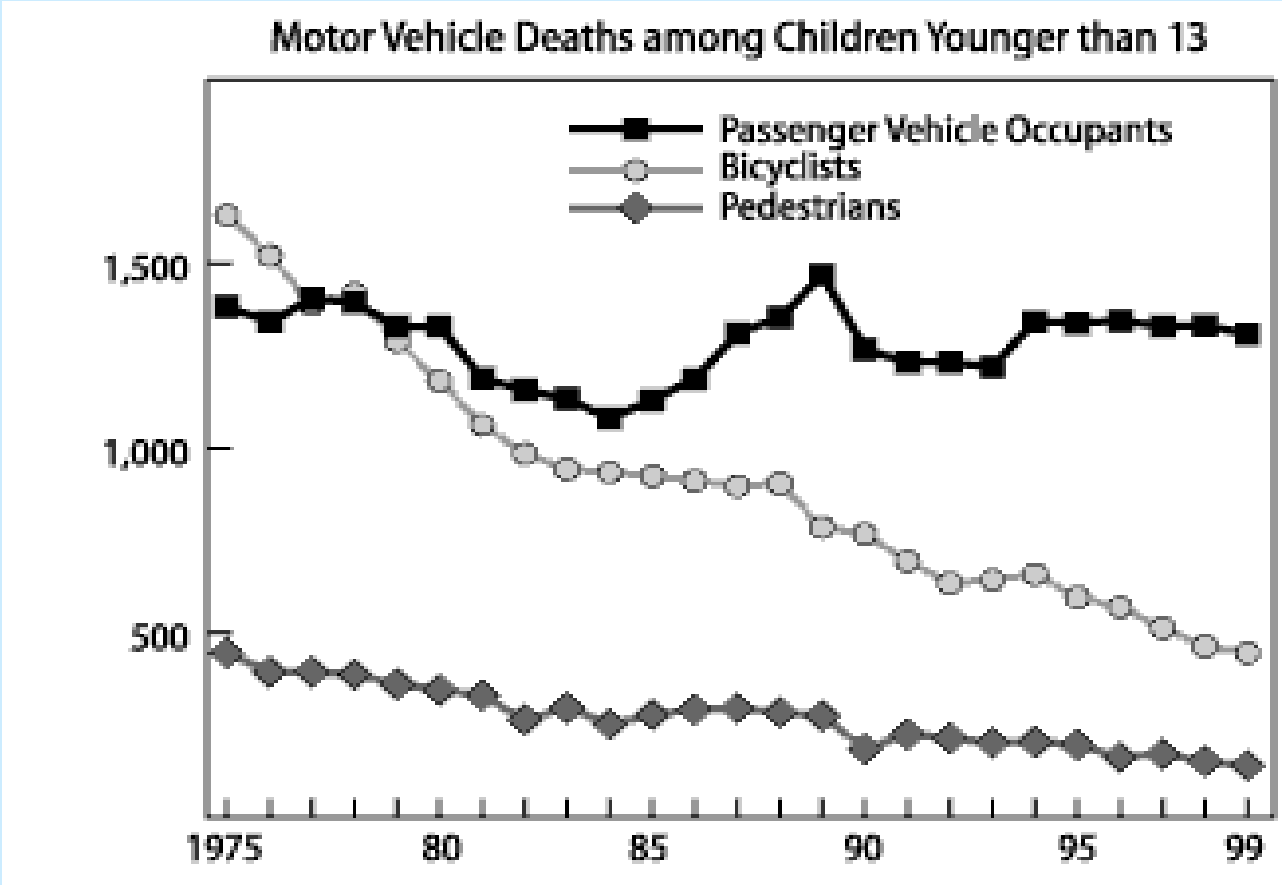
Childhood Crash Injury Patterns Associated with Restraint Misuse

