

# Comparison of Mortality, Injury Severity and Injury Patterns Between Near Versus Far Occupants of Lateral Crashes

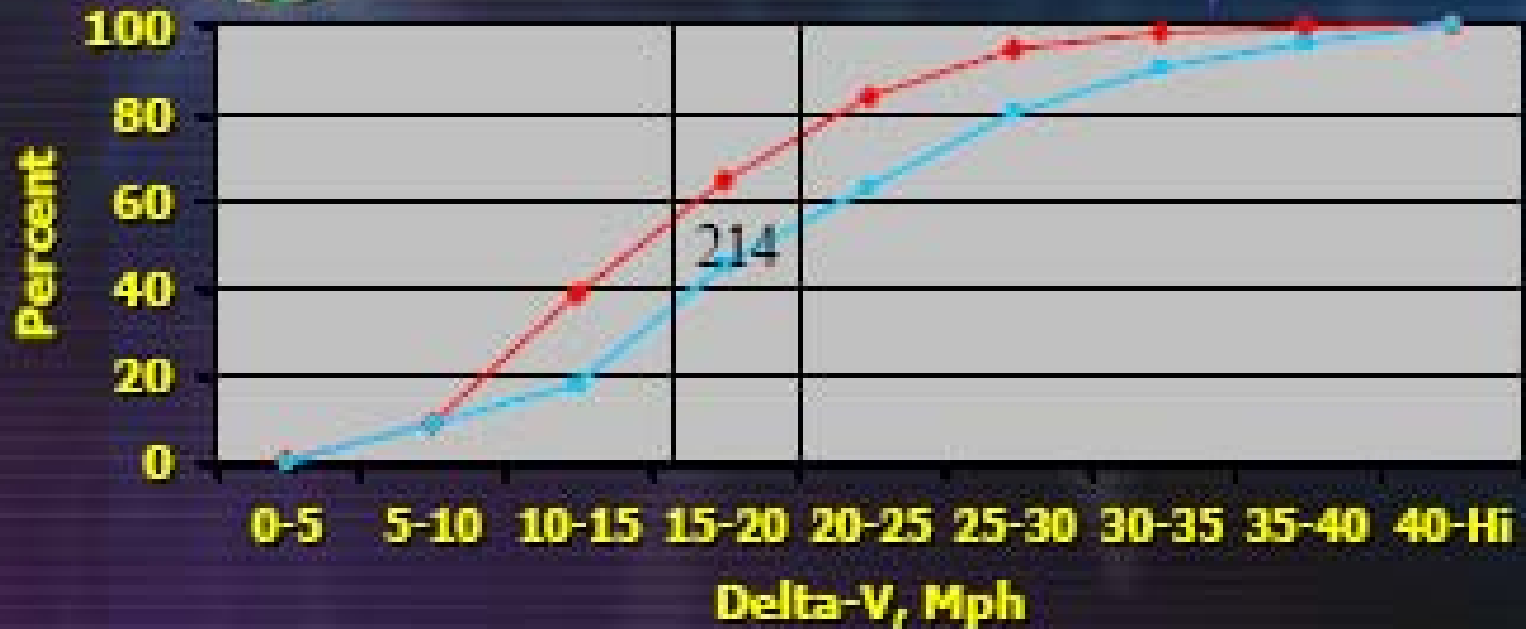
University of Maryland, Baltimore  
CIREN Quarterly Meeting  
March, 2007

# Introduction

- Importance of lateral crashes:
  - Lower frequency than frontal
  - Higher injury severity
  - Higher mortality
- Far lateral
  - 42% of deaths among side impact crashes
  - Not addressed by current regulation



## Severity - Side Impact



■ Near Side    ◆ Far Side Restrained

University of MIAMI

# MAIS3+ INJURY - RESEARCH MATRIX

CIREN March 28th 2006

	Head	Face	Neck	Thorax	Abdomen	Spine	Upper extremity	Lower extremity		
Age 31-40	0.70	NUMBERS TOO SMALL TO STUDY	NUMBERS TOO SMALL TO STUDY							
Age 41-50	0.57									
Age 51-60	0.55			1.83						
Age 61-70				2.49						
Age 71-80				3.14			2.72	1.80		
Age 81+				3.66			2.20			
Male gender								0.67	0.74	
Unrestrained	1.79					1.40		1.50	1.30	
Near side impact	2.86					4.12	2.88		0.46	0.77
Far side impact	4.36					2.55			0.25	0.24
DV 30-39 kph						1.85	2.27			1.44
DV 40-49 kph						2.74	2.63			1.86
DV 50-59 kph						2.90	3.02			1.85
DV 60+ kph	1.45					4.53	3.81			2.46
DV unknown	1.40					2.34	2.45		1.92	1.53
Obese										1.47
Overweight							0.70			
Test of Fit	.95					0.55	0.77	0.99	0.35	0.09

