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 are all factors that increase injury severity for children.

2012 Traffic Safety Facts, NHTSA

| Percent of Passenger Vehicle Occupants Involved in Fatal Crashes, by Restraint Use and Age Group, 2012 |
|--------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age Group (Years) | <4 | 5-6 | 6-7 | 7-8 | 9-10 | 11-12 | 13-14 | 15-20 | 21+ |
| Restrict Used (%) | 54 | 63 | 62 | 78 | 82 | 63 | 24 | 76 |
| Restrict Not Used | 7 | 14 | 18 | 22 | 18 | 32 | 20 | 26 |

Note: Excluding unknown age and unknown restraint use.

2012 Traffic Safety Facts, NHTSA

| Children 4 and Younger Killed in Passenger Vehicles, by Type of Restraint and Age Group, 2012 |
|--------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Type of Restraint | <4 | 5-14 | Total |
| Restrict Used | 65 | 73 | 88 |
| Adult-Size Belt | 2 | 19 | 21 |
| Child-Size Belt | 4 | 1 | 5 |
| Restrict Used—Unknown | 0 | 3 | 3 |
| Unknown | 2 | 12 | 14 |
| Total | 92 | 246 | 298 |
Children in Side Impacts

Roll of Booster Seat Positioning

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)

Example of upper door panel intrusion

Compact Wagon vs. side impact with light truck vehicle

Upper door panel intrusion may occur

Head Injuries

Remember that children are exposed to more surface area for head contact in side impact crashes when not using a booster seat.

Larger Vehicle and Side Impacts

Large Vehicle types vs. Passenger vehicles

Impact to upper door may occur

This becomes head contacts for children

Side View

End View
CIREN Case review

- Compact Sedan
- Moderate force
- Struck by large pickup
- 8 yr. old
- Back right seat
  - lap/shoulder restrained
- Sleeping with head against the door panel
- No Booster Seat used

Interior Contacts and Door Panel Intrusion

- Critical Head Injury
- 40 cm of upper door panel intrusion at location of child's head

Side impact w/ child in booster seat

- 7 yr old, second row right
- Lap/shoulder with booster seat
- No Head Injury
- Head positioned above door interior

Inflatable Curtain

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

Child Seat Misuse Rear-facing Infants

- 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

Significant Frontal Impact

Loose lap belt allowed child seat to extend additionally forward then it flattened down onto the center console. The child seat then rebounded and flipped over to the right and came to final rest on its side.

INJURIES

Severe Head
Severe bilateral lower leg injuries

Retainer (chest) clip was positioned incorrectly and allowed the upper body to come out of the shoulder straps putting all the loading force on the lower legs.

Frontal Impacts

Forward-Facing Child Seats
Lower Extremity Fractures
Crash Test – Feet protrude forward

A loosely installed forward facing child seat and harness straps will increase the lower extremity extension forward allowing a greater chance of contact with the seatbacks.

Case Review

Compact Sedan
Severe frontal impact
Child less than one year old
2nd Seat Left
Forward Facing Child Seat

Case Review – Misuse FWD

Adjusted to upright setting
Lap/shoulder restrained without locking clip
Child should have been rear-facing for age

Case Review – Misuse FWD

Scuff mark from lower leg on driver’s seat back
Belt webbing loading mark – no locking clip used, allowed more child seat movement forward

Injuries

Minor Head and Neck Injury
Lower leg fracture

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

Bennet T., Kaufman, Schiff M., Mock C., Quan L. “Crash analysis of lower extremity injuries in children in forward-facing car seat during front and rear impacts.” Journal of Trauma. 2006;61-592-597
Children (1-4 yr.) Lower Extremity Fractures
Research Summary

- CIREN – Evaluated Detailed Case Reviews
- Selected 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 were only using lap or lap/shoulder belt
    - Average Delta V = 29 mph, 46 k/mph

Frontal Impacts

Misuse of Forward-Facing Child Seats

Case Review Child Seat Misuse

Compact Sedan
Case occupant - 2nd row left
2-year old - FWD facing child seat

Exterior Crush

Crush extended down left side with some lateral door panel intrusion occurring to the left near-side seat positions

Child Safety Seat

- Forward-facing child car seat with a 5-point harness not secured with a retainer clip
- No locking clip used to secure child seat in vehicle

Contacts and Lateral Intrusion
Pre-impact Location of Child Seat

Forward movement of child seat matched to contact marks on door

Injury Summary

Frontal Impacts

4-8 year olds
Booster seat positioning

Lap only restraint and shoulder belt behind back in frontal impacts

Body buckles forward and head/face contacts interior surface in front of seating position with significant loads also occurring to abdomen.

Subject Vehicle

Subject
8 yr. old. 
Back left seat
L/S - w/ shoulder belt behind the back
Belt Positioning Booster Seats

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

Success Case Review

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

Injuries

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

Case Review

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

Injuries

- 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