Presenters: Eileen Bulger, MD
Rob Kaufman, BS

HARBORVIEW
INJURY PREVENTION
& RESEARCH CENTER

CIREN- Crash Injury Research and Engineering Network

Death rates among children in motor vehicle crashes through the last decade



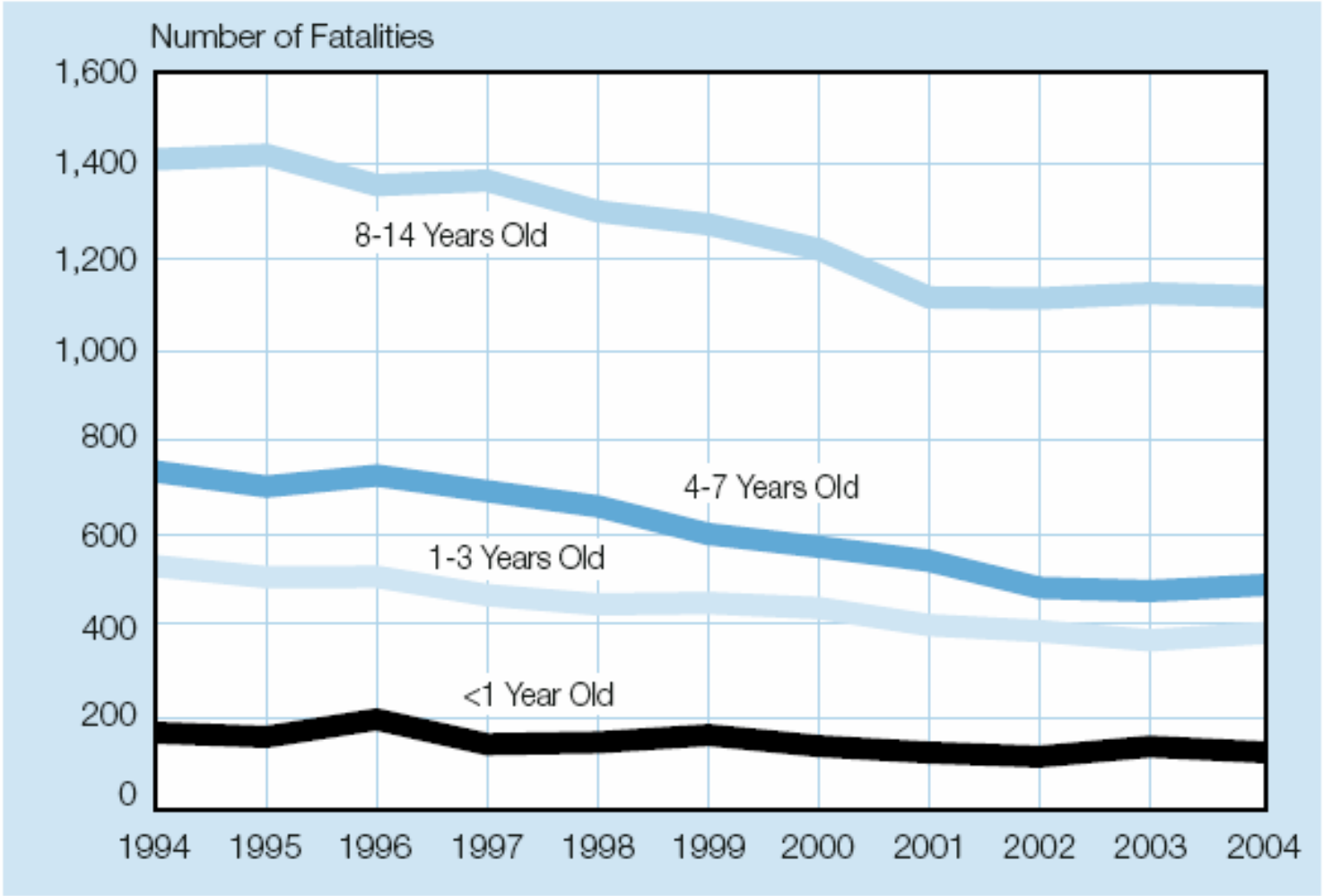
NHTSA - Traffic Safety Facts

Pediatric Motor Vehicle Deaths

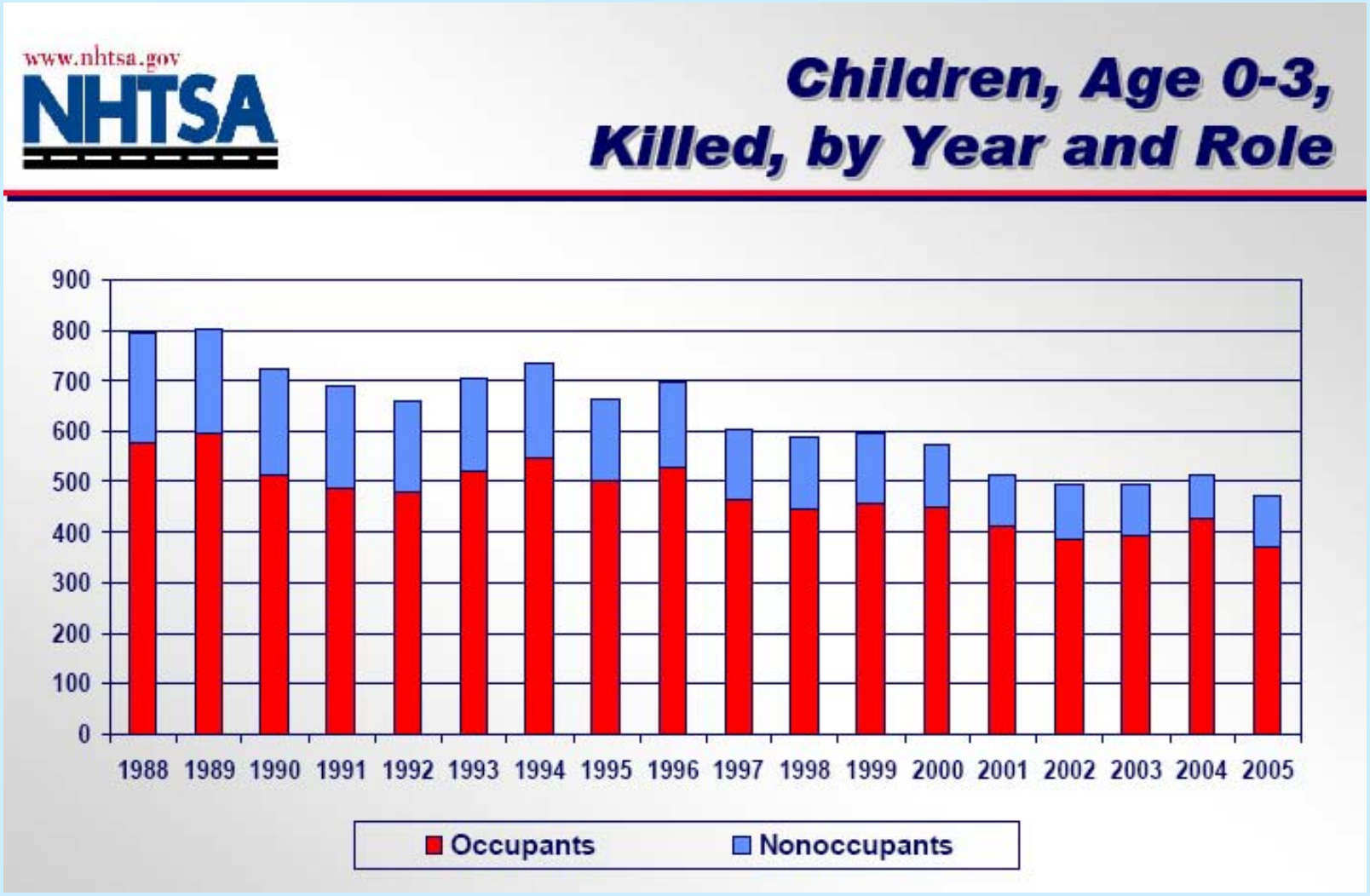
- Motor vehicle crashes are one of the leading causes of death for 3-13 year olds.
- Premature graduation to seatbelts, none used, or child restraint misuse.
- No decrease in 4-8 yr child occupant death rates between 1994-99.
- Starting in Year 2000 fatality data reported for ages 0-15 dropped to lowest level.
  (0-4 down 3.9% and 5-15 down 4.6%)

2004 NHTSA Traffic Safety Facts – Total Traffic Fatalities

Total Traffic Fatalities Among Children 14 and Younger by Age Group, 1994-2004



NHTSA's National Center for Statistics and Analysis



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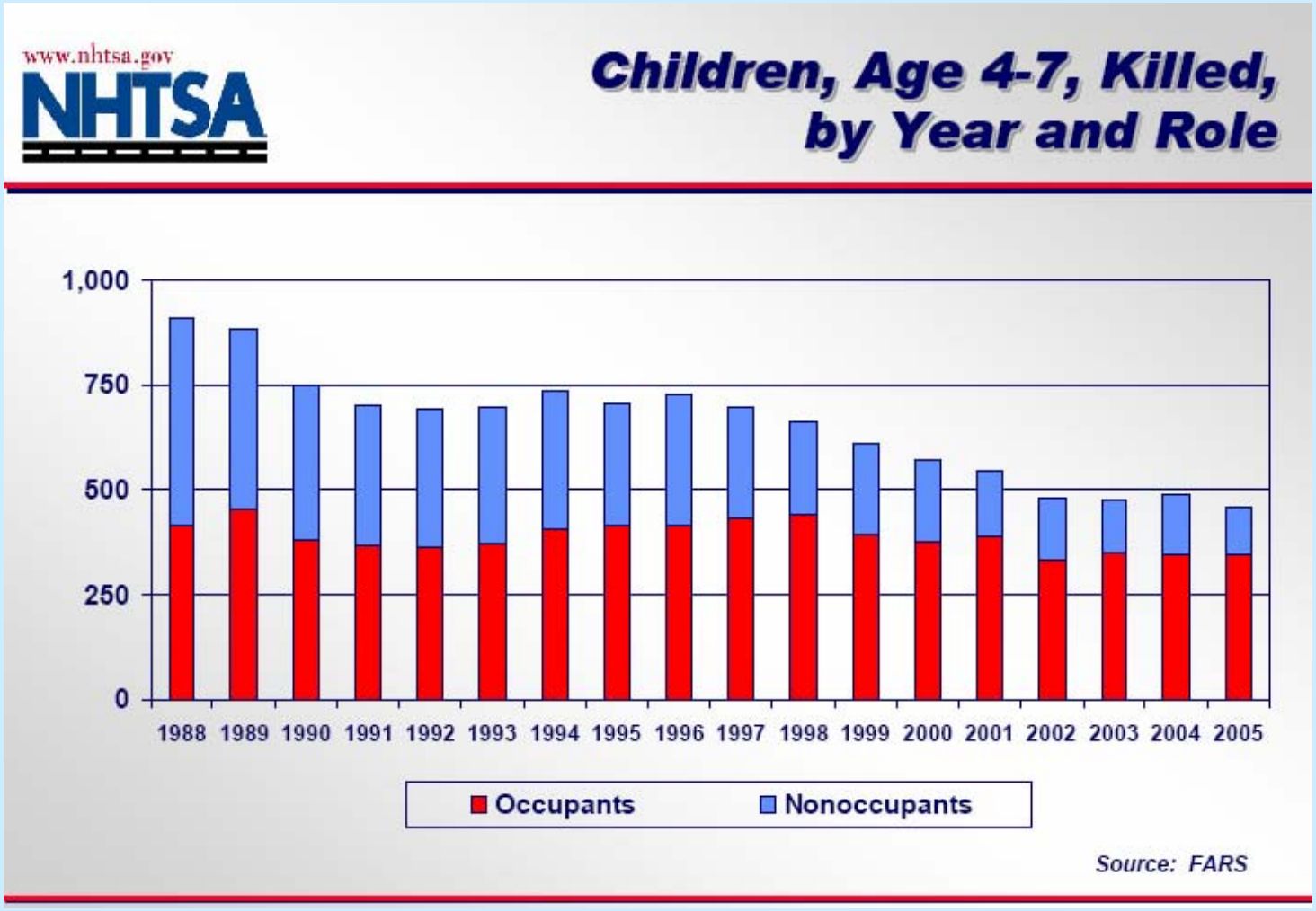


Non-occupant declined, but occupant shows no change last 3-4 yrs

2004 Traffic Safety Facts, NHTSA

Children Under 5 Years Old Fatally Injured in Passenger Vehicle Crashes by Age Group and Type of Restraint, 2004

Type of Restraint	Infants (Under Age 1)	Toddlers (Age 1-4)	Total
None Used	36	142	178
Child Safety Seat	80	191	271
Adult Safety Belt	4	42	46
Total	**120**	**375**	**495**

