal injury is unexpected unless fall is onto a pointed object

Accidental Genital Injury

• More likely to be anterior (front part of the genitals)
• Tend to be external
• In boys, consider zippers and toilet seats as culprits (should have clear history)
Key Points

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- Falls are the most common true and false histories when children are injured
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- Teamwork between investigators and medical is critical!

References

- Kurinsky RM et al. Pediatric injuries associated with fall and nonaccidental trauma: Does injury pattern correlate with mechanism? Pediatrics 2001 Sep; 155: 1008-1014
- Hettler J, Greenes DS. Can the initial history predict whether a child with a head injury has been abused? Pediatrics. 2003;112: e683-687.
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