

# Real World Frontal Impacts Involving Belted Rear Pediatric Occupants

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# MOVES Research Team

- Conducts field investigations and research for Transport Canada
  - Collision investigations
  - Investigations of public complaints of safety-related motor vehicle defects
  - Motor vehicle safety research
- Collision investigation studies
  - Air Cushion Restraint Study (ACR9)
  - Special Investigations (ASF7)
  - Pediatric Restrained Occupant Study (PROS)
  - Rear Occupant Protection Study (ROP3)
  - Side Impact Study (SID7)



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**Pediatric Restrained  
Occupant Study**

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# Pediatric Restrained Occupant Study

- Injury causation study focused on children
  - Pediatric = 17 years of age and under
- Case notifications
  - LHSC Trauma Program, police and media
- Police and injury data
  - Data collected for all pediatric vehicle occupants that attend LHSC
- Field investigations of severe collisions
  - Transport Canada's real world collision research program

*Delta-V: 72 km/h (Longitudinal at t = 92 ms)*  
**0110: 39-yr-F, Lap/torso/airbag, Major injuries**  
**0130: 17-yr-F, Lap/torso/airbag, Major injuries**  
**0210: 10-yr-F, Lap/torso, Fatal injuries**  
**0230: 11-yr-F, Lap/torso, Fatal injuries**



**Figure 1 ROP3-1602 Case Vehicle**

# Aims

- Mechanisms of pediatric injury
- Crash performance of restraint systems
- Increased knowledge of pediatric injury causation to mitigate and prevent injury

*Delta-V: 50 km/h (Longitudinal at t = 102 ms)*  
**0110:** 41-yr-M, Lap/torso/ airbag, MAIS-2  
**0130:** 70-yr-F, Lap/torso/airbag, Minor injuries  
**0210:** 9-yr-F, Lap/torso, MAIS-1  
**0220:** 42-yr-F, Lap/torso, MAIS-4  
**0230:** 11-yr-F, Lap/torso, Fatal



**Figure 2 ROP3-1622 Case Vehicle**

# Methodology

- Focus on frontal impacts involving belt-restrained children under 12 years of age
- Collisions investigated by the Western MOVES Team
  - Weighted towards severe pediatric injury
- Comparison of injury severity (AIS)

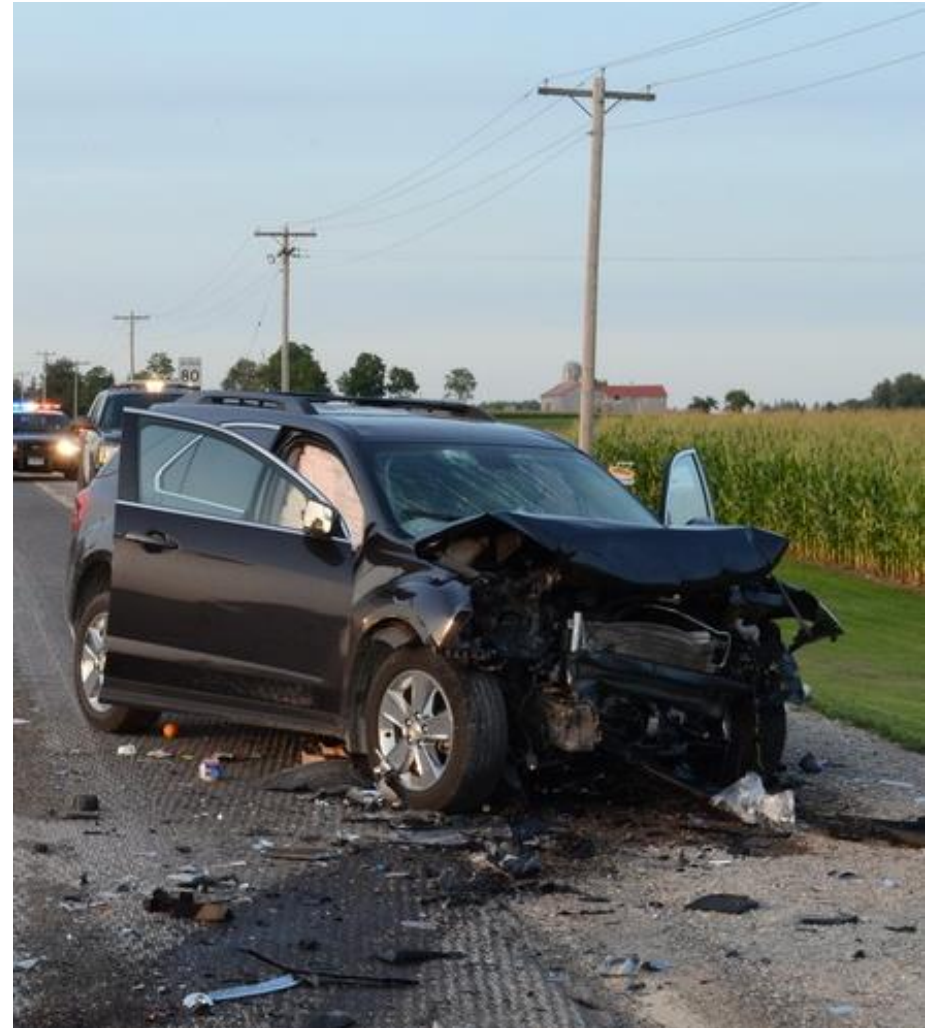
# Abbreviated Injury Scale (AIS)

