



Injury Mechanisms in Seat Belt-restrained Occupants in Side Impact Crashes

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Background

- Much attention on frontal crashes and tremendous success
- Recent attention on side impacts
 - Extensive focus on adults
 - Focus on children: limited to CRS

→ 42% of fatalities of rear seat occupants age 0-8 were in side impacts (FARS)

Background

Previous Research Findings

- Know general information about injury risk in side impact
 - Fatality risk Risk Increase
 - Nearside vs. center, rear, all restraints 2.5 [Howard, 2004]
 - Injury risk
 - Nearside: front vs. rear, all restraints 2.6 [Durbin, 2001]
 - Nearside vs. farside, belted rear 1.8 [Maltese, 2005]
 - Belt vs. Booster, side impact rear 1.7 [Arbogast, 2005]
 - Injured Body Region, belt restrained [Maltese, 2005]
 - Head injuries the most frequent, rear
 - Abdominal injury increase suspected in center/non-struck

→ Limited injury mechanism information.

Project Goal

Delineate injury mechanisms for belt-restrained children involved in side impact crashes.

Methods

Retrospective Case Review

- CIREN-like Interdisciplinary Team
 - Met ~3x per month
 - Reviewed 2-3 cases per meeting
 - For 8 months
- CIREN, PCPS Databases
- Case Review
 - CIREN-type presentation
 - BIOTab AIS 2+
 - Contact Points



Methods

Dataset Inclusion Criteria

- Side impact
- Belt-only restrained
- Rear row
- 4 to 15 years old
- AIS 2+

63 cases met criteria

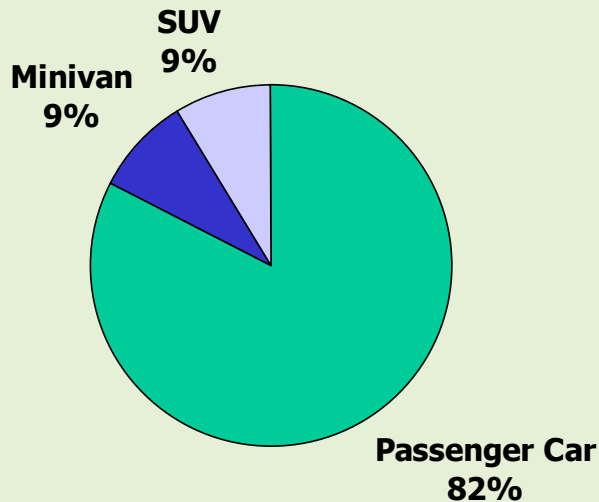
— 17 cases eliminated
after quality control

