

UNDERSTANDING ABUSIVE HEAD TRAUMA

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ADVANCING HEALTH EDUCATION & RESEARCH



The Oklahoma Child Death Review Board 2014 Annual Report

- The Board reviewed and closed 60 cases where it was determined that child maltreatment (abuse or neglect) caused or contributed to the death.
- Thirteen (21.7%) cases were ruled abuse, 45 (75.0%) cases were ruled neglect, and two (3.3%) were ruled both.
- Nine of the 15 (60.0%) abuse cases were due to abusive head trauma.

THINGS YOU MAY HAVE HEARD...

- There is a big controversy about shaken baby syndrome (SBS)
- Even the AAP backed away from “shaken baby syndrome” in 2009
- There are medical conditions that we now know look just like SBS
- There are many people wrongly convicted of SBS

HISTORY



Investigating Baby Murders: Past

- **Catherine Welch : April 10th 1828.**

“ I am a surgeon and live at Fulham...the Eyes were a good deal suffused with blood...I opened the body after the inquisition, the internal parts were perfectly healthy, except the vessels of the brain and lungs, being overloaded with blood.”

Investigating Baby Murders: Past



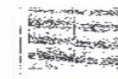
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CATHERINE WELCH, KILLING : INFANTICIDE, 10TH APRIL, 1828.

The Proceedings of the Old Bailey Ref:
t18280410-17

TRIAL SUMMARY:

- ♦ Crime(s): [killing : infanticide](#),
- ♦ Punishment Type: [death](#),
(Punishment details may be provided at the end of the trial.)
- ♦ Verdict: [Guilty](#),
- ♦ [Other trials on 10 Apr 1828](#)
- ♦ Name search for: [CATHERINE WELCH](#),
- ♦ Crime Location: [Parson's-green](#)
- ♦ [Associated Records...](#)



[See original](#)

ORIGINAL TEXT:

Before Lord Chief Justice Tenterden.

810. CATHERINE WELCH was indicted for the wilful murder of a certain male child, whose name is unknown .

MARY INGLEFIELD . I live at Turnham-green. I was going by Parson's-green with my husband about half-past eight o'clock on Sunday morning, the 2d of March; I observed something in a ditch - there was very deep water in the ditch; I thought at first there was a dog in the water, but as I was waiting for my husband, who stopped behind for a necessary purpose, I perceived that it was the body of a child; it was entirely covered with water; I went back and called my husband - he came and looked, and thought it was a child: we went up into the road, and saw a man - we got him to look, and he said it was a child.

Q. Then this was out of the road? A. Yes, a little way from the road, in a field; we had gone out of the road, towards Parson's-green - there is a foot-path there

Q. Then when you say you went back to the road, you mean the carriage-road? A. We went forward to the carriage-road, and there



HISTORY

- 1860s: Ambrose Tardieu – described abusive subdurals
- 1946: John Caffey – relationship of long bone fractures and intracranial hemorrhage = trauma
- 1971: Norman Guthkelch – first description of shaking as a mechanism
- 1972, 1974: John Caffey popularized shaking as a mechanism




HISTORY

- Mid 1970s – advent of CT scans. This revolutionized diagnosis
- 1986: Alexander et al. first described use of MRI with SBS
- 2000s: more MRI variations (e.g. diffusion weighting, MRA, MRV)

DEFINITIONS AND ISSUES





SAHIS

AAP 2009

ABUSIVE

- Whether the diagnosis is SBS or AHT, the diagnosis is still physical abuse
- With SBS:
 - The mechanism is shaking (with or without impact trauma)
- With AHT:
 - Multiple mechanisms
- “AHT” unless you know for sure

HEAD:

TYPES OF ABUSIVE INJURIES

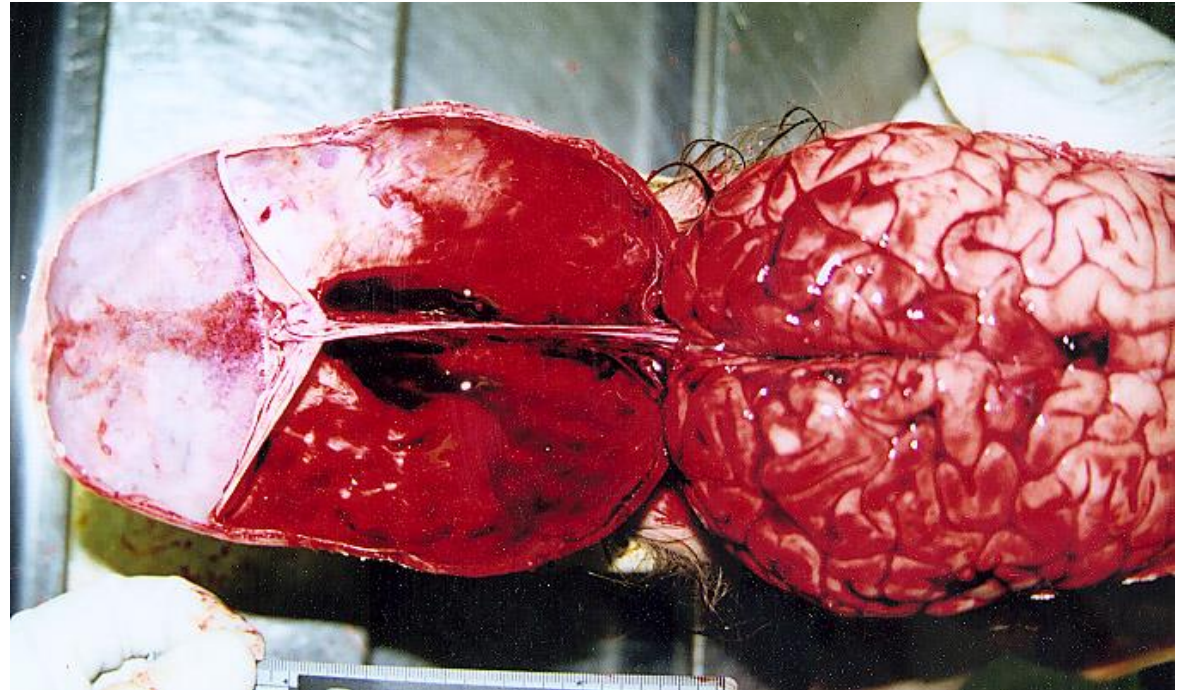
- Impact only injuries = AHT



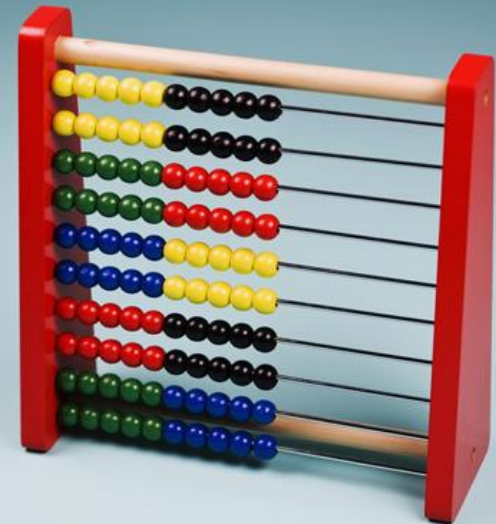
HEAD:

TYPES OF ABUSIVE INJURIES

- Shaking injuries = AHT



EPIDEMIIOLOGY



INCIDENCE OF AHT (INFANTS)

Location	What is measured	Rate	Cite
Southwest England and Wales	SDH – under 1 year of age	21 per 100,000	Jayawant et al, 1998
Scotland	SDH under 1 year of age (retrospective)	11.2 per 100,000	Barlow et al, 1998
Scotland	SDH under 1 year of age (prospective)	24.6 per 100,000	Barlow et al, 2000
North Carolina	Hospital surveillance (prospective)	29.7 per 100,000	Keenan et al, 2003
Canada	Hospital surveillance (retrospective)	40 cases/year	King et al, 2003
New Zealand		14.7 – 19.6 per 100,000	Kelly et al, 2008
Estonia	Hospital surveillance (retrospective)	13.5 per 100,000	Talvik et al, 2006
Estonia	Hospital surveillance (prospective)	40.5 per 100,000	Talvik et al, 2006

SHAKEN BABY SYNDROME: DEFINITION

- When a child is violently shaken sufficient to cause:
 - Direct brain injury (which leads to cerebral edema, loss of brain substance, etc.)
- Secondary injuries:
 - Intracranial bleeding almost always is present (subdural, subarachnoid, or both – one side or both)
 - Retinal hemorrhages in 90% of cases



BLUNT FORCE TRAUMA

- This is non-penetrating trauma (i.e. not intrusive like a knife or bullet)
- Examples of blunt force trauma:
 - Impact
 - Impact and shaking
 - Shaking



SPECTRUM OF SBS

- Originally described by Guthkelch (1971) and Caffey (1972,1974)
- About 50% of cases have no signs of impact to the head. About 50% do.
- About 70% have evidence of prior abuse (33 to 40% have medical signs of prior shaking)



PATHOPHYSIOLOGY



Two-story drop – Texas case

- 15 month old
- No injuries





5 11 2011





BASICS MOTIONS OF SBS

- Child held under the arms, facing the adult-sized person in nearly all cases
- May have impact in 50 to 75% of cases
- Repetitive motions – they are cumulative

BASICS MOTIONS OF SBS

- Smith and Alexander, Robert Mimms, Carole Jenny – all have shown the weighted dolls are shaken at a “natural” rate of about 3 cycles/second
- Head moves in AP direction in an arc (centripetal accelerations are to the 4th power), to the side, pivots on the neck, and is all occurring on a moving body
- Thus many motions - complicated



BASICS

- Gravity has been present a long time
- Primates are built to survive most falls
- Not built to survive repetitive 3 cycles/second shaking injuries

BLEEDING – REMEMBER!