Restraint Use by Passenger Vehicle Occupants Involved in Fatal Crashes by Age Group, 2004

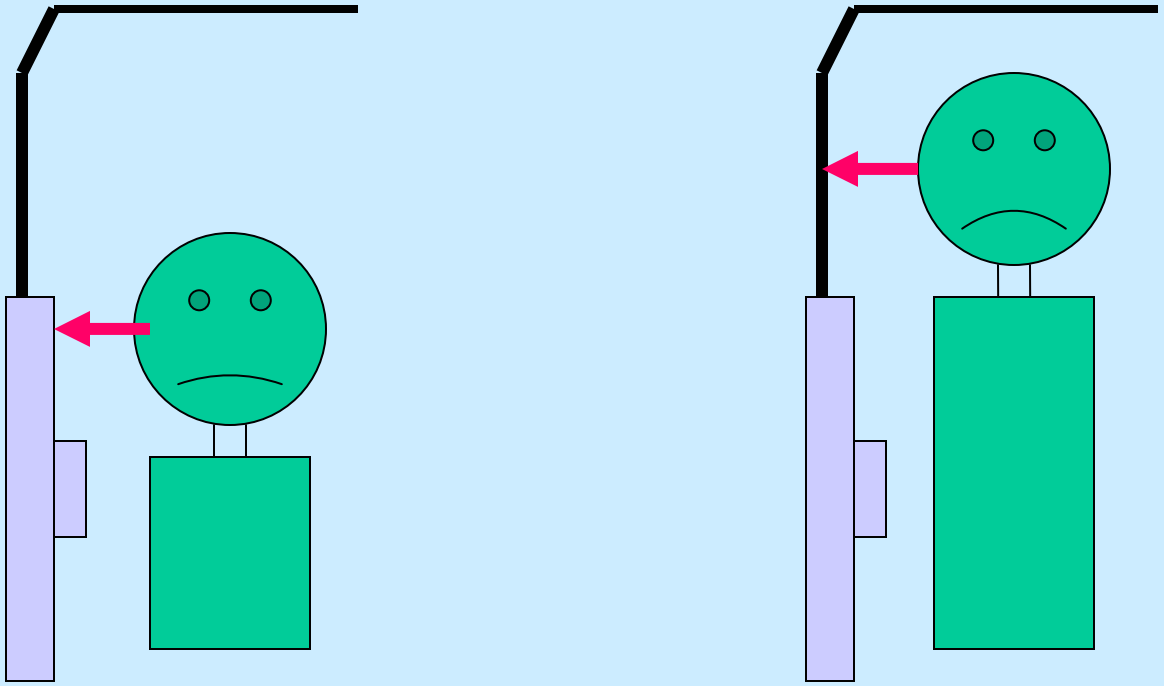
Percentage Unrestrained	Age Group (Years)					
	<1	1-3	4-7	8-14	All Other	Total
	16	18	28	36	38	37

Children in Side Impacts

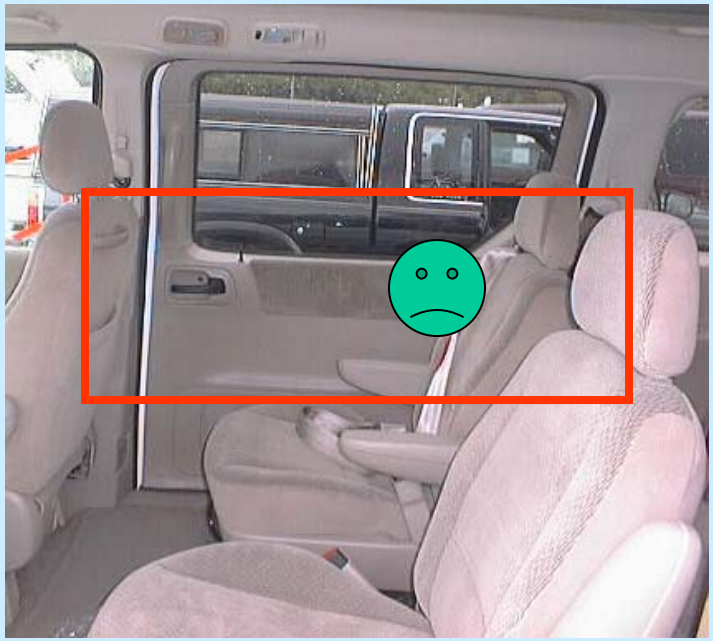
Roll of Booster Seat Positioning

Head Injuries

Remember that children are exposed to more surface area for head contact in crashes.

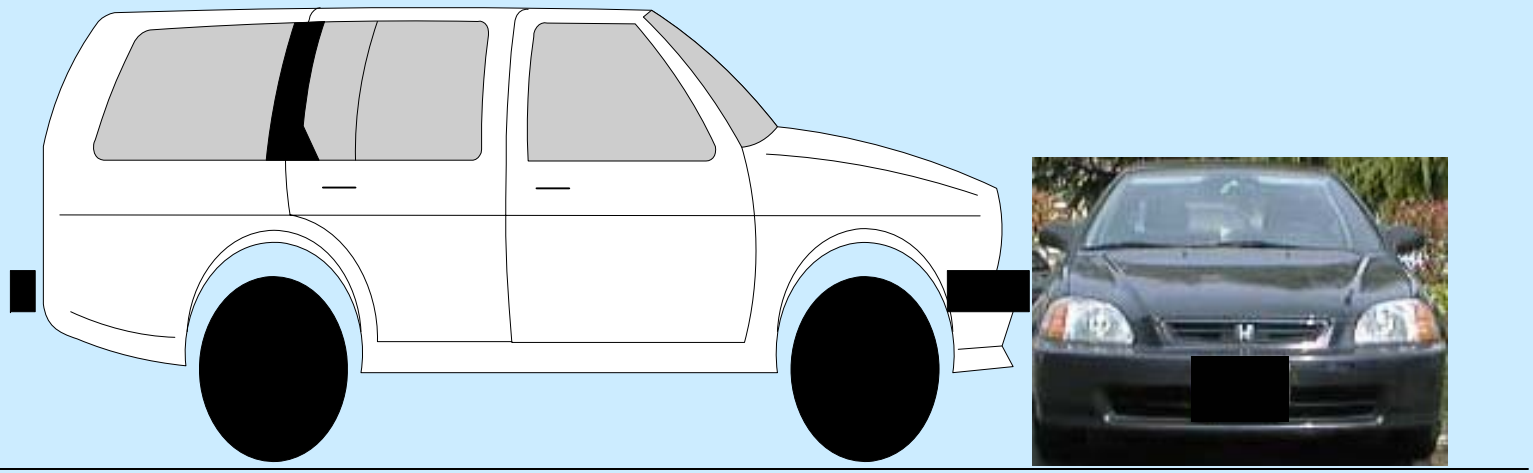


Children that are seated in vehicles expose themselves to more surface area for head contacts



Adults head contacts will occur to the greenhouse structure (roof and roof pillars)