—————
46 total cases

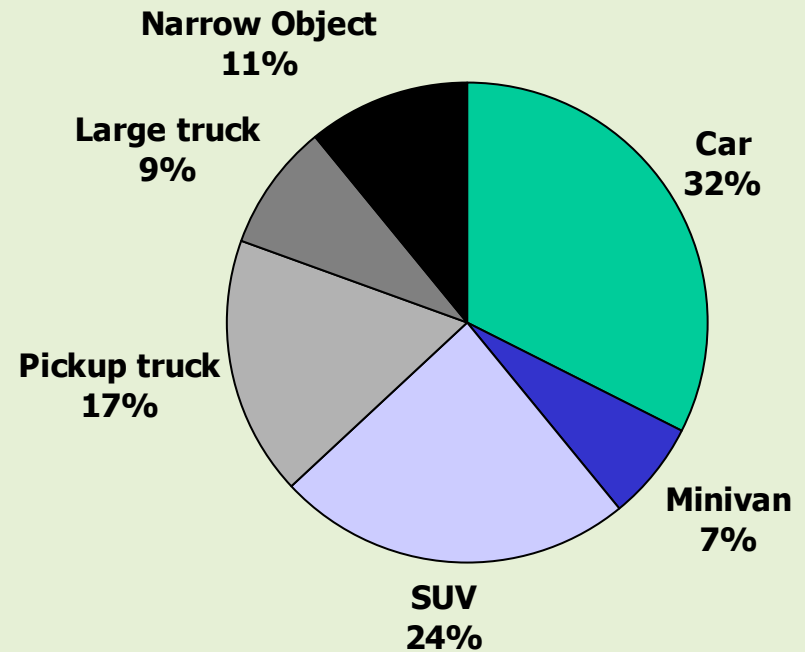
Dataset Characteristics

Vehicle

Case Vehicle



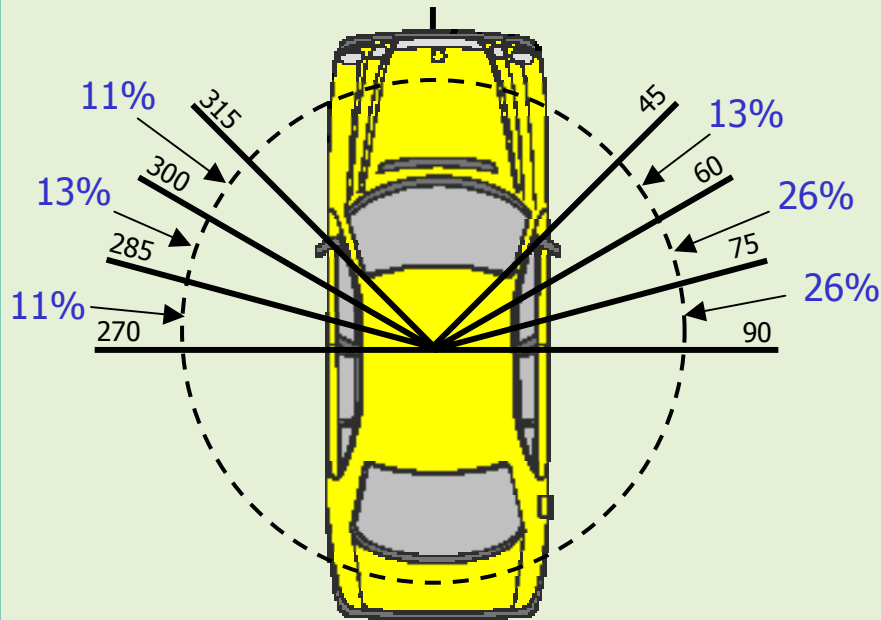
Other Vehicle/Object



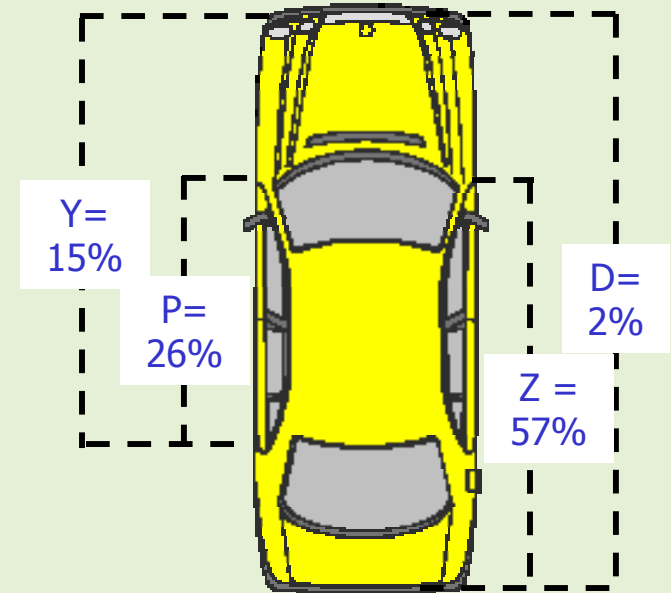
Dataset Characteristics

Crash

PDOF



CDC Damage



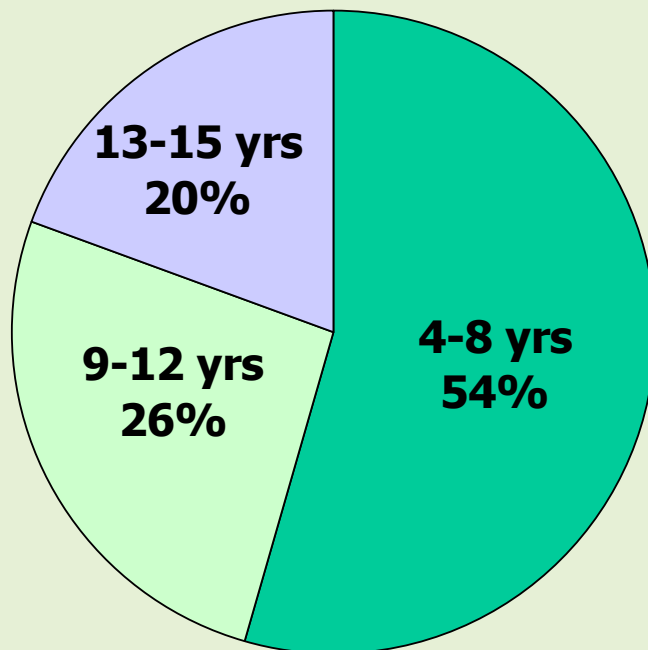
Delta V (kmph)