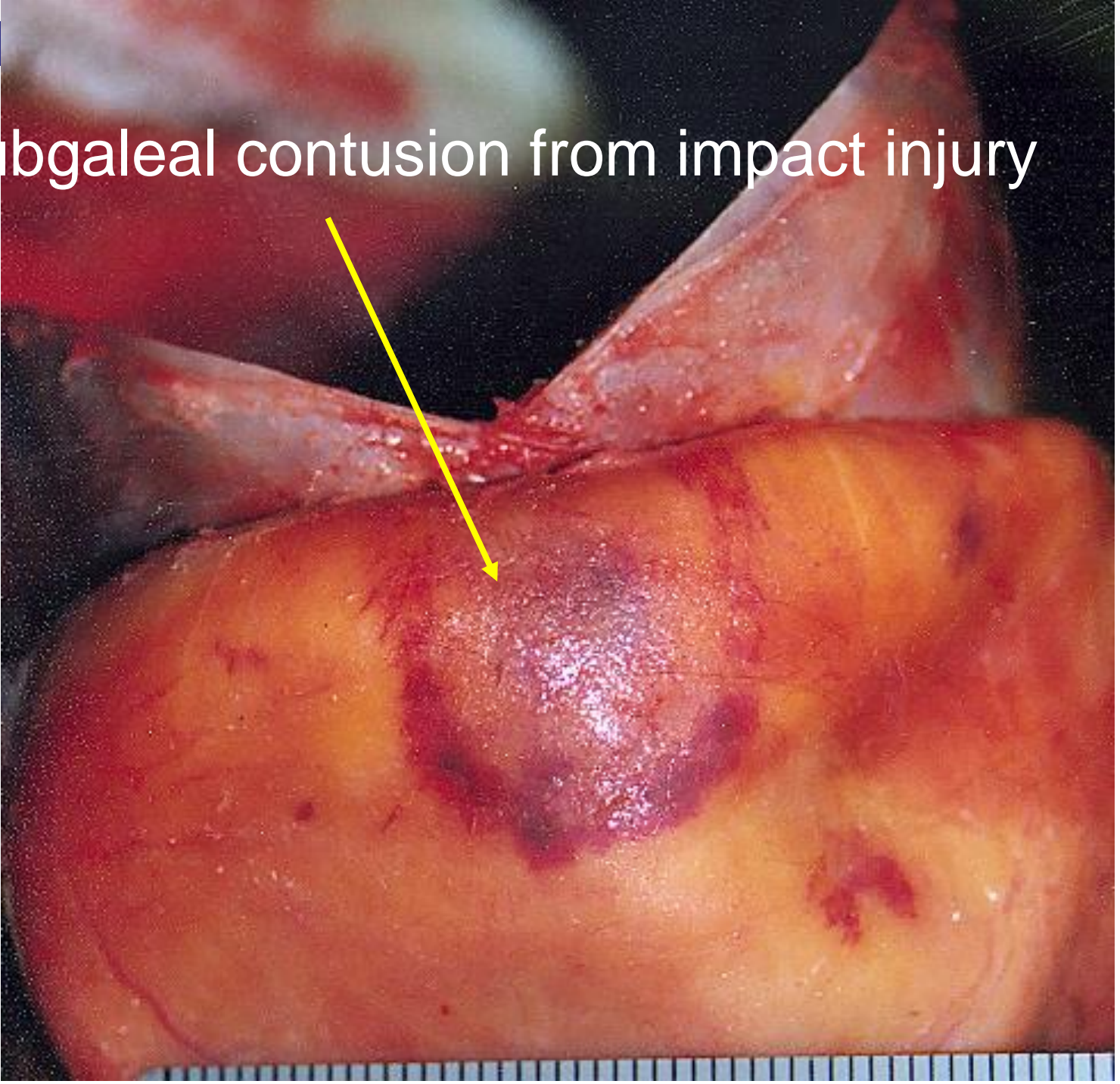
- The central issue is **brain damage**, not bleeding