# RESEARCH MATRIX

## March 28<sup>th</sup> 2006

	Head	Thorax	Abdomen	Spine	Upper extremity	Lower extremity
Near side impact	2.86	4.12	2.88		0.46	0.77
Far side impact	4.36	2.55			0.25	0.24

# Background

- In a near lateral crash, proximity between the occupant and the impacting structures is associated with specific injury patterns
- Given the same crash characteristics, near lateral occupants are expected to result in more severe injuries than far lateral occupants.

# Purpose

- To characterize and compare the mortality, injury severity and patterns of injury of near lateral occupants and far lateral occupants.

# Outline

- Population-based analysis (CODES)
- CIREN (Sample Cases)
- CIREN Analysis



# Sampling Bias?

- CIREN:
  - Non-random
  - Level I trauma center
  - AIS selection criteria
  - Consent process
  - Researcher preferences
  - Detailed and accurate crash and injury data
- CODES:
  - Population based
  - Hospitalized
  - Linkage of police and hospital data
  - Less detailed and less accurate crash and injury data

# Crash Outcome Data Evaluation System

- Population-based research project funded by the National Highway Traffic Safety Administration (NHTSA)
- Probabilistic linkage, for individuals involved in vehicular crashes of
  - Hospital records
  - EMS run sheets
  - Police reports
- Provides valuable information on injury trends and outcomes

# Methods

## Selection Criteria:

- Maryland CODES data
- Hospitalized drivers (with or without passengers) of automobile, station wagon, pickup truck, van and SUV
- 1993 model year or newer
- Crashes between 1997 and 2004
- Frontal, near or far side lateral crash

## Statistical Analysis:

- Chi-Square
- Wilcoxon Rank-Sum Test

# Summary Characteristics By Direction of Impact (8,937 Drivers)

	Frontal	Near Side	Far Side	P-Value
	(n=5,741)	(n=1,960)	(n=1,236)	
Male	57.0%	59.3%	52.1%	<0.001
Died	2.0%	3.4%	2.4%	0.08
Median Age	38	36	37	NS
Median ISS ( 25 <sup>th</sup> -75 <sup>th</sup> )	5 (2-9)	5 (4-14)	5 (1-9)	<0.001
Belted	88.0%	91.2%	86.1%	<0.001
Air Bag	33.4%	26.1%	25.1%	NS