Average	26.5
Standard Dev.	12.4

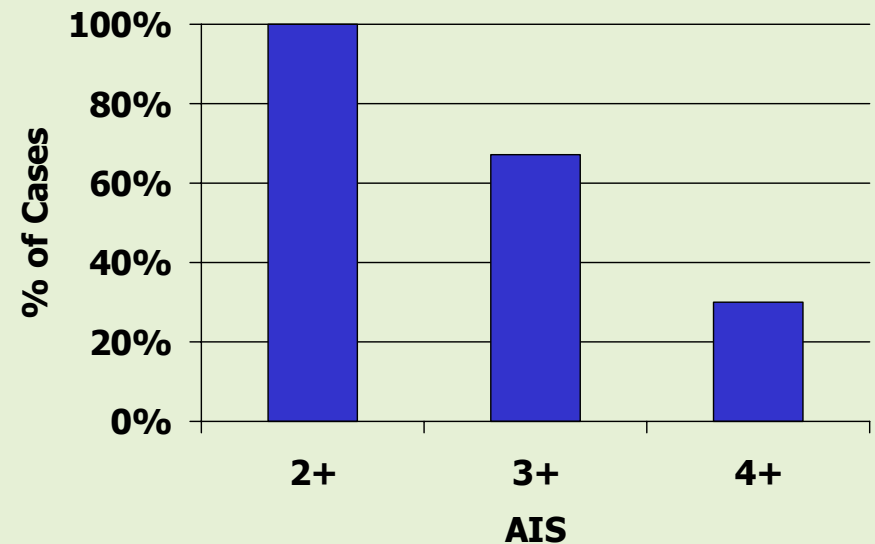
Dataset Characteristics

Occupant

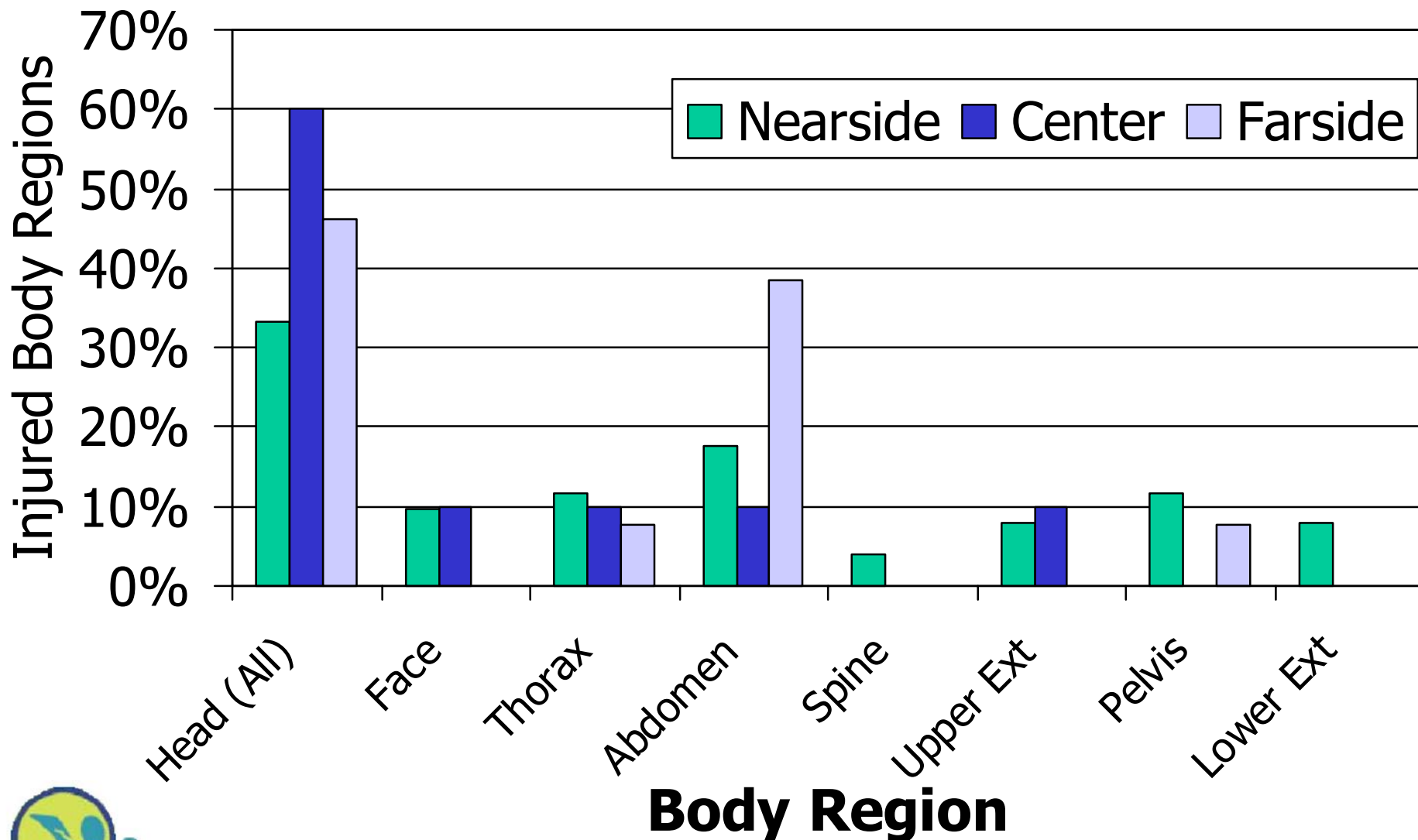
Occupant Age



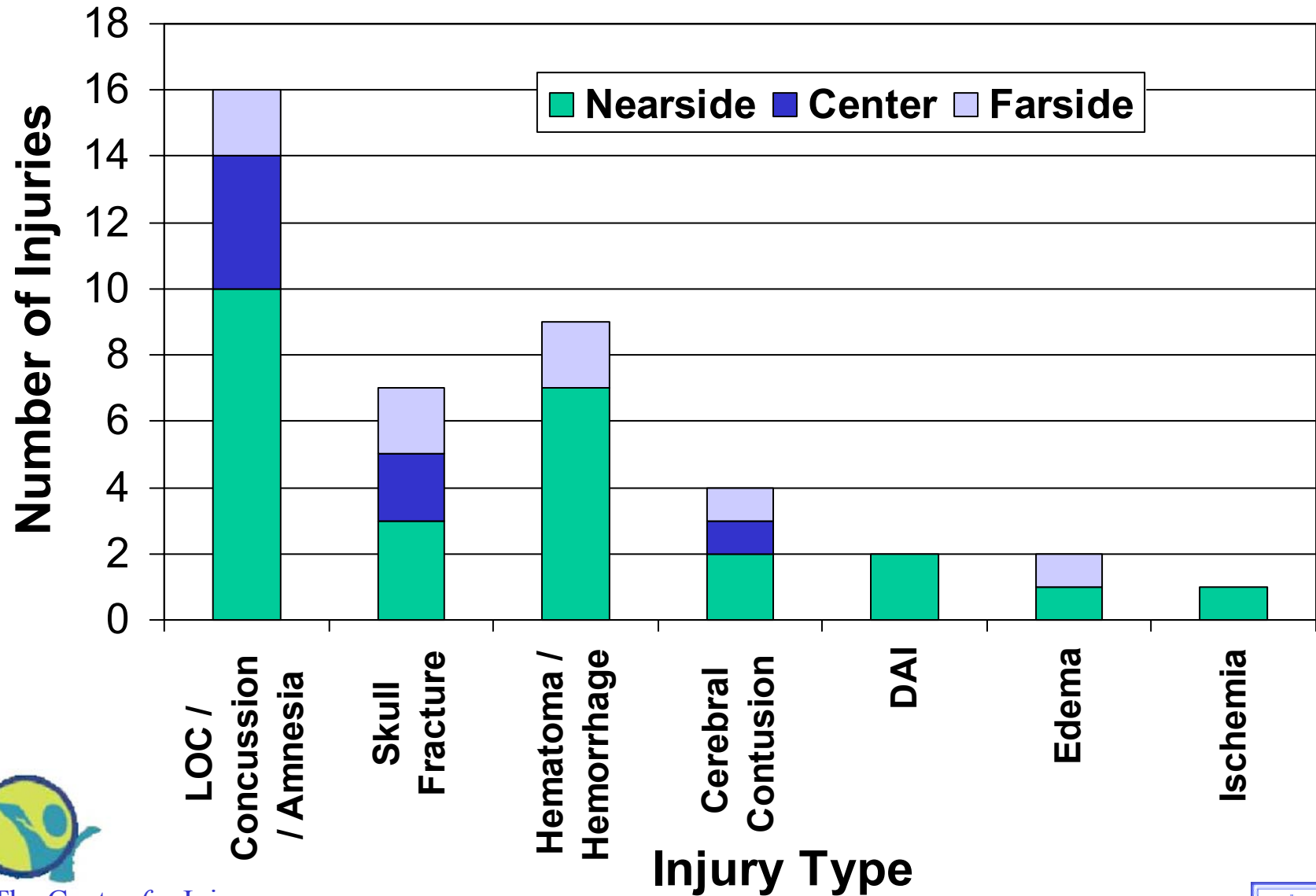
Injury Severity



Injured Body Regions

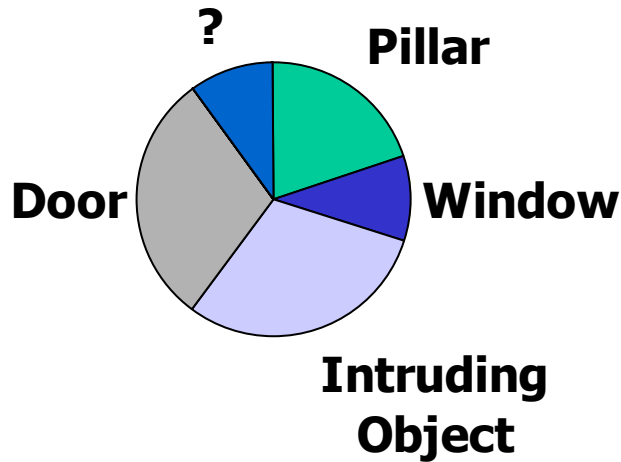