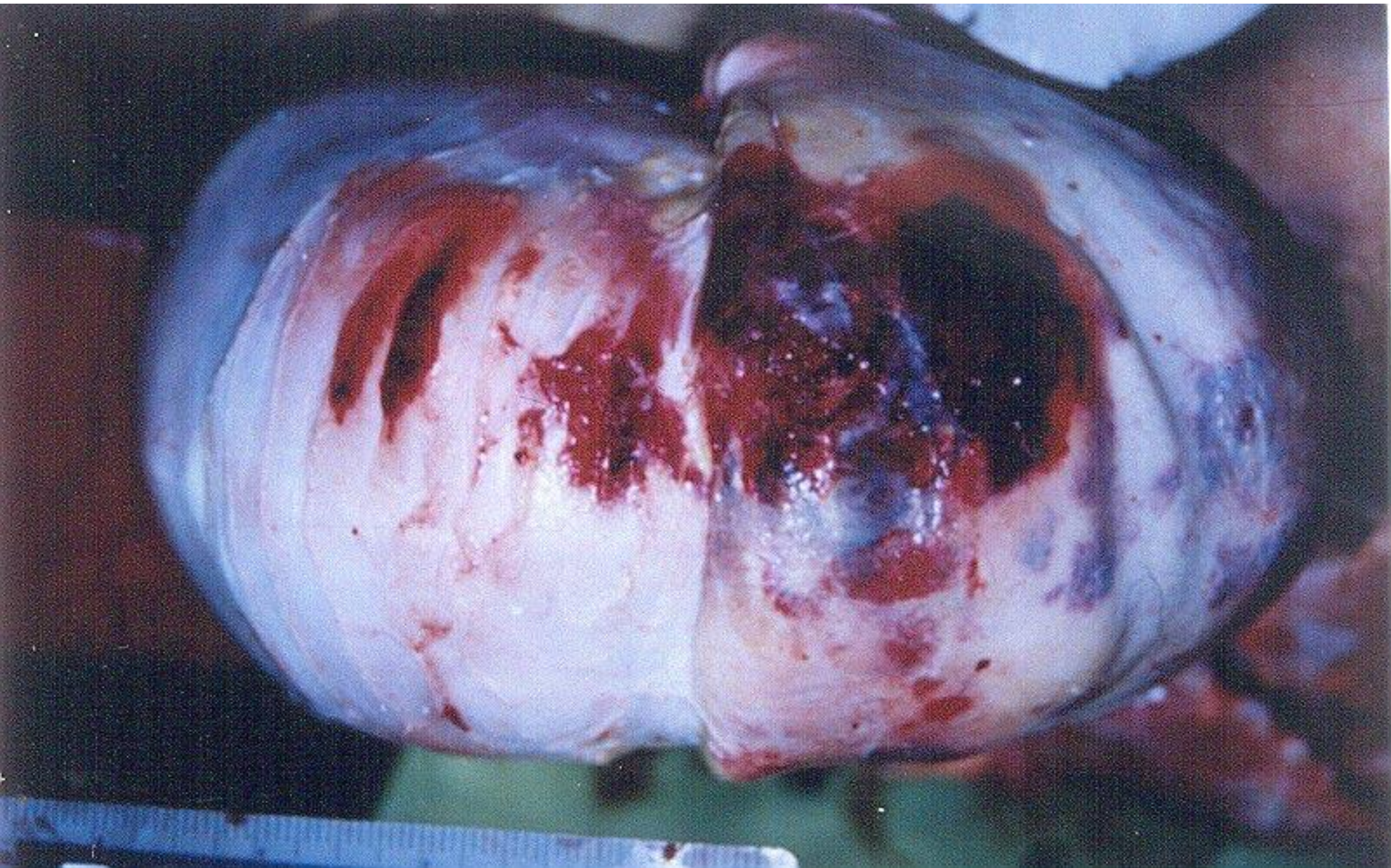


BLEEDING - SCALP

Subgaleal contusion from impact injury



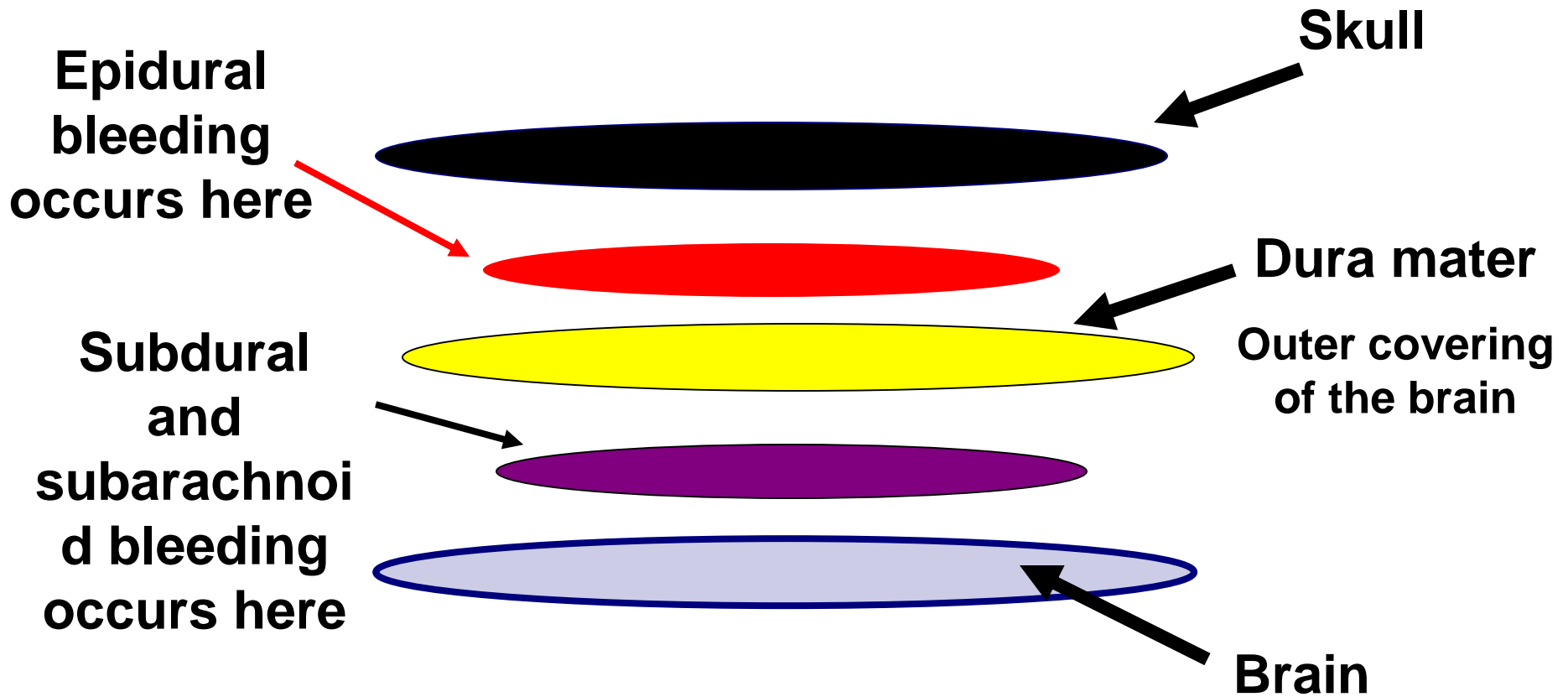
SUB GALEAL CONTUSSIONS





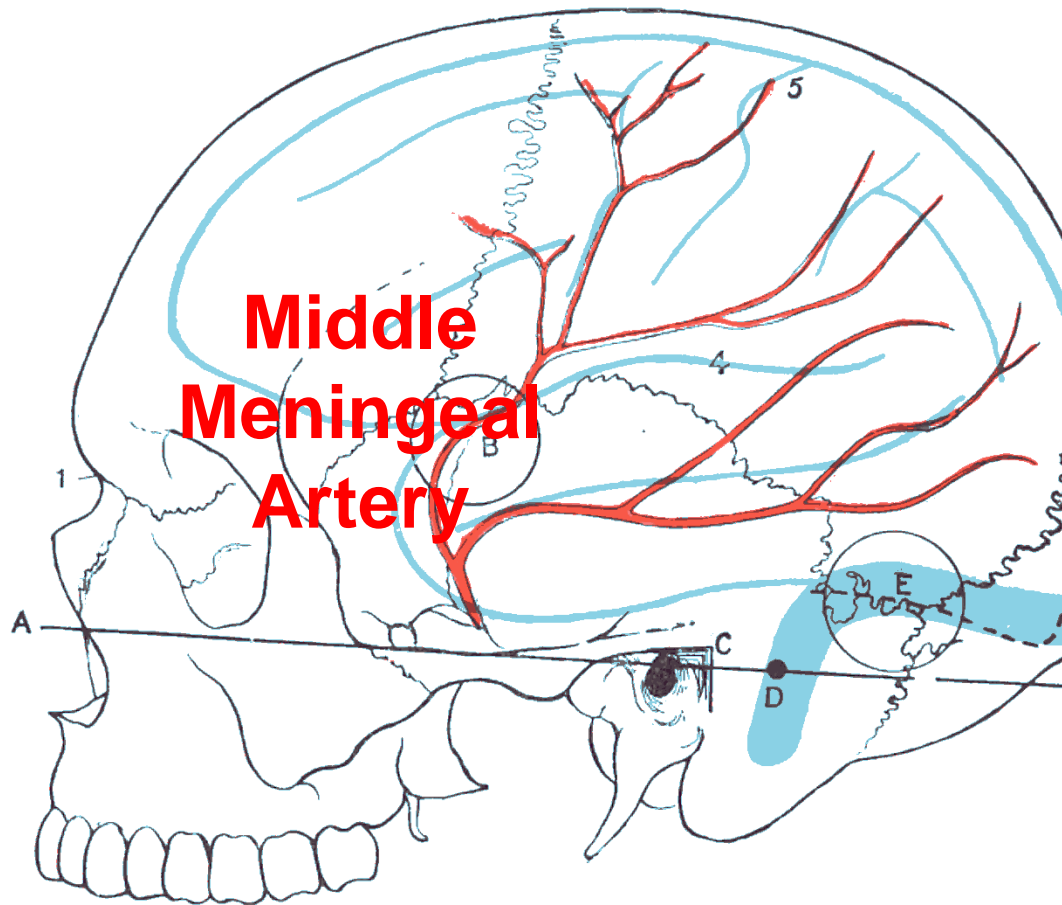
BLEEDING – AROUND THE BRAIN

BLEEDING – AROUND THE BRAIN

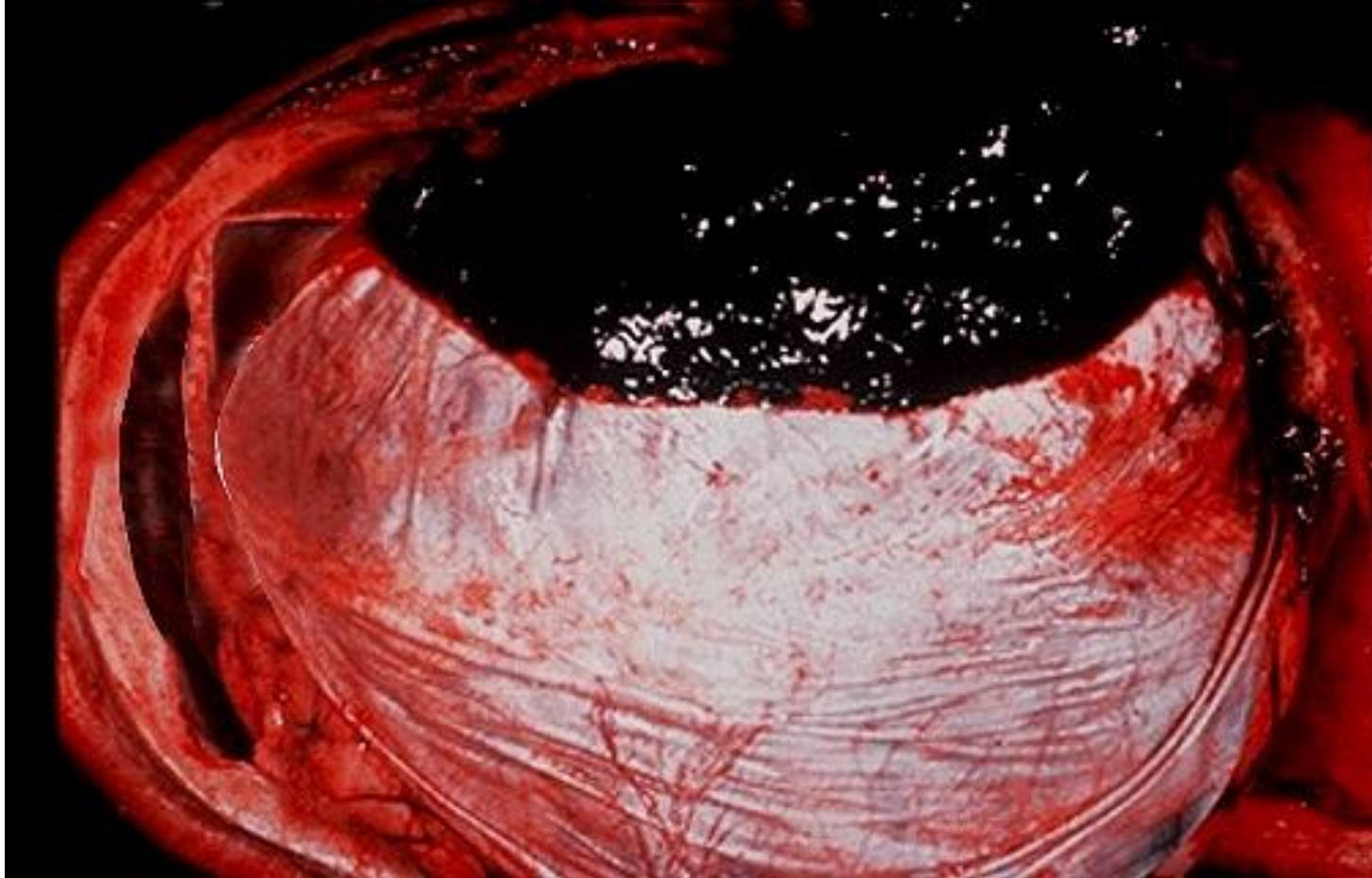


Epidural Hematoma