# Incidence of AIS 3+ Body Region by Direction Impact (8,937 Drivers)

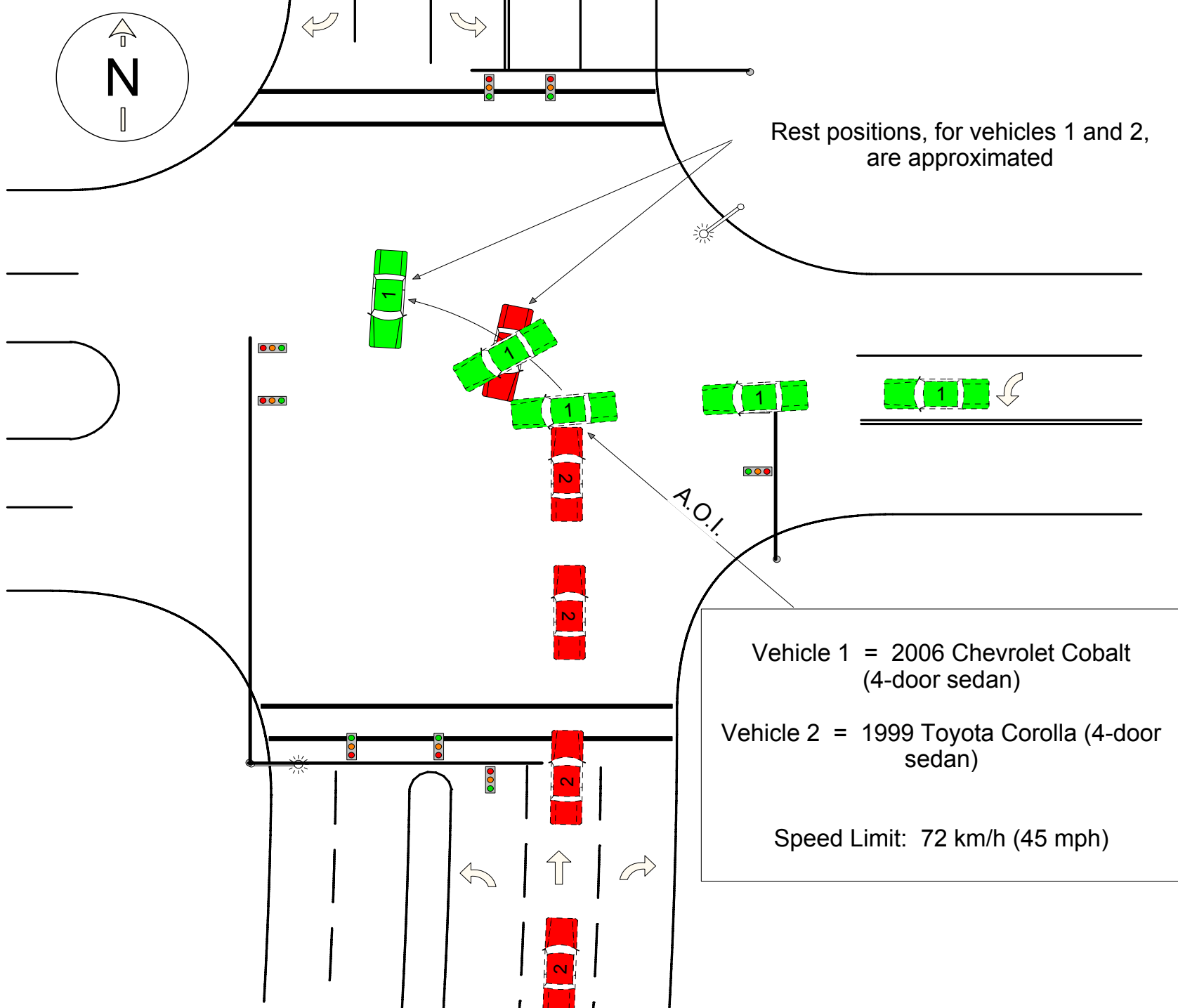
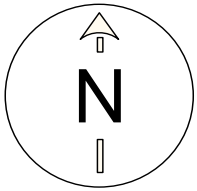
	Frontal	Near	Far	P-Value
	(n=5,741)	(n=1,960)	(n=1,236)	
	(%)	(%)	(%)	
<b>Head</b>	<b>6.44</b>	<b>12.09</b>	<b>12.46</b>	<b>NS</b>
Face	0.03	0.05	0.00	NS
Neck	0.12	0.10	0.00	NS
Thorax	11.48	20.71	12.54	<0.001
Abdomen	2.21	4.49	1.38	<0.001
Spine	0.92	1.12	1.05	NS
Upper Ext.	1.64	1.33	0.65	0.07
Lower Ext.	10.40	16.63	6.07	<0.001

Similar findings regardless of the presence of passengers

# *Case Study:* Near-Side

# Crash Data

- Delta V= 29 kph (18 mph)
- CDC= 10LPEW3
- PDOF= 300 degrees
- Maximum Crush= 43 cm (17 in) at driver's B-pillar / trailing door edge
- Intrusions (left): B-pillar (30 cm lat); Door Panel (30 cm lat); Sill (13 cm lat); Roof Side Rail (10 cm lat)





# Vehicle 1 Exemplar













Vehicle 1  
Exemplar

# V1 Interior









# Injury List

- Scalp contusion
- Left rib fractures (4-7)
- Left lower lobe pulmonary contusion
- Left pneumothorax
- Grade III spleen laceration
- Right acetabulum fracture (LC-IIB)
- Right superior ramus fracture
- Right iliac wing fracture

# Only head injury

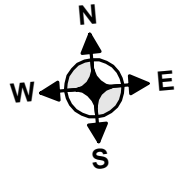


# *Case Study:* Far Side

# Crash characteristics

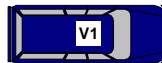