Head Injury Type by Seat Position

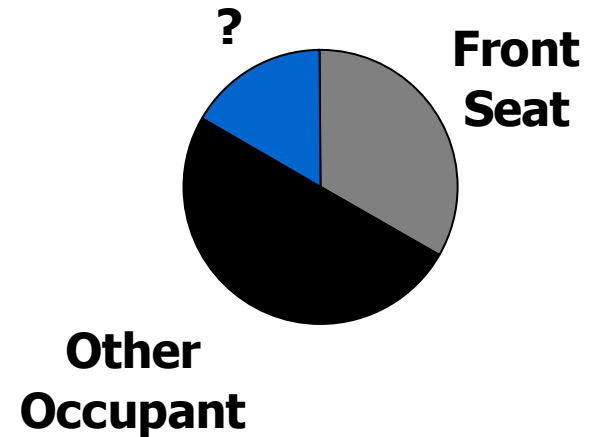


Head Injury* Contact Points

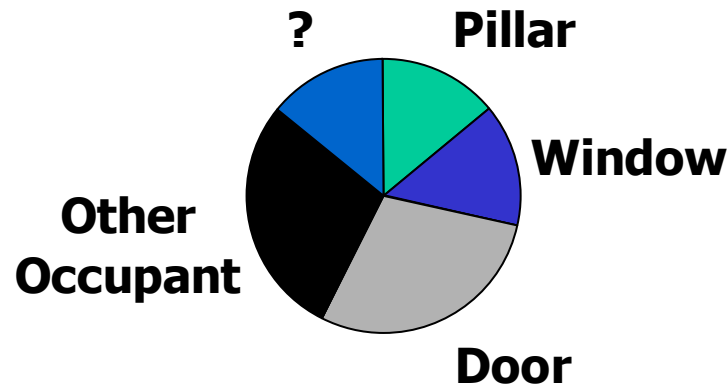
Nearside



Farside



Center



*no concussion



Head Injury Case

- 9 year old female
- 127 cm (50 in.):
16%
- 34 kg (75 lb.): 78%
- Second row right
- 3 pt. lap and
shoulder belt
- Maximum AIS: 4



Injuries

Head

- Right Small Subdural Cerebrum Hematoma/Hemorrhage, AIS 4, Right side window frame
- Lower Base (basilar) Skull Fracture NFS, AIS 3, Right side window frame
- Right Posterior Minor Scalp Laceration, AIS 1, Right side window frame