The Exception to the Rules

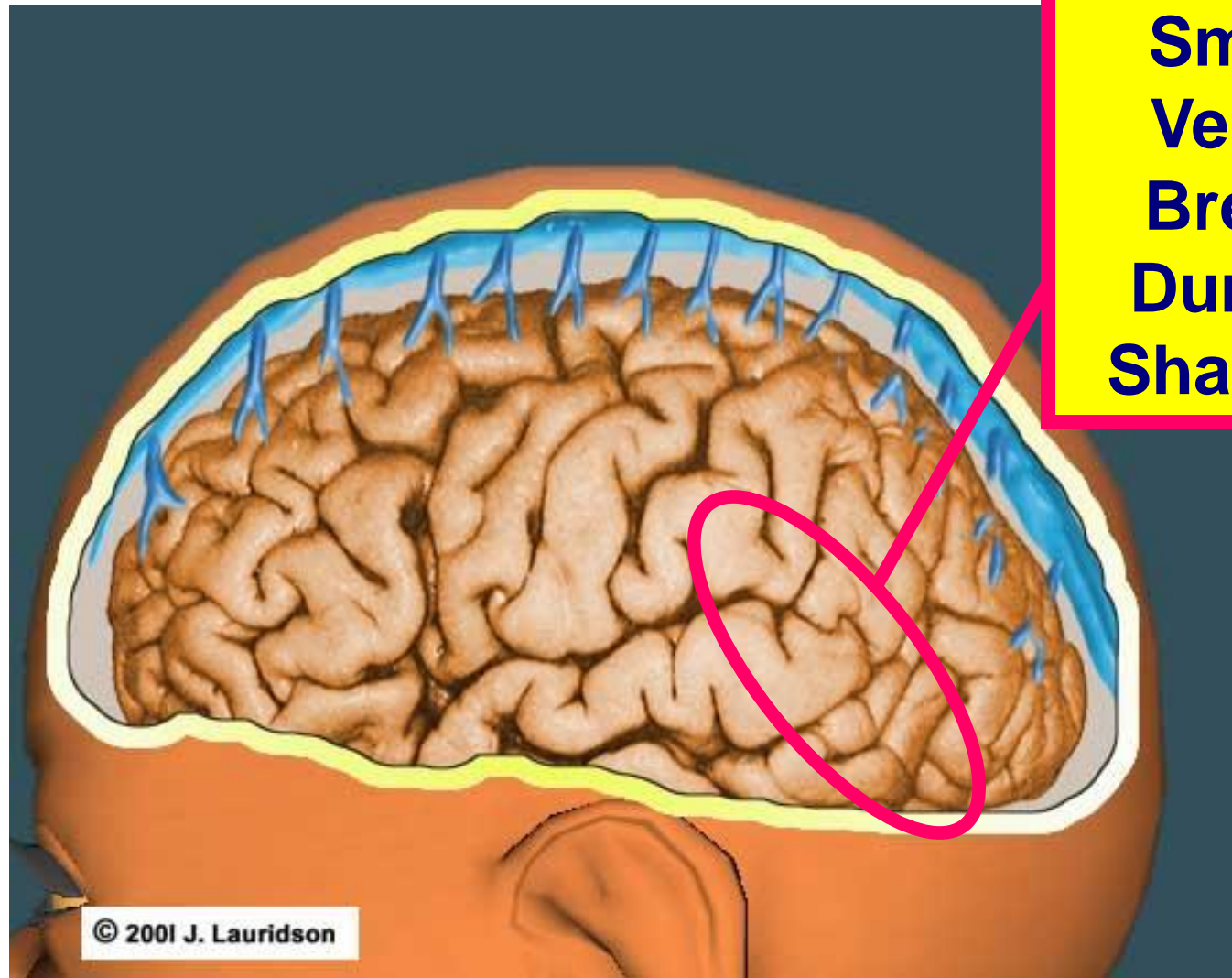


Epidural hematoma



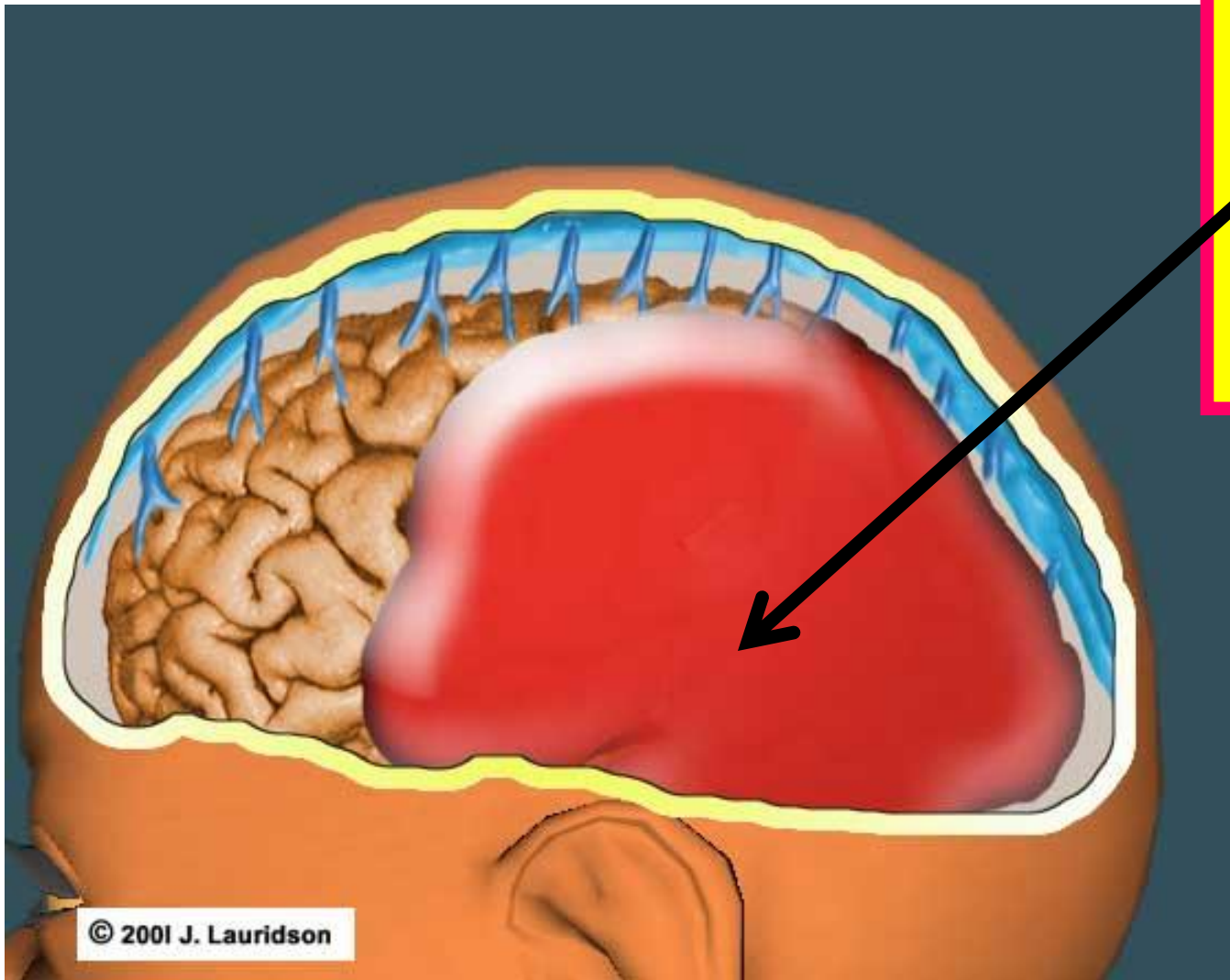
Usually associated with ACCIDENTAL injuries

**Small
Veins
Break
During
Shaking**



© 2001 J. Lauridson

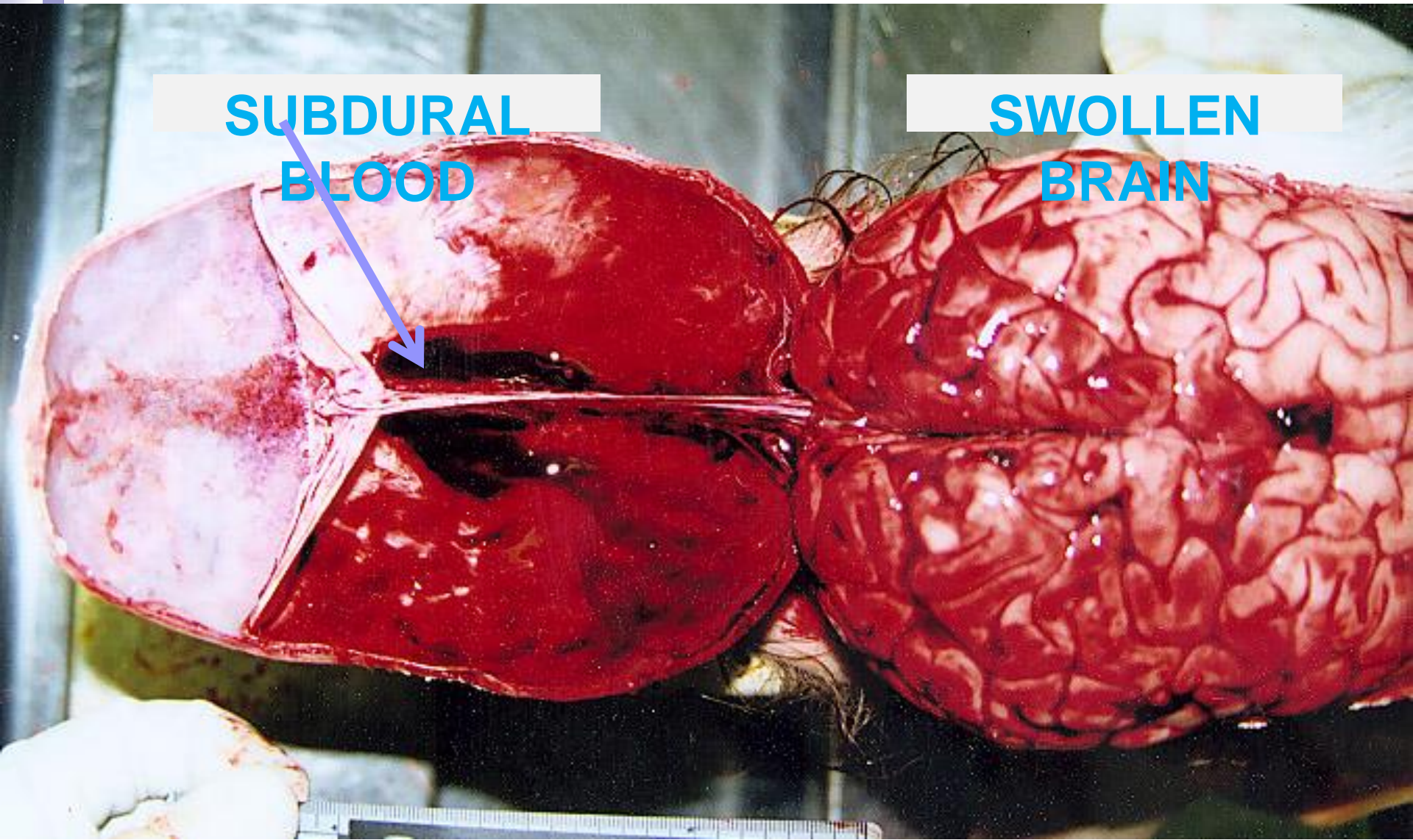
**Bleeding
Around
Brain
(Subdural
Hematoma)**