Larger Vehicle and Side Impacts



Large vehicle types vs. compact/economical

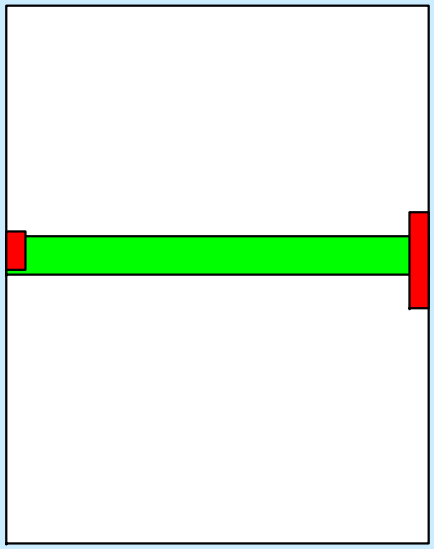
Impact to upper door

Upper door panel intrusion

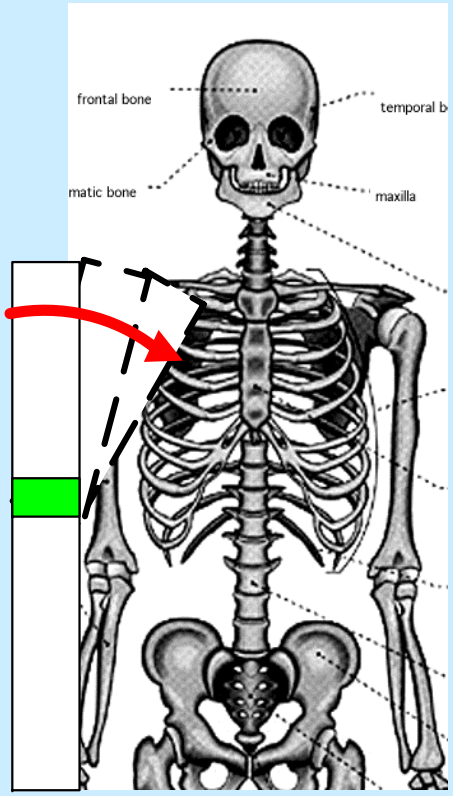
Compact Wagon vs. SUV

Upper door panel intrusion may occur into near-side impact position

Side impacts with larger vehicles with lateral door support beams



Side View

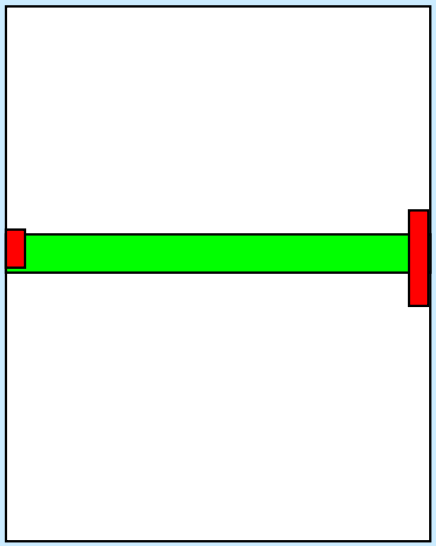


End View

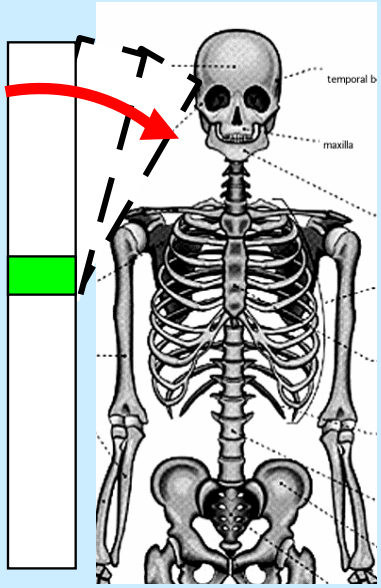
Adult pattern

Impact to thoracic region

This becomes head contacts for children



Side View



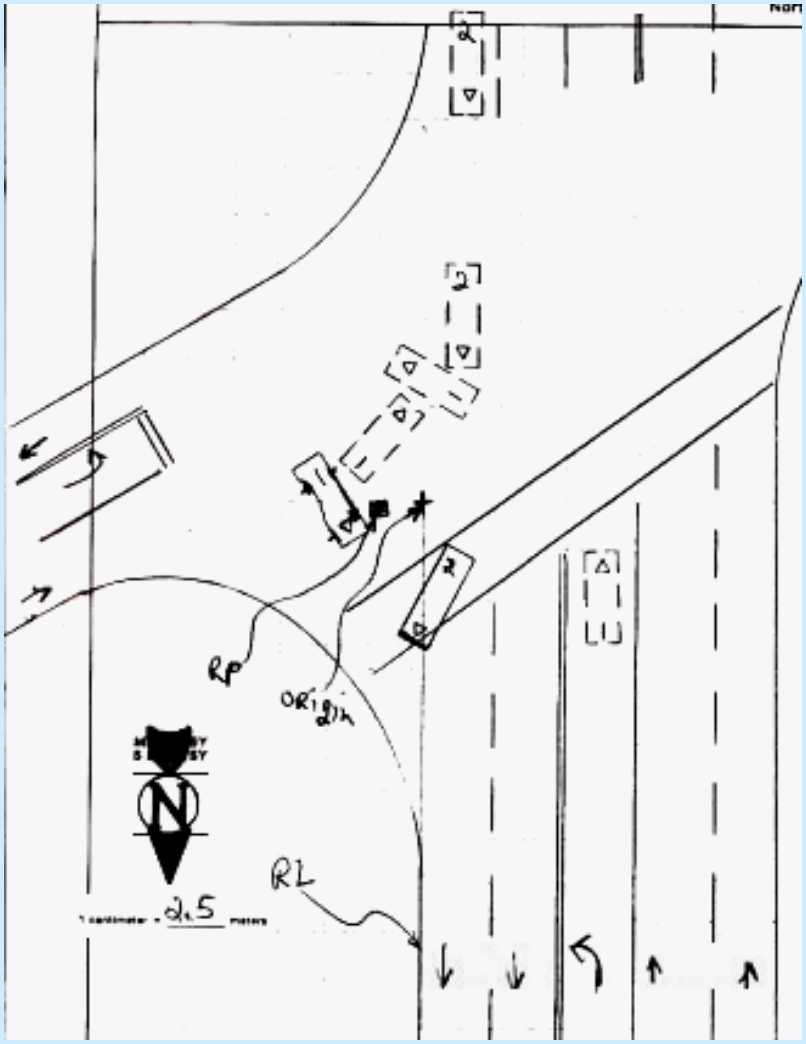
End View

CIREN Case Review

1990’s Compact Sedan

Moderate force

Struck by large pickup



Case review

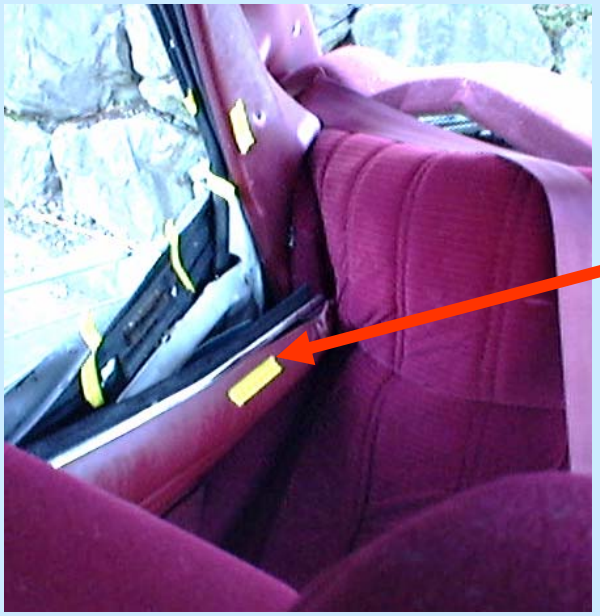
8 yr.

Back right seat - fully restrained

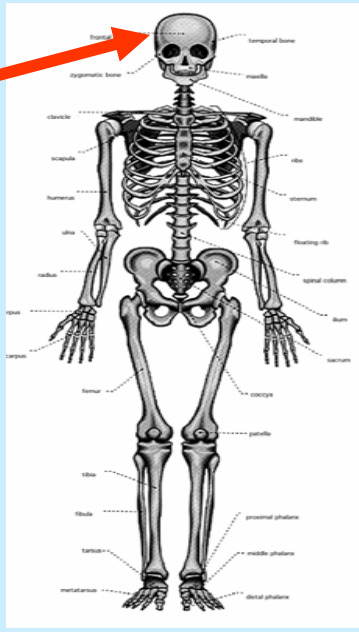
Sleeping with head against the door panel