Other Injuries

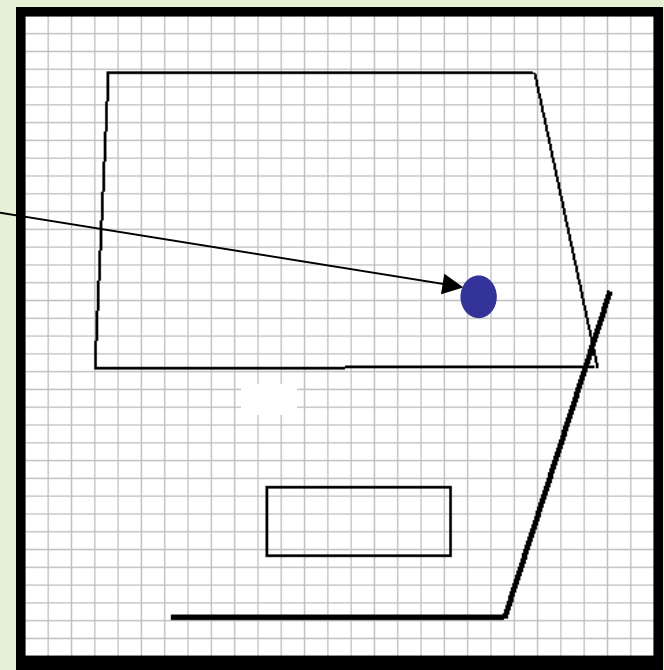
- Thorax - AIS 2
- Abdomen - AIS 2
- Upper Extremity - AIS 1
- Lower Extremity – AIS 2