© 2001 J. Lauridson

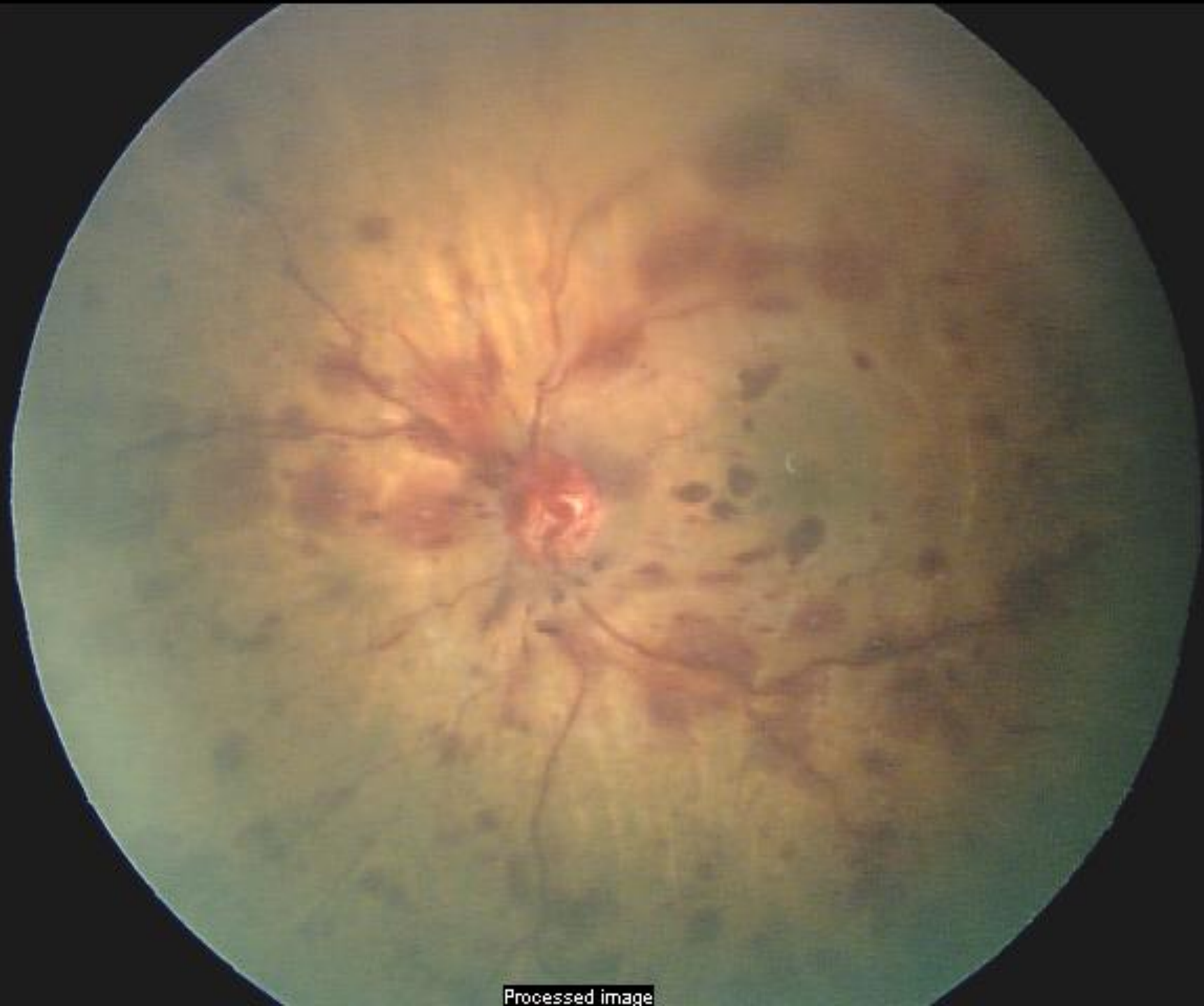
**SUBDURAL
BLOOD**

**SWOLLEN
BRAIN**



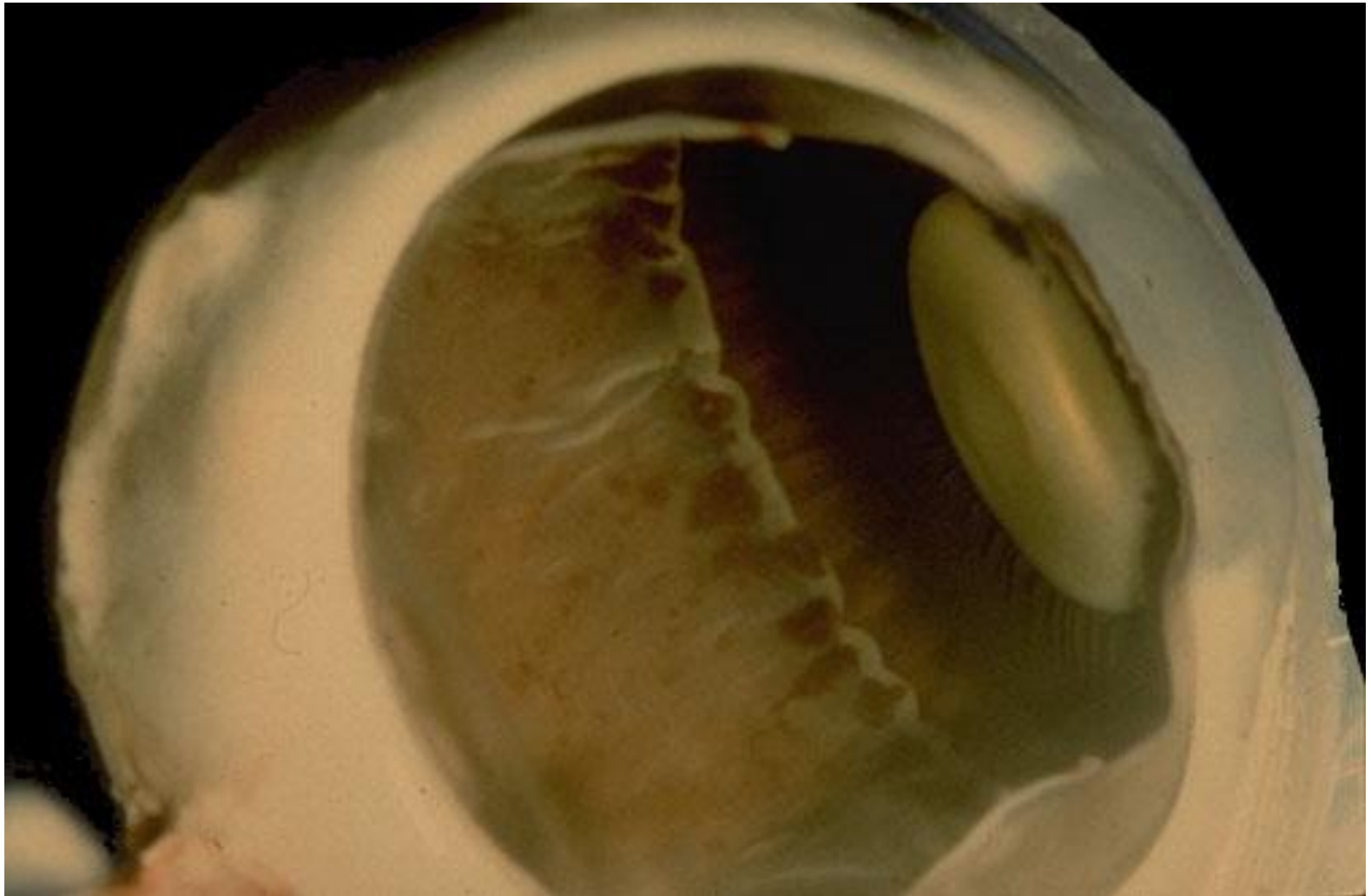


BLEEDING - EYES



Processed image

Retinal Hemorrhages







MECHANISM



VIDEO ANIMATIONS

- The Shaken Baby Syndrome: A Visual Overview – James Lauridson MD, Alex Levin MD, Robert Reece MD, Amy Wicks
 - www.dontshake.com
- The Mechanism of the Injury in Shaken Baby Syndrome – Dan Davis MD
 - www.expertdigital.com



ASSOCIATED INJURIES

SBS – OTHER INJURIES

- About 50% of cases have no signs of impact to the head. About 50% do.
- About 70% have evidence of prior abuse (33 to 40% have medical signs of prior shaking)
- Estimated 40 – 50% have rib fractures
- Grab marks maybe 20%???
- Neck injuries rare



SBS – OTHER INJURIES

- Abdominal injuries are of great concern – they may have an even higher fatality rate.
- Get lab studies (amylase, pancrease, liver functions)
- Consider getting an abdominal CT (maybe while getting the head CT – as one whole process)

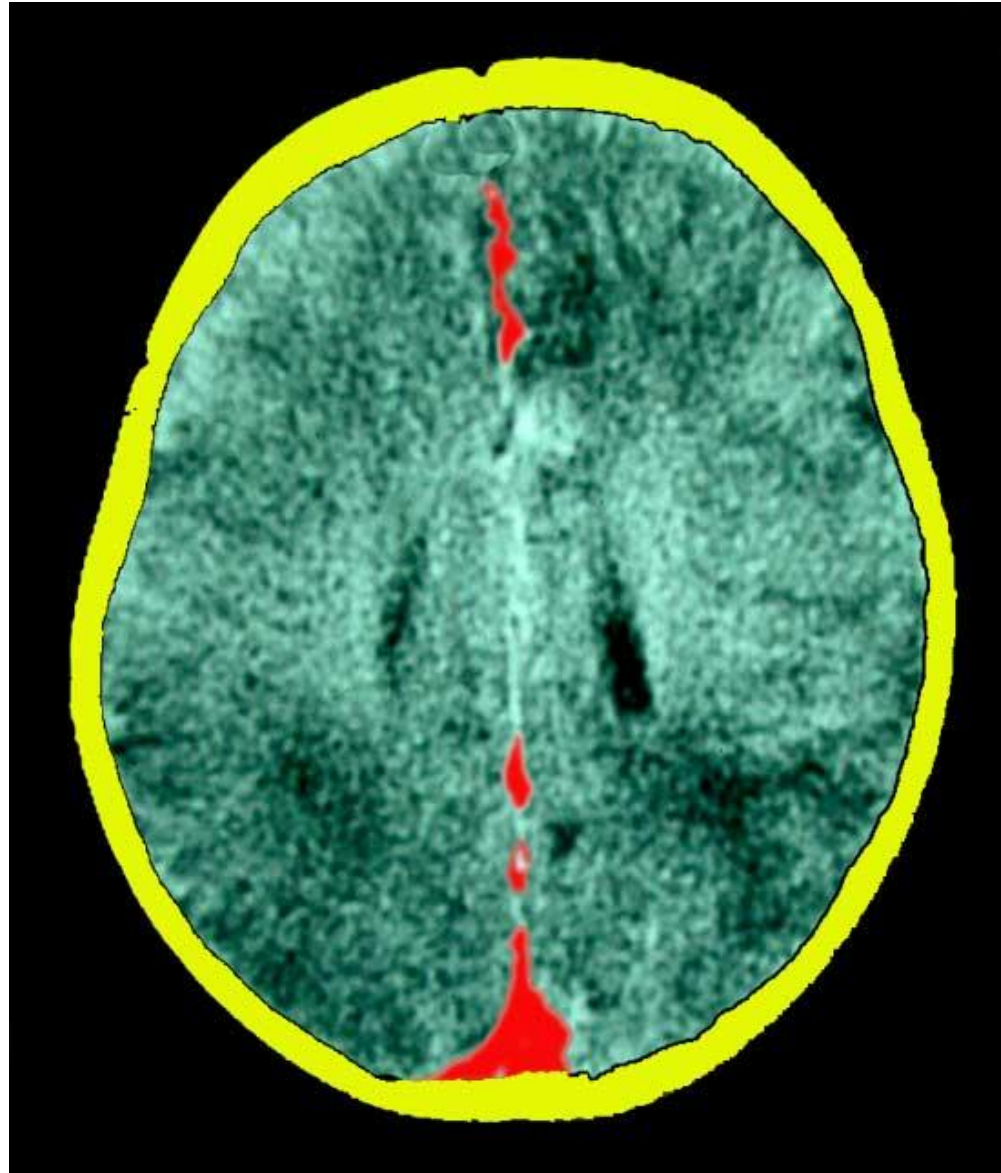
SBS – OTHER INJURIES

- Skeletal survey
- Other labs
 - Urinalysis
 - Drug screen
- Check for genital injuries
- Growth parameters
- Get a head CT and skeletal survey of the twin