No Booster Seat used

Interior Contacts and Door Panel Intrusion



Critical Head Injury

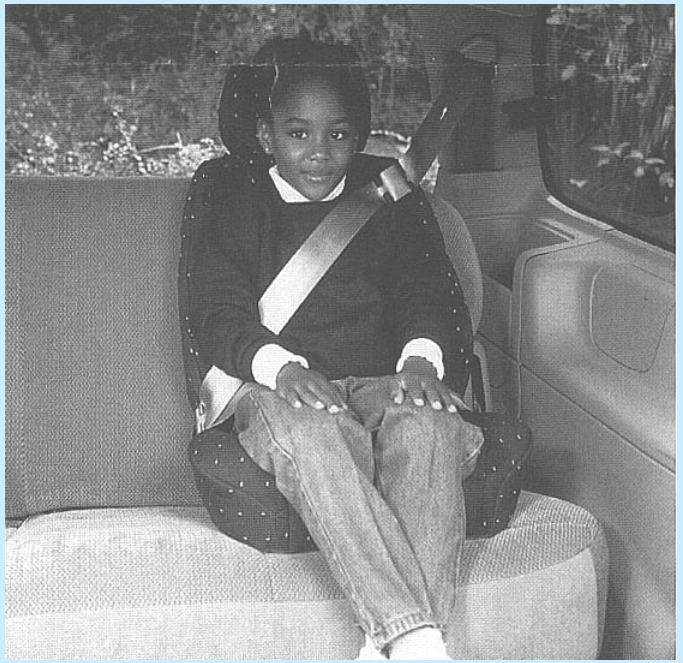


40 cm of intrusion at door panel, window sill

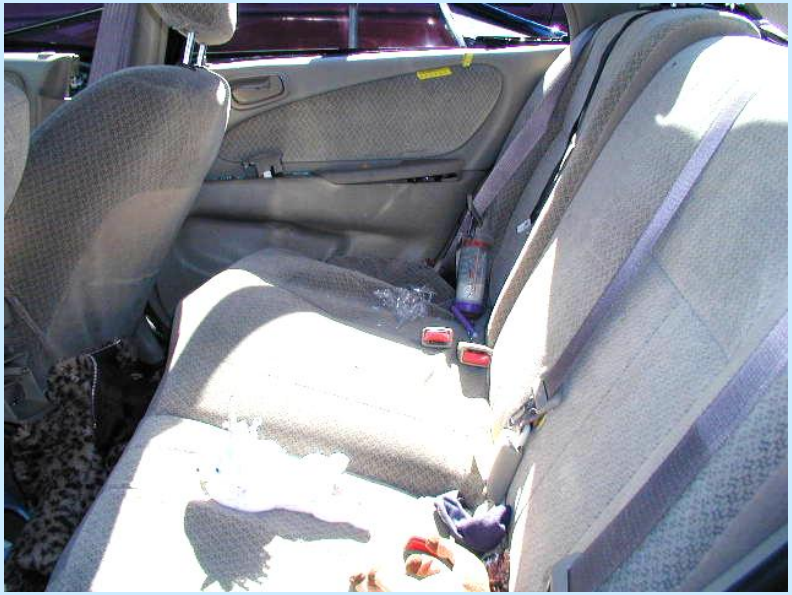
Side impact w/ child in booster seat

7yr old, second row right

Lap/shoulder with booster seat



Minor Head Injury



Head positioned above door interior

Inflatable Curtain

- Booster seat will allow children to possibly benefit from a side impact air bag

FRONTAL IMPACTS

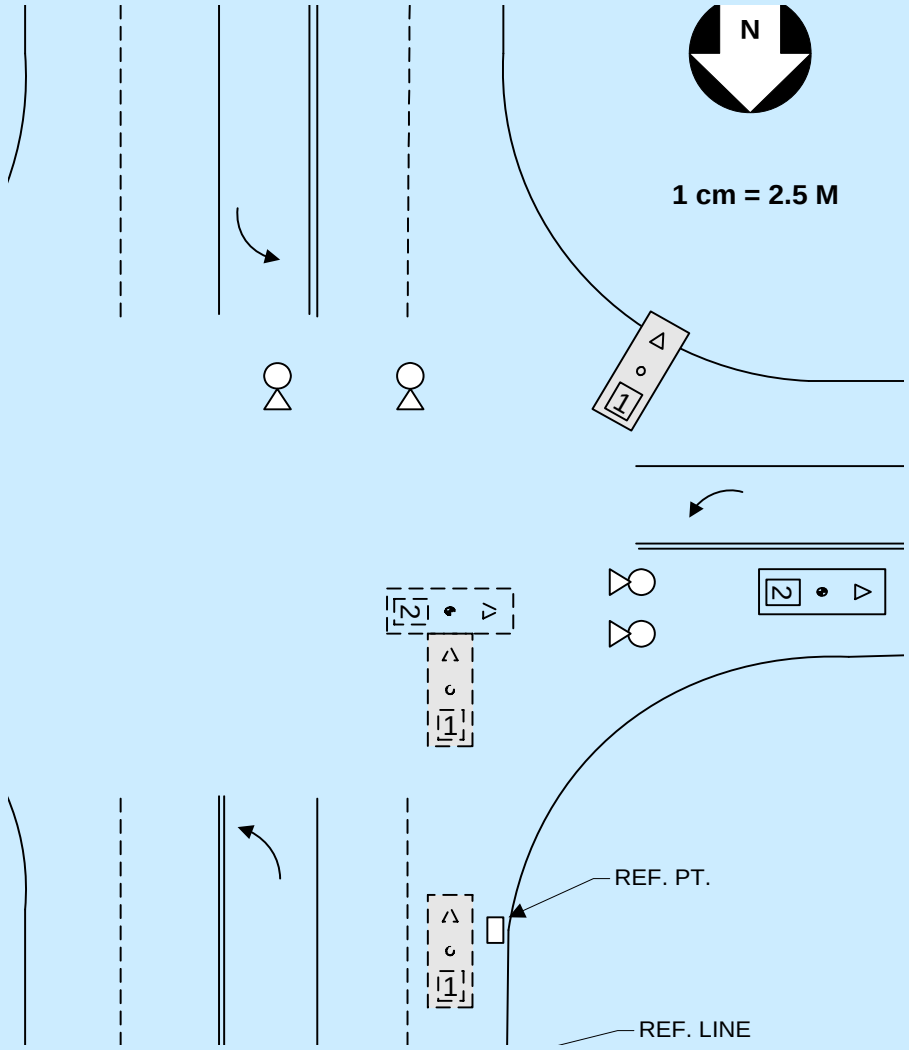
Child Seat Misuse
Rear-facing Infants

Child Seat Tech 101

1. Harness SNUG
2. Retainer clip at armpit level

3. Child seat secured firmly w/ seat belt

Case Review



1990's Compact Sedan

Delta V = 12 mph/19kmph

PDOF = -30 or 11 o'clock

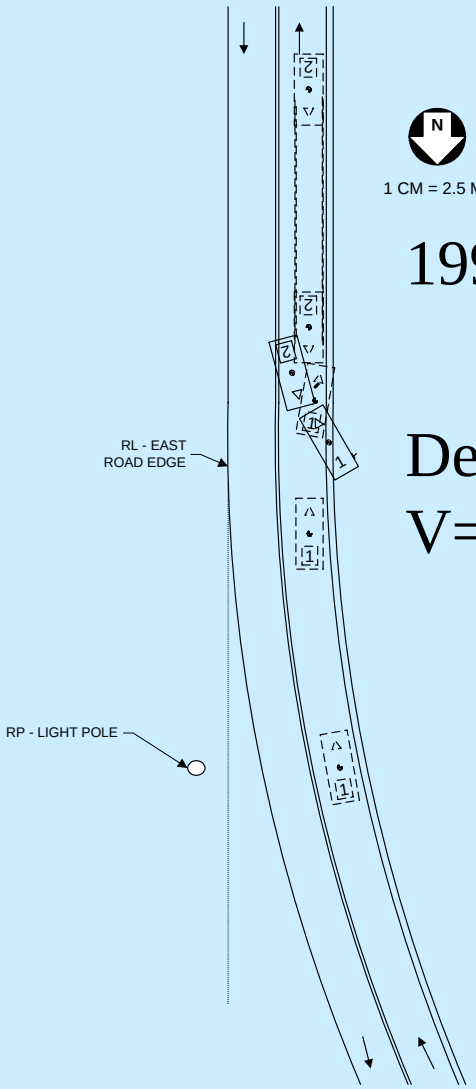
Case Review

Infant

Harness not used, and child seat not belted

Interior contacts

Unrestrained child seat flew forward into center instrument panel resulting in a serious head injury