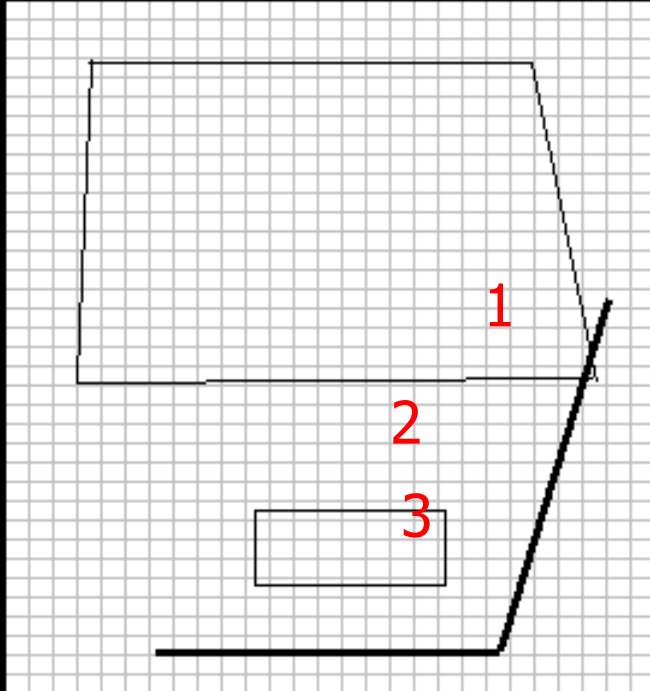


Interior Contacts



Head Contact Location



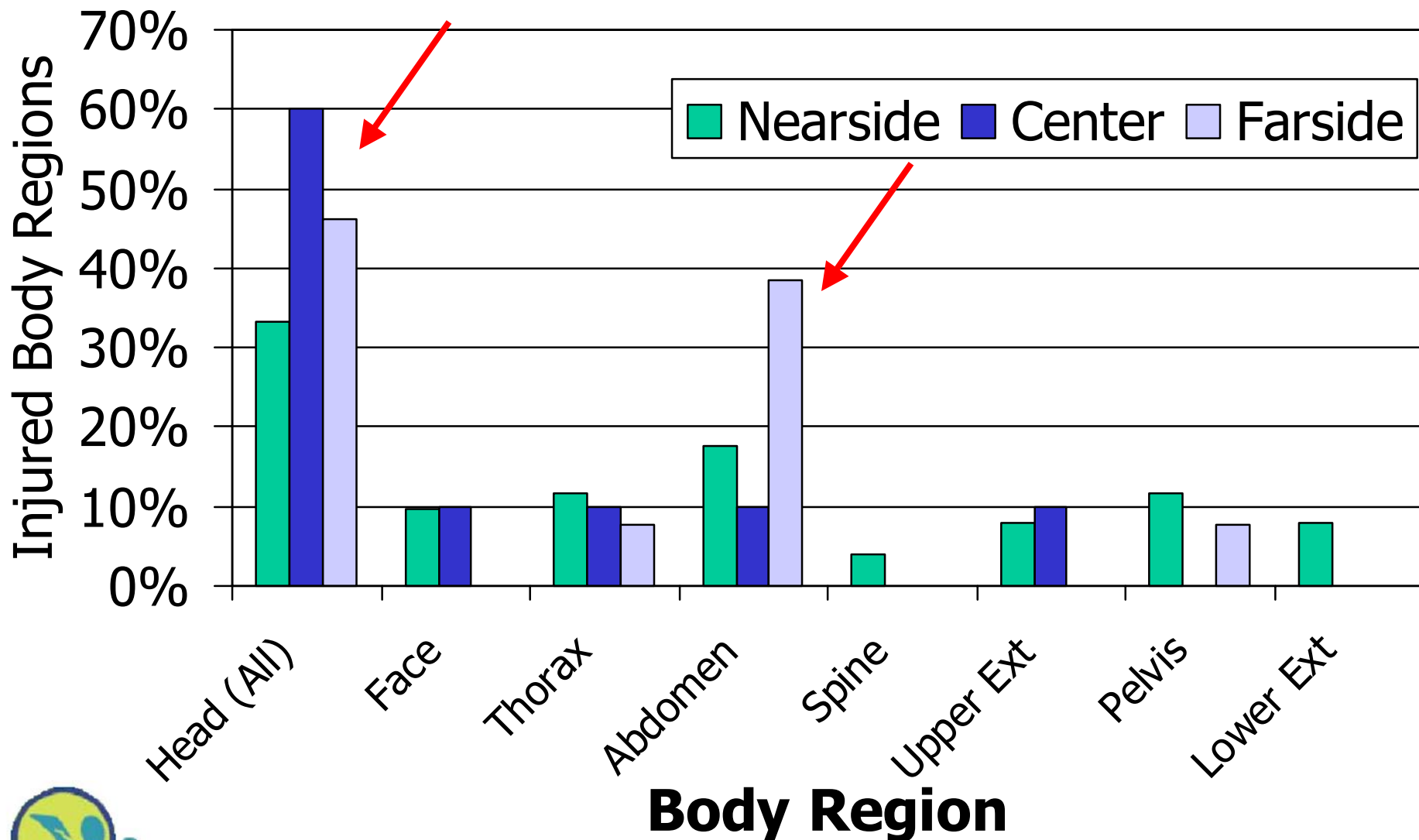


On the left, you see an artist's rendering of the interior of a motor vehicle. On the right is a photograph the interior of the vehicle that was involved in a crash, with one or more numbers in the picture. The numbers signify the location inside the vehicle where an occupant contacted the vehicle interior. Your task is to estimate the position of the numbers relative to the position of the seatback, locate the corresponding cell in the image on the left, and type the number in the cell.

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Injured Body Regions



Farside Abdominal Injury Case

Case Occupant

- 13 year old male
- 168 cm (66 in), 93%
- 66 kg (145 lbs), 95%
- Second seat right seating position
- 3 pt. manual lap and shoulder belt
- Maximum AIS: 3

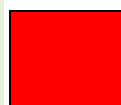


Summary of Vehicles

- Case Vehicle: 1997 Plymouth Neon 4-door sedan
- Vehicle 2: 1991 Ford Aerostar minivan