- ❑ Injuries are ranked on a scale of 1 to 6 according to the associated threat to life
- ❑ MAIS = Maximum Abbreviated Injury Scale

<b>AIS Score</b>	<b>Injury</b>
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurvivable

# Results

- Collisions (N = 28) involved 40 children (23 F / 17 M) 3-12 years
- Severe frontal impacts
  - Offset frontals most common (N=15)
  - Delta-V ranged from 22 km/h to 89 km/h (average=  $52.6 \pm 15.8$  km/h)
  - No intrusion into rear occupant compartment
- 6 fatalities and 20 children admitted to hospital with serious injuries
  - Minor injuries or no injuries (N = 14)



# Results: Booster Seat

- 16 (9-F, 7-M) rear occupants
- 14 frontal impacts
- 3-10 years old  
(average= 6.1 +/- 1.7 years)
  - 14 children between 4 and 8 years
- 2 fatalities and 5 survivors of MAIS 2+ injuries
  - 9 children not injured or MAIS 1 injuries
- Restraint misuse 7 of 16 cases
  - Serious misuse in 5 cases (both fatalities and 2 cases of MAIS 2+ injuries)
  - Torso belt not worn (n=3), incorrect seat belt routing (n=1), out of position (n=1)
- Fatal cases- abdominal and head injuries (front seatback contact)



# Results: 3-point Seatbelt



- 24 (14-F, 10-M) in 16 frontal crashes
- 4-12 years (average= 9.3 +/- 2.3 years)
  - Most (n=20) between 8 and 12 years
- 4 occupant fatalities and 14 survivors of MAIS 2+ injuries
  - Only 6 children not injured or MAIS 1 injuries
- Restraint misuse 15 of 24 cases (4 fatalities and 9 MAIS 2+ cases)
  - Serious misuse in 8 cases (1 fatality, 6 MAIS 2+)
  - Torso belt not worn (n=4), booster seat was required and not used (n=4)
- Fatalities- abdominal injuries

# Discussion

- Front seats: multi-stage airbags and seatbelt pretensioners for lap and torso
- Rear seats: lap/torso belts without pretensioners
- Optimal seatbelt anchorage locations for small children are very different from those for adults
- Even with booster seats, the torso belt can roll off shoulder or lap belt ride up into abdomen



# Discussion



- Serious restraint misuse in 3 pediatric fatalities
  - Torso belt behind back, misrouted seatbelt, young child not using required booster seat
- Other 3 fatalities (10-11 years old) using lap and torso belt
  - Lap belt initially positioned on abdomen or rode up during collision
- Children properly restrained in booster seats fared well
- Children using seatbelts only were more frequently seriously or fatally injured

# Discussion

- Lots of attention given to smaller children using age appropriate infant and child seats
- Older children typically buckle themselves in and are frequently out of position



# Conclusions

- Booster seats improve occupant protection in frontal impacts when worn properly
- Misuse can cause devastating consequences in severe frontal impacts
- Need for better education of caregivers and children regarding proper restraint use
- Improvements are needed in restraint technology for rear occupants





**Occupants must be properly restrained *especially* when using a lap and torso seatbelt in rear rows**



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# Acknowledgments



**SPECIAL THANK YOU TO  
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