N

1 CM = 2.5 M

1990's Compact Sedan

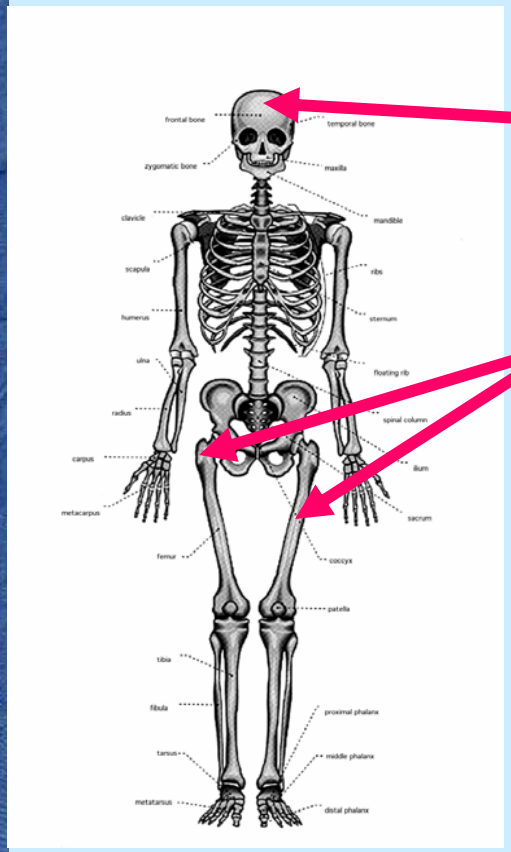
Delta V=33mph/53kmph

Child less than one year old

Infant rear facing\5 pt. belt

Flipped forward (backwards for child seat) and then found flipped to the right and on to its side

INJURIES



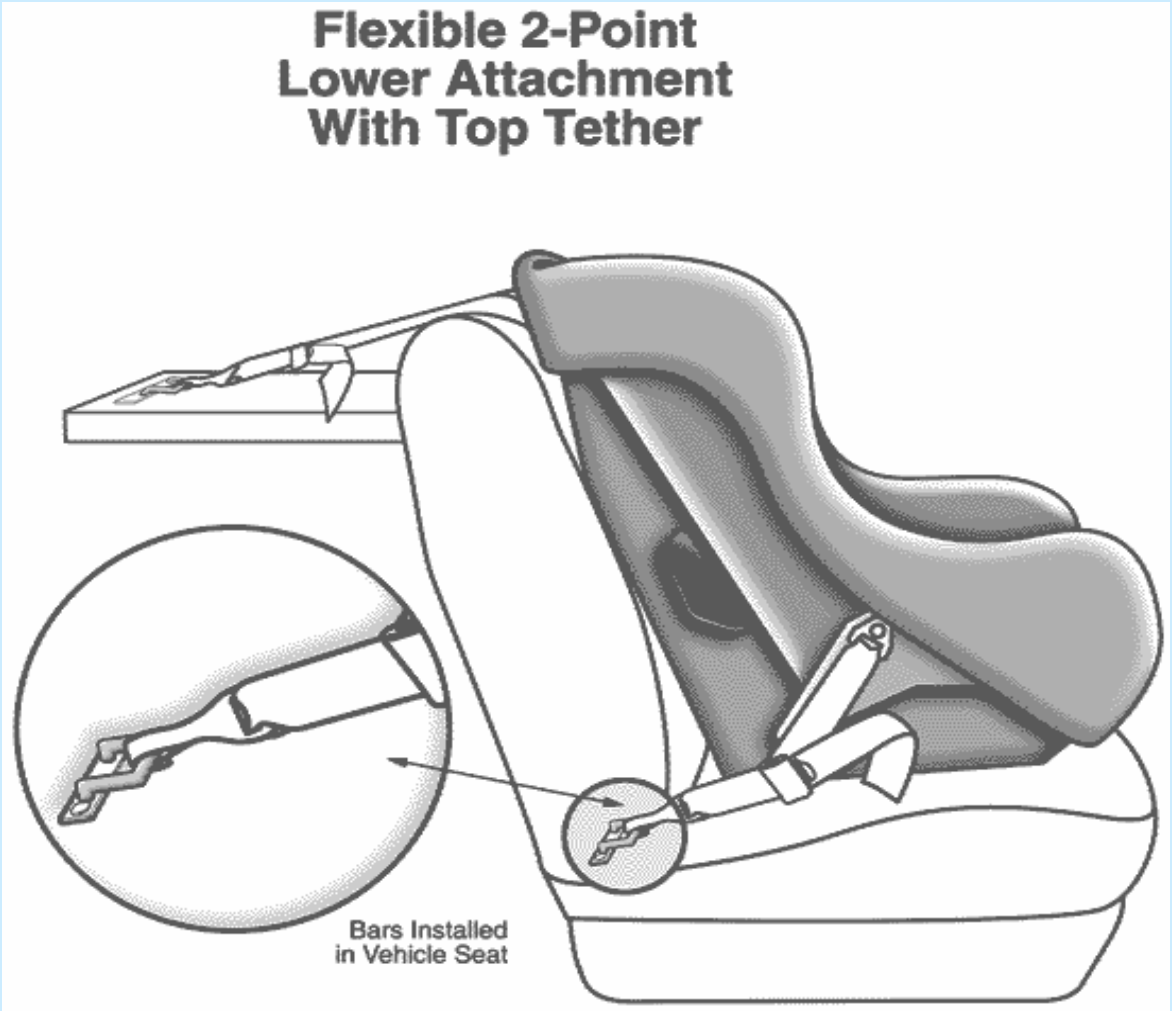
Severe Head

Severe lower leg injury

Addressing Car Seat Issues

- Incompatibility and incorrect usage
  - LATCH anchorage system
- 100 % of vehicles manufactured on or after Sept. 2002 must have lower anchorage
- Sept. 2000 - 100% tether anchorage required

Tether and LATCH System



Frontal Impacts

Forward-Facing Child Seats

Lower Extremity Fractures

Crash Test – Feet protrude forward

A loosely installed child seat and harness straps will increase the lower extremity extension forward

Case Review

1990's Compact Sedan

Severe frontal impact

Child less than one year old
2nd Seat Left

Early 1990's Fisher Price model
Forward Facing

Case Review – Misuse FWD

Early 90's Fisher Price

Adjusted to upright setting

Lap/shoulder restrained without locking clip

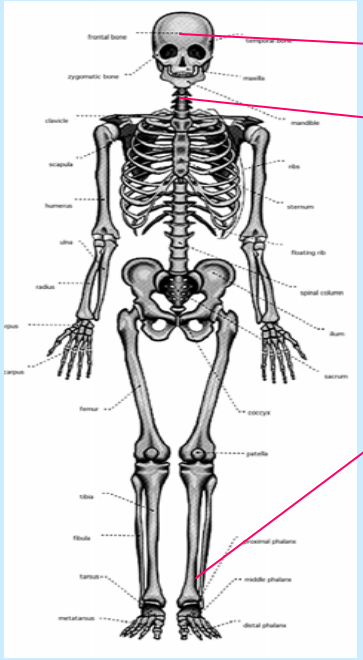
Child buckled in straps – should be rear-facing

Case Review – Misuse FWD

Scuff mark on driver's seat back

Belt webbing mark – no locking clip used

Injuries



Minor Head and Neck Injury

Lower leg fracture

Research on Lower Extremity Injuries in FWD facing car seats (1-4 year olds)

"Crash Analysis of Lower Extremity Injuries in Children Restrained in Forward-Facing Car Seats During Front and Rear Impacts"
T. Bennett MD, Robert Kaufman BS, Melissa Schiff MD MPH, Charles Mock MD PhD, Linda Quan MD

IN PRESS – *Journal of Trauma* (submitted 12-2004)

Children (1-4 yr.) Lower Extremity Fractures Research Summary

- CIREN – Evaluated Detailed Case Reviews
- 11 cases meeting criteria (1-4yr., frontal impacts)
  - Sources of lower extremity fractures
    - Three fourths involved contact with interior surface ahead of child with over half assigned to the seat back
  - 3 children only using lap or lap/shoulder belt
  - Average Delta V = 29 mph, 46 k/mph