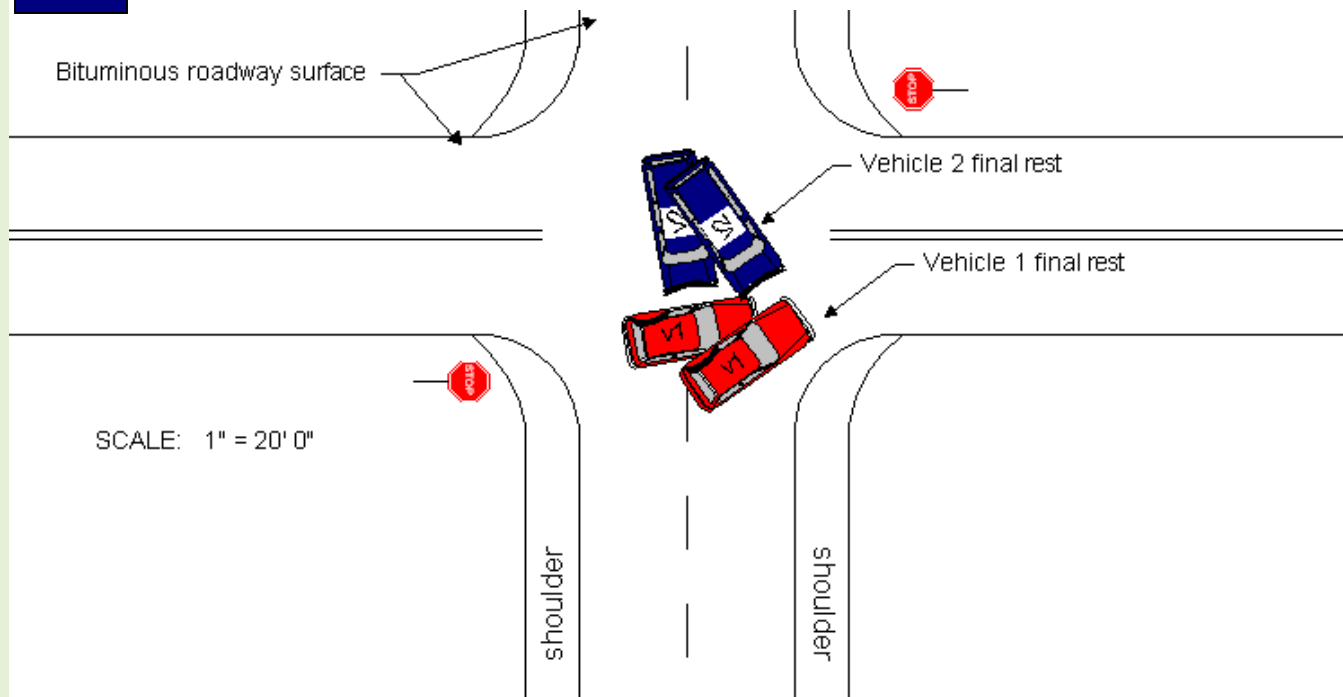
Scene Diagram



Case Vehicle: 1997 Plymouth Neon



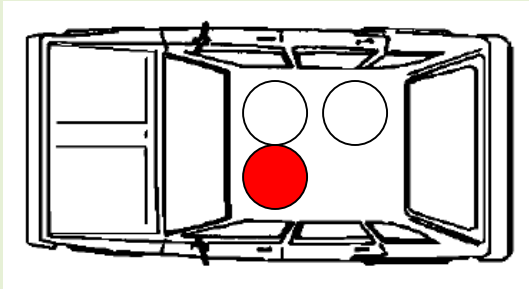
Vehicle 2: 1991 Ford Aerostar



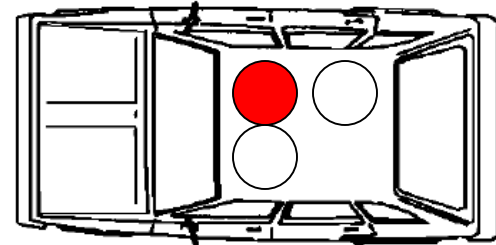




Other Occupants



- 17 year old male
- 178 cm, 72 kg
- Left front seating position (driver)
- Manual lap/shoulder belt
- Injuries:
 - Contusions to anterior chest
 - Contusions to left shoulder
 - Contusions to abdominal wall



- 16 year old male
- 173 cm, 68 kg
- Right front seating position
- Manual lap/shoulder belt
- Injuries:
 - Contusions to right hip
 - Contusions to left hip

Injuries

Head

- Right anterior cerebrum contusion, AIS 3, Unknown source

Abdomen

- Lacerated small intestine, AIS 3, Lap belt webbing
- Lacerated/ruptured spleen, AIS 2, Shoulder belt webbing
- Contusions to right hip, AIS 1, Lap belt webbing
- Contusions to left hip, AIS 1, Lap belt webbing

Upper Extremity

- Contusions to right arm, AIS 1, Right rear inside door panel
- Abrasions to right arm, AIS 1, Right rear inside door panel

Conclusions

- Application of CIREN-model to retrospective case review
 - Retrospective BioTab
- Method developed for occupant contact localization from photographs
- Head injuries most common
 - Most frequent contact point is rear 1/3 of door, on the window sill and lower 1/2 of window (preliminary)
- Farside injuries in minor crashes
 - 4-point belts
 - Load limiters

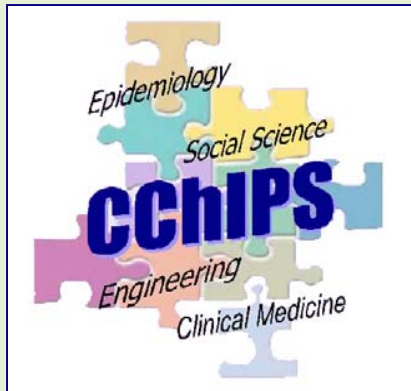


Future Work

- Compare Crash Investigation dataset with PCPS Surveillance
- Compare farside child with adult
- Head injury protection
 - Headform
 - Curtain Airbag



Acknowledgements



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Crash Injury Research & Engineering Network



Partners for Child Passenger Safety