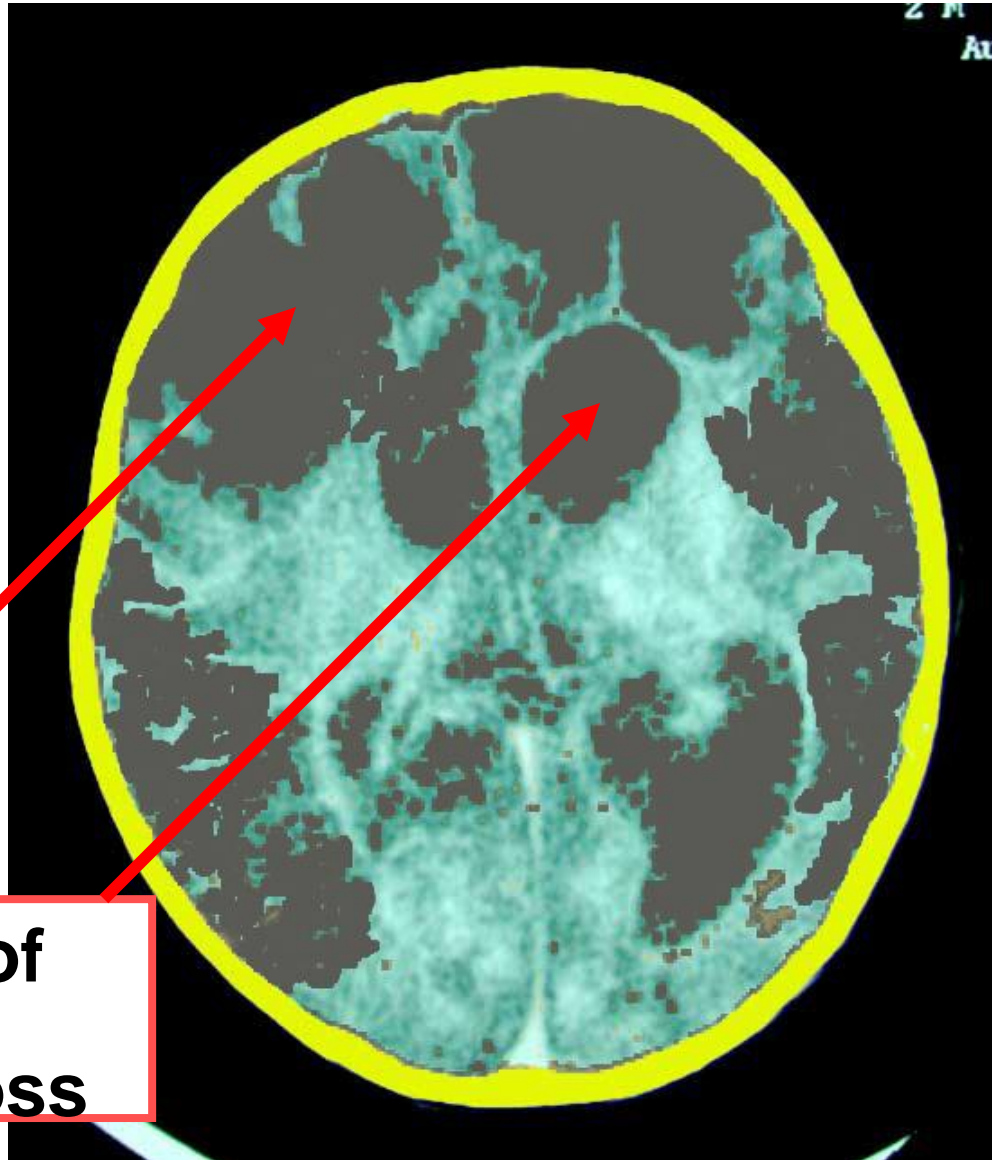


OUTCOMES

CT Scan Immediately After Shaking



CT Scan Three Months Later



Areas of
Brain Loss

PATIENT OUTCOMES

- 25% die
 - Immediate and serious symptoms
 - Fatal cases would die within 1-2 hours without medical intervention
 - Contrast to Chadwick et al. 1991 who found that in falls of 10 – 45 feet, only 1/117 children died



PATIENT OUTCOMES

- 65% have varying degrees of significant disabilities
 - Motor
 - Cognitive
 - Visual



PATIENT OUTCOMES

- ~10% look ok in the short term
 - Usually this is by neurologic examination within one year
 - Often this means child is less than 2 or 3 years of age at time of exam
 - Only screens for moderate or severe problems, not mild disabilities
 - Subtle problems may show much later





USUALLY NOT A HARD DIAGNOSIS

- Begins with history
- Paramedics often suspect – before the child even gets to the ER
- Made by non-child abuse physicians every day



MEDICAL STUDIES

- Brain imaging – CT, MRI
- Eye examination
- Skeletal survey
- Abdominal studies
- U/A, genital exam



MEDICAL STUDIES

- 3 D reconstruction?

APPROACH TO SBS CASES

Other siblings:

- Interview is important
- Examination is important
 - Especially twins and children under 5 years of age
 - Which studies?
 - Skeletal survey if under 2 years of age. 2-5 years – maybe.
 - MRI



TIMING INJURIES

- Who did it?



DATING THE INJURIES

- Radiologic: least sensitive
- Physiologic: a bit better
- Clinical: the best!

TIMING AND ONSET OF SYMPTOMS IN SBS

■ Mild Cases

- Immediate onset of symptoms will occur with any injury but the symptoms may be vague
- These symptoms can be missed by medical professionals

(C. Jenny, JAMA, 1999, 281:621-626)

■ Severe or fatal cases

- Immediate onset of symptoms
- No lucid interval (normal behavior) following traumatic insult to the brain



Old & new injuries are common

“Contrary to early speculations, SBS is unlikely to be an isolated event. Evidence of prior child abuse is common.”

Children are commonly shaken more than once by the same perpetrator. The violence often increases and the final shaking incident is severe / fatal to the child.

**American Academy of Pediatrics Policy Statement, Vol. 108,
Number 1; July 2001**

Yes, It is Possible Shake a Baby to Death



- Alexander prospectively examined 24 infants diagnosed with SBS looking carefully for signs of impact trauma
- Nine infants died and were autopsied
- No evidence of impact trauma was found in 12 infants, including 5 of those autopsied
- The death rate and spectrum of intracranial injuries noted was the same in those with and without evidence of impact

Alexander R, et al. Incidence of Impact Trauma with Cranial Injuries Ascribed to Shaking. AJDC 144:724-726, 1990.

MALE AND FEMALE PERPETRATORS

- 34 cases of AHT (17 male and 17 female perpetrators)
- Injuries worse if male perpetrator
- Male perpetrators more likely to confess (88% vs. 18%)
- Males more likely to be convicted

Jenssen D, Tai J, Sylvia K. Abusive had trauma in children: a comparison of male and female perpetrators. *Pediatrics*. 2011. 127: 649-57.



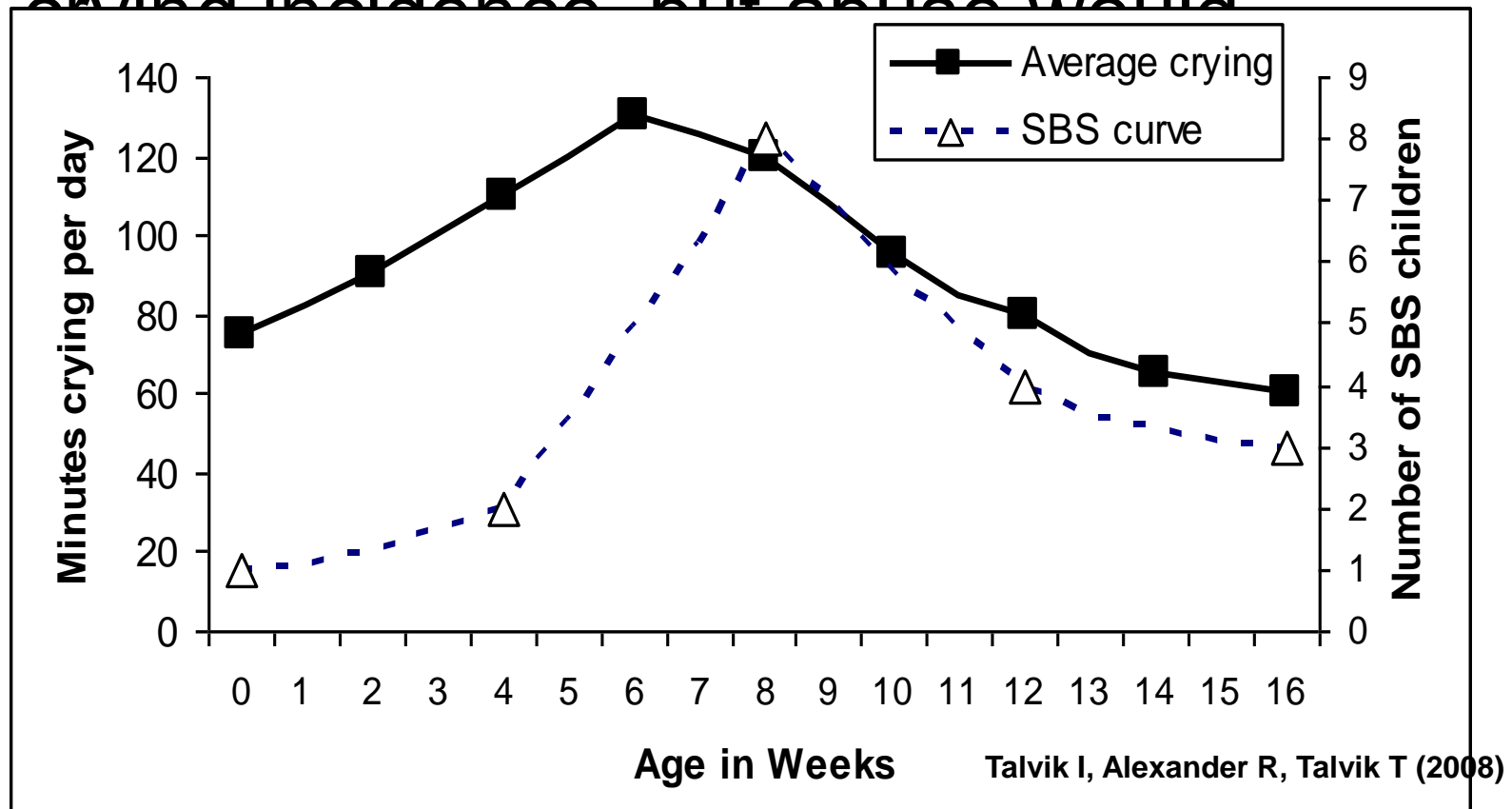
MEDICAL-LEGAL ISSUES



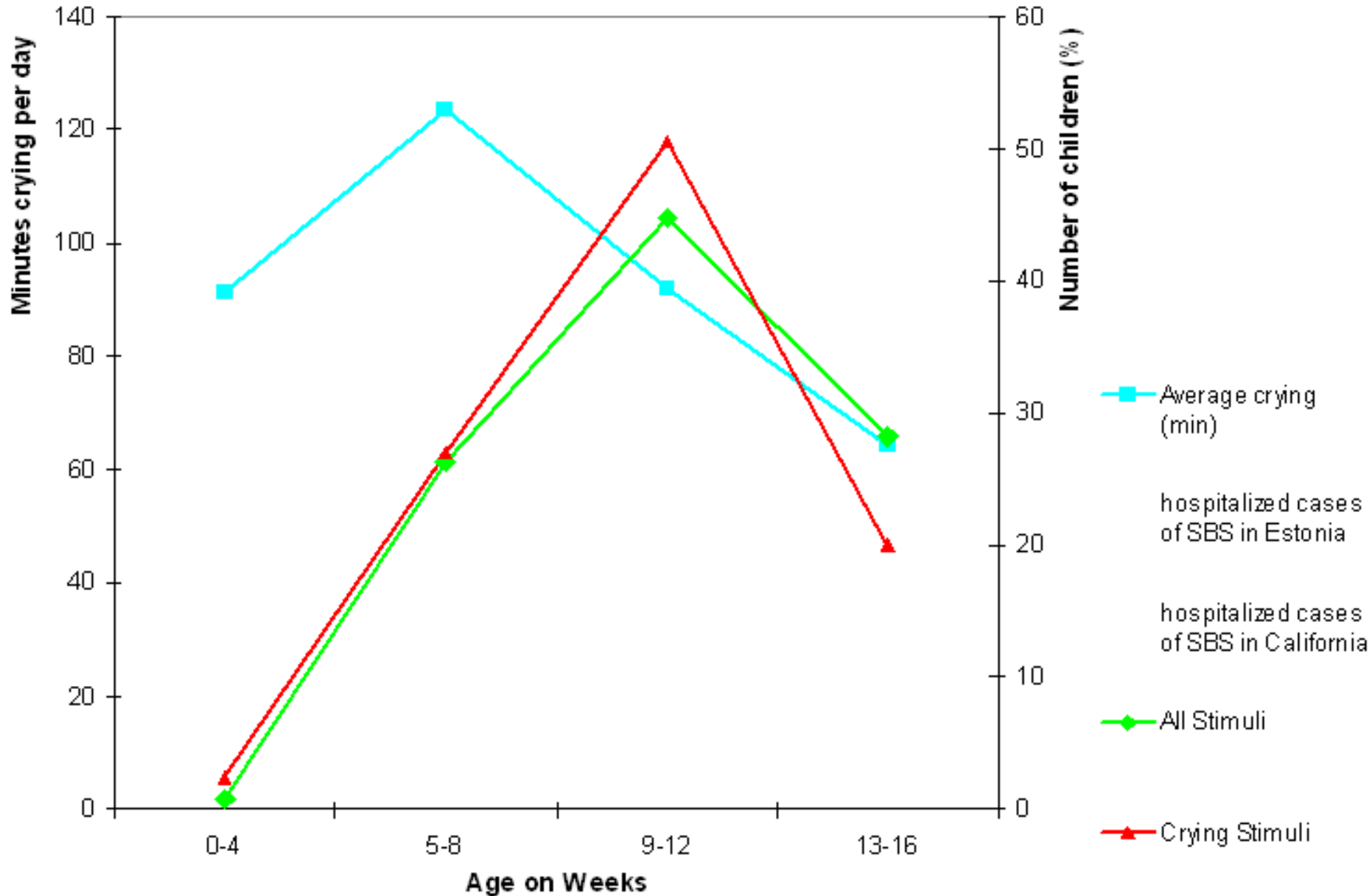
WHY SBS EXISTS

REASONS FOR SBS

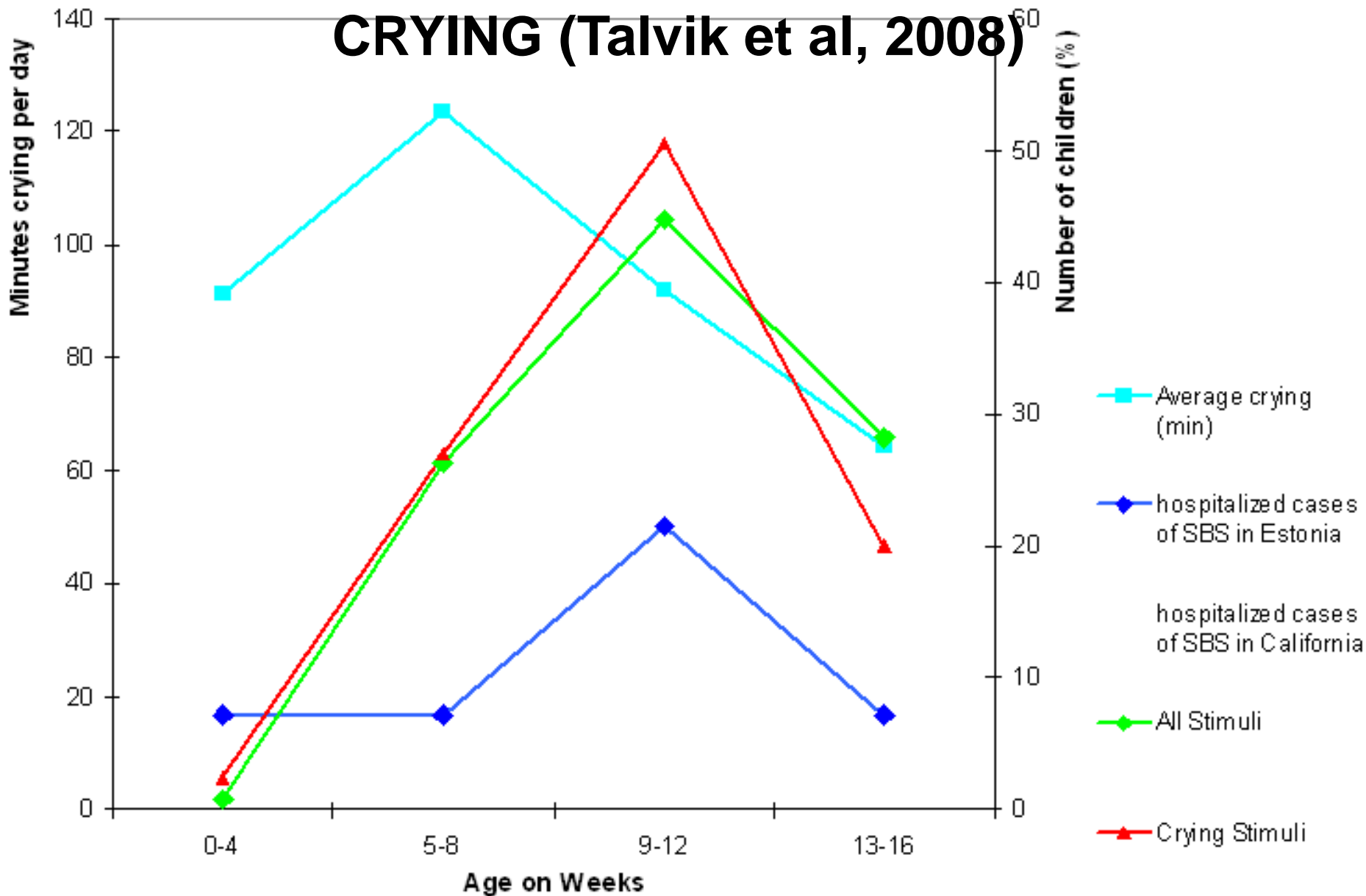
1. Falls would not follow a pattern of infant crying incidence, but abuse would



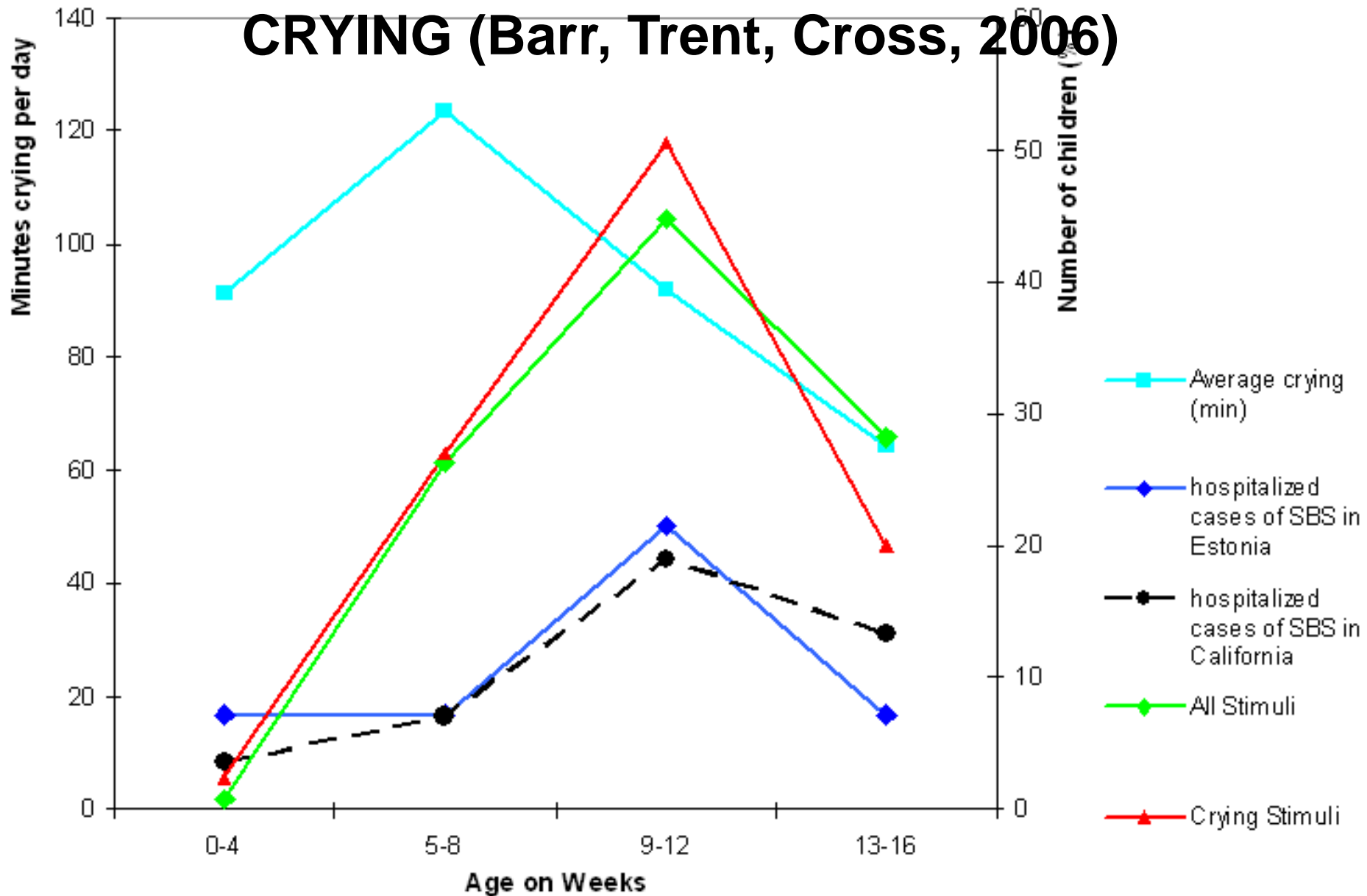
ALL STUDIES AGREE ON SBS INCIDENCE AND CRYING (Lee, Barr, Catherine, Wicks, 2007)



ALL STUDIES AGREE ON SBS INCIDENCE AND CRYING (Talvik et al, 2008)



ALL STUDIES AGREE ON SBS INCIDENCE AND CRYING (Barr, Trent, Cross, 2006)





REASONS FOR SBS

2. Retinal hemorrhages are seen at fairly high frequencies with SBS (up to 90%) but are uncommon (about 5%) with serious or fatal car crashes. They also more extensive and multi-layer overall.
3. Evidence of impact or not – little difference in outcome.
4. Histories correlate highly with findings



REASONS FOR SBS

5. Pattern of brain injuries does not typically resemble that of a fall
6. High percentage of SBS cases have other abusive injuries.
7. SBS cases are almost always with a lone adult around. Accidents would not necessarily follow this pattern.