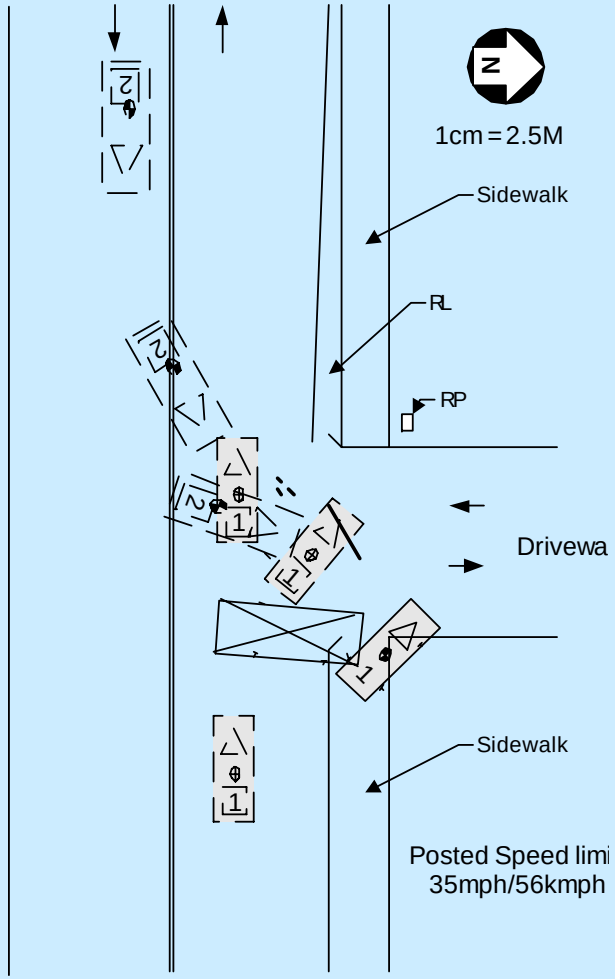
Children (1-4 yr.) Lower Extremity Fractures Research Summary

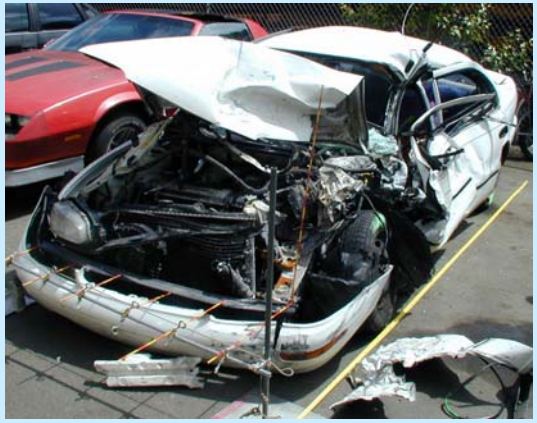
- National Automotive Sampling System Review
  - 15 children (1-4yrs.) In-line impacts
    - Seatback support sourced to two thirds
    - Lower extremity fractures – 8 femur, 5 tibia/fibula, 2 ankle
    - 14 of 15 involved had a fatality or hospitalized occupant due to injuries.
    - Mean Delta V -40kmph/25mph

Frontal Impacts

Misuse of Forward-Facing Child Seats

Case Review Child Seat Misuse



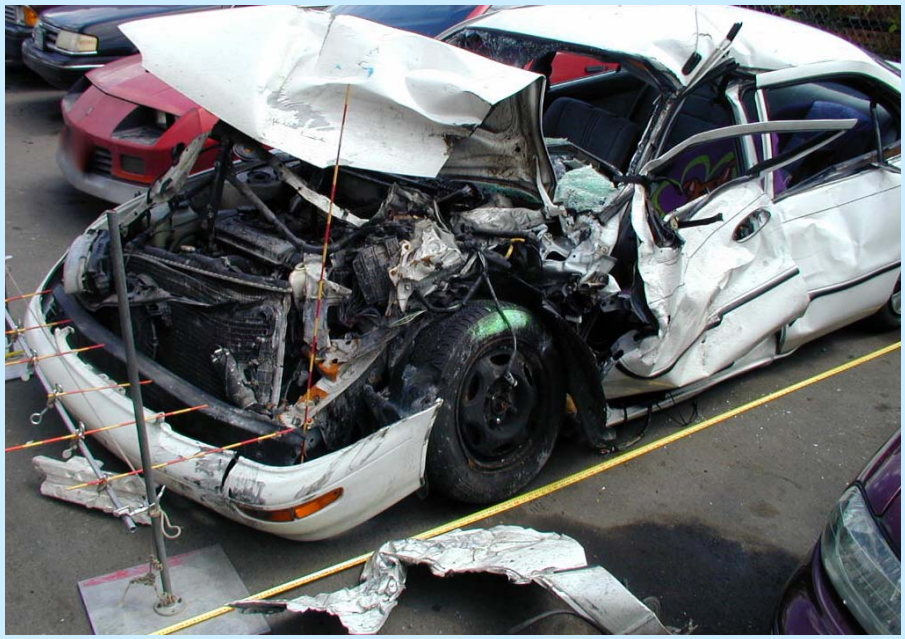


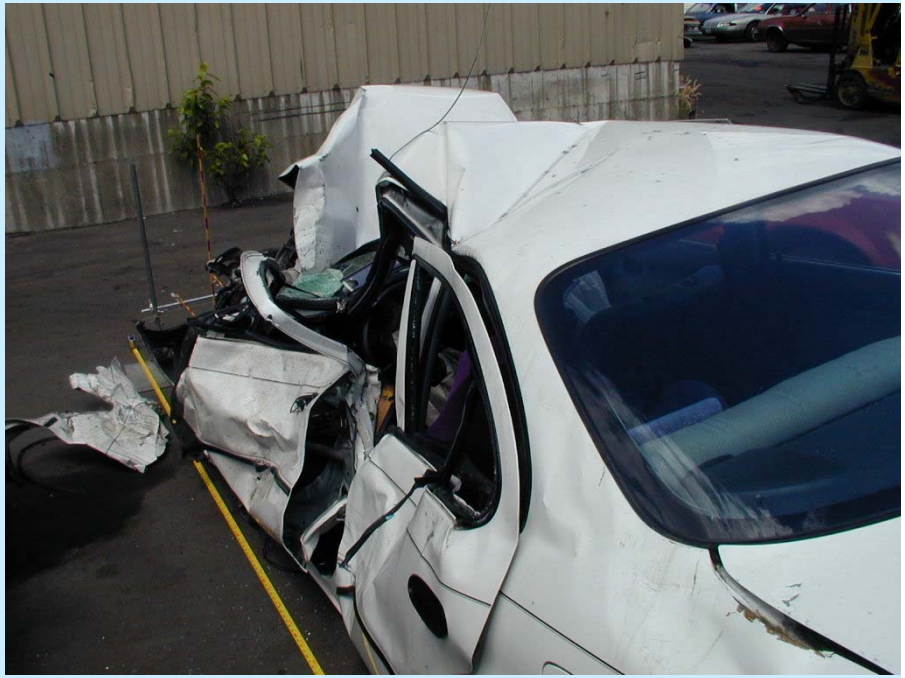
1990's Compact Sedan

Case occupant - 2nd row left

2-year old - FWD facing child seat

Exterior Crush





Crush extends down left side with lateral intrusion occurring to left near-side seated positions

Child Safety Seat

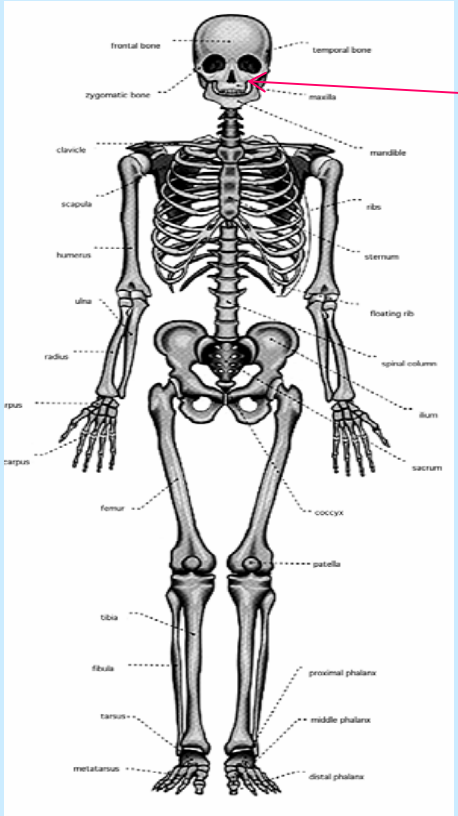
- Forward-facing Evenflo car seat with a 5-point harness secured with a retainer clip
- No locking clip used