IS IT SERIOUS?



AAP Policy Statement on SBS

“... the act of shaking leading to Shaken Baby Syndrome is so violent that individuals observing it would recognize it as dangerous and likely to kill the child.”

**American Academy of Pediatrics Policy Statement, Vol. 108, Number 1;
July 2001**

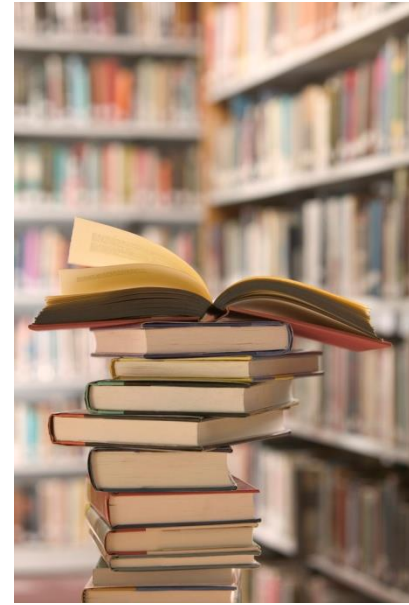


IT IS SERIOUS

- Life threatening action
- 20 to 25% death rate
- Brain damage seen probably in all cases
(a spectrum)



GOOD ARTICLES



JUDICIAL ADMISSIONS → AHT IS VIOLENT AND REPETITIVE

- 112 AHT cases over 7 years
 - 29: confessed to violence
 - 83: no confession
- No differences of injury patterns between the two groups
- Confessions:
 - 93% under 1 year of age
 - Mostly boys



JUDICIAL ADMISSIONS → AHT IS VIOLENT AND REPETITIVE

- All confessions came during police custody or judicial investigation – weeks or months later
- Perpetrator
 - Father/stepfather 45%
 - Mother 27%
 - Childminder 21%

JUDICIAL ADMISSIONS → AHT IS VIOLENT AND REPETITIVE

- All described violent shaking
 - 45% described a single episode
 - 55% described multiple episodes (mean = 10). Daily in some cases. Because it stopped crying (63%)
 - Impact uncommon (24%)

JUDICIAL ADMISSIONS → AHT IS VIOLENT AND REPETITIVE

- Confessions are listed for some cases
- Conclusions:
 - Violent
 - Often repetitive
 - Shaking alone causes these injuries

AHT INCREASING – MAYBE BECAUSE OF UNEMPLOYMENT

- 442 children diagnosed with AHT from January 2004 to June 2009 for 3 geographic areas (74 counties)
 - Ohio area
 - Pennsylvania area
 - Washington state area
- Mean age = 8.9 months
- 76% under 1 year old



AHT INCREASING – MAYBE BECAUSE OF UNEMPLOYMENT

- Recession defined as December 1, 2007 through June 30, 2009
- Rate of AHT increased from 8.9 per 100,000 before the recession to 14.7 per 100,000 during the recession
- No relationship between AHT and county-level unemployment rates

AHT INCREASING – MAYBE BECAUSE OF UNEMPLOYMENT

■ Conclusions

- Increased AHT during 19 months of recession vs. 47 months before
- Stress of recession may be linked to violence
- Recession may have policy implications regarding numbers affected, morbidity and mortality, and costs
- Prevention should be increased during times of economic hardship

AHT: AN ANIMAL MODEL

- Lambs have a relatively large gyrencephalic brain like a human infant
- 9 anaesthetised lambs shaken “vigourously” for 30 seconds – 10 times over 30 minutes
- No impact

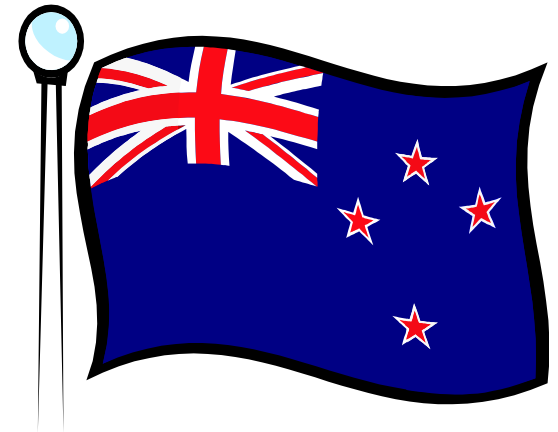


AHT: AN ANIMAL MODEL

- Retinal injuries
- Only 3 had subdural hemorrhages
- 3 died unexpectedly at 2,3, and 5 hours – showing that shaking can be lethal

AHT PREVENTION: COST ANALYSES

- 5 year cohort of infants with AHT admitted to Auckland hospital
- Looked at:
 - Direct cost of hospital care
 - Community rehabilitation
 - Special education
 - CPS and law enforcement costs
 - Criminal trials
 - Department of Corrections
 - Lifetime care for moderate to severe disability



AHT PREVENTION: COST ANALYSES

- 52 cases of AHT identified
- The average cost per child was \$813,532
- Conclusions:
 - AHT is very expensive
 - Acute hospitalization is only 4% of total costs
 - Strong argument that effective prevention would be cost effective (with improved health outcomes)

AHT IN THE US: 2000-2009



- CDC review panel definition of AHT:
“injury to the skull or intracranial contents of an infant or young child due to inflicted blunt force trauma and/or violent shaking”
- Used broad coding definition
- Kids’ Inpatient Database – looked at only children under 2 years of age

AHT IN THE US: 2000-2009

- Rate of 39.8 per 100,000 under 1 year of age
- Compared to non-abusive head trauma, AHT children were:
 - Younger
 - More often male
 - Enrolled in Medicaid
 - Hospitalized longer
 - More likely to die

AHT IN THE US: 2000-2009

■ Conclusions

- AHT is often more severe and lethal than non-abusive head injuries
- Prevention should incorporate some of the demographic considerations

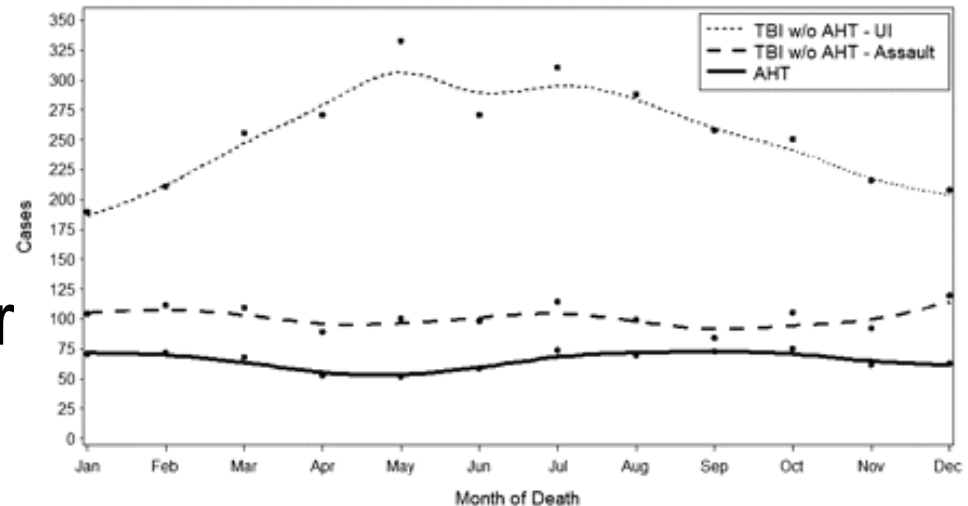
FATAL AHT IN THE USA: NATIONAL HOSPITAL DATA

- Used expert panel definition of AHT and ICD codes that apply
- Data from Health Statistics National Vital Statistics System from 2003 – 2007
- Coding:
 - 699 definite/presumptive
 - 81 probable



FATAL AHT IN THE USA: NATIONAL HOSPITAL DATA

- Fatal AHT highest under 1 year of age
- Peak from 1 – 2 months of age
- No seasonal effect for AHT, but there is for non- AHT (i.e. they are not the same!)



NON-FATAL AHT IN THE USA: NATIONAL HOSPITAL DATA

- Used expert panel definition of AHT and ICD codes that apply
- Data from Healthcare Cost and Utilisation Project from 2003 – 2008
- AHT highest under 1 year of age (32.3 per 100,000)
- Peak between 1 and 3 months
- Non-fatal AHT did not vary across seasons



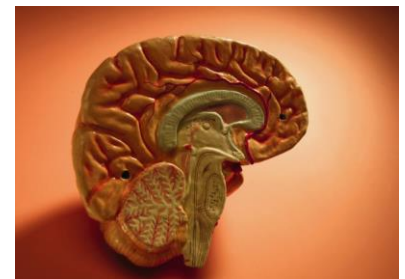
AHT IN THE NETHERLANDS: MULTIPLE INCIDENTS OF ABUSE COMMON

- Review of all cases in Netherlands in which forensic medical expertise requested by courts 2005 – 2010
- 89 cases
 - 62% boys
 - Median age = 3.5 months
 - Male perpetrator in 81%
 - Impact trauma in 48%
- Evidence of prior abuse in 81% of cases



COGNITIVE OUTCOMES OF AHT: THEY ARE NOT OK

- 11 children diagnosed as victims of SBS
- Matched to a control group of 11 children for age, gender, socioeconomic status, and family composition
- Battery of tests given for cognitive functions
- Average age was about 7.3 years



COGNITIVE OUTCOMES OF AHT: THEY ARE NOT OK

- Victims had significant weaknesses for
 - IQ
 - working memory
 - mental organization
 - alternation
 - inhibition
- Deficits most for verbal skills
- Mostly associated with the frontal regions of the brain

COGNITIVE OUTCOMES OF AHT: THEY ARE NOT OK

- Most of the parents said the child was normal
- “All child victims of SBS, even those affected to a lesser degree, will likely have special needs throughout their entire life”
- Need regular monitoring of school years to set up an intervention program for each child’s particular needs



“NEW SCIENCE”

- Contrary to defense witnesses and lawyers, the science is extensive and reinforces what was previously known/suspected
- Statements to the contrary are irresponsible