Contacts and Lateral Intrusion

Pre-impact Location of Child Seat

Forward movement of child seat matched to contact marks on door

Injury Summary

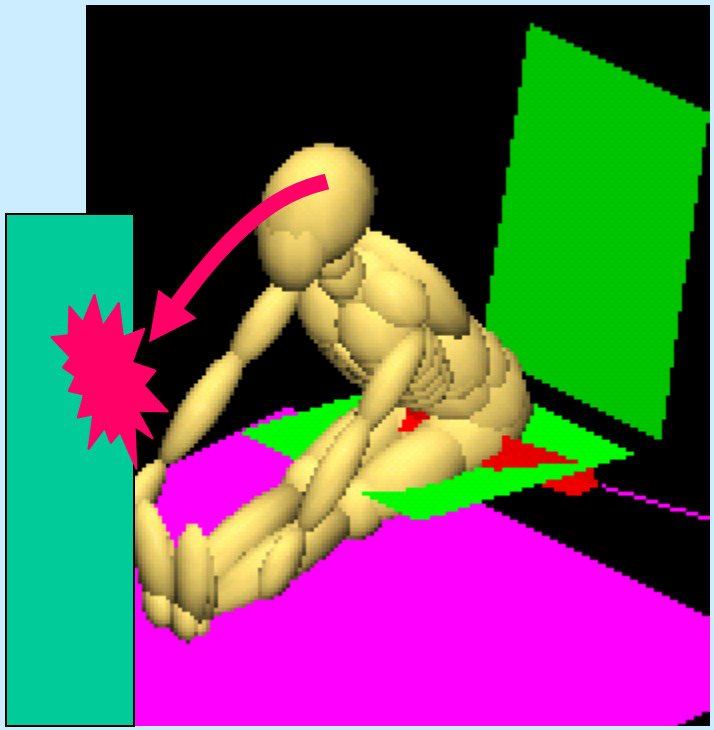


Face/Head – Moderate Injuries

Frontal Impacts

4-8 year olds
Booster positioning

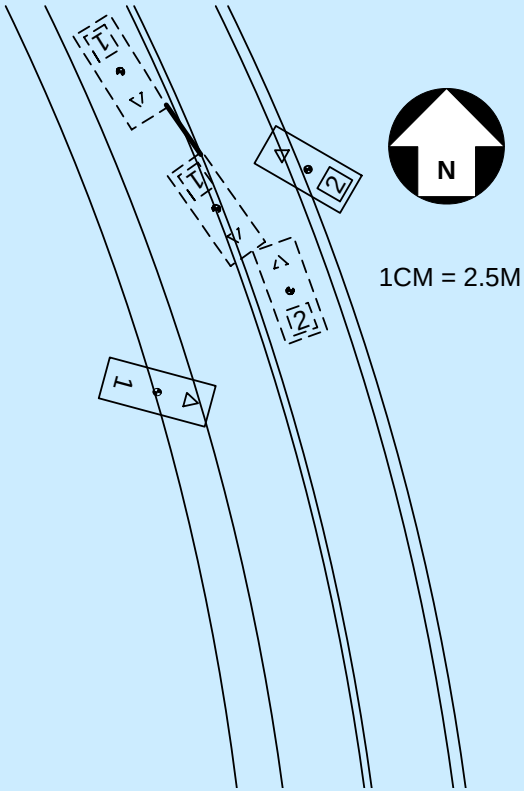
Lap only restraint/Shoulder belt behind back in frontal impacts



Body buckles forward and head/face contact interior surface in front of seating position

Subject Vehicle

1990’s Compact Sedan
Moderate frontal impact



<u>Subject</u>

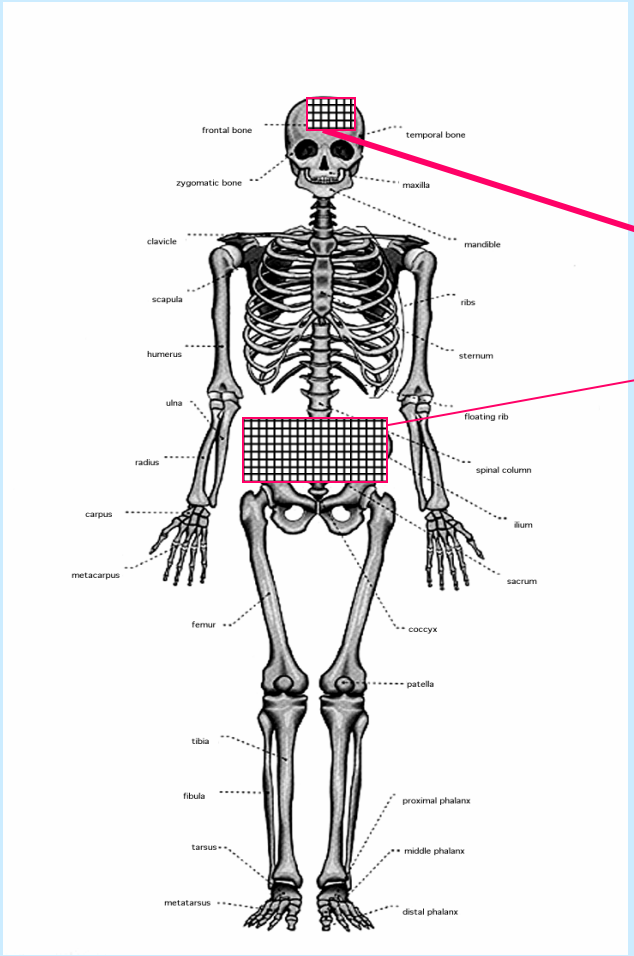
8 yr.old.

Back left seat
L/S - w/ shoulder belt
behind the back

-Head contact

- Shoulder behind back

Injuries



AIS	
2	**Moderate injury to the face**
2	**Multiple moderate injuries to the abdomen**

Belt Positioning Booster Seats

- Recommended for children 4-8 years old; 40-80 pounds
- Moves belt down off abdomen and neck
- Decrease the risk of head contacts and injury

CIREN Case Review

Subaru

4 yr. child, 2nd Left

Low back booster with lap and shoulder belt

Case Review

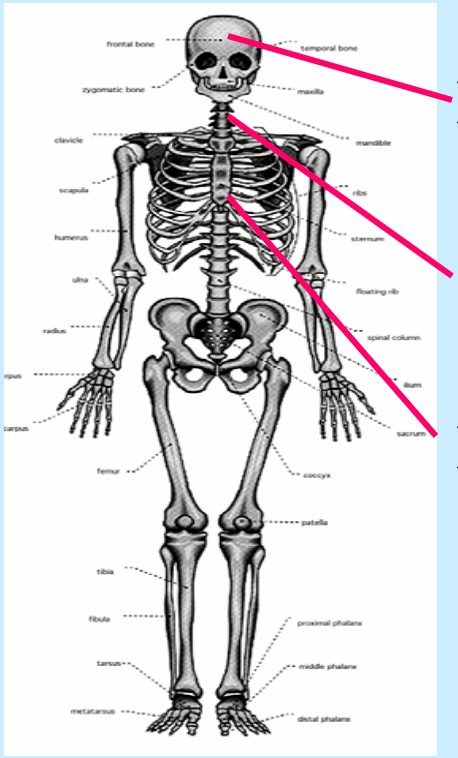
4 yr. Old
Booster Seat w/
Lap/Shoulder belt

Cosco Booster

Injuries

4 yr. old

Booster Seat w/
Lap/Shoulder belt



Minor head injury

Minor neck strain

Minor chest injury

Child seats reduce risk of injury

- When used correctly, child safety seats are
  - 71 percent effective in reducing fatalities;
  - 67 percent effective in reducing the need for hospitalization; and
  - 50 percent effective in preventing minor injuries.

Source- NHTSA

Triage for Children in Crashes Assessing Misuse and Mechanism

- Any external marks to the child face/head
- Near-side impacts
  - Assess height of impact and door intrusion location into head or body
- Frontal impacts
  - Was another occupant in the crash critically injured /or dead
  - And/or significant frontal crush or A-pillar movement
  - Child in appropriate child seat, use of restraints correctly
- Rear or forward facing child seats
  - Is the child seat still firmly secured to the seatbelt
  - Is the harness snug and retainer clip used and positioned mid-chest
  - Examine lower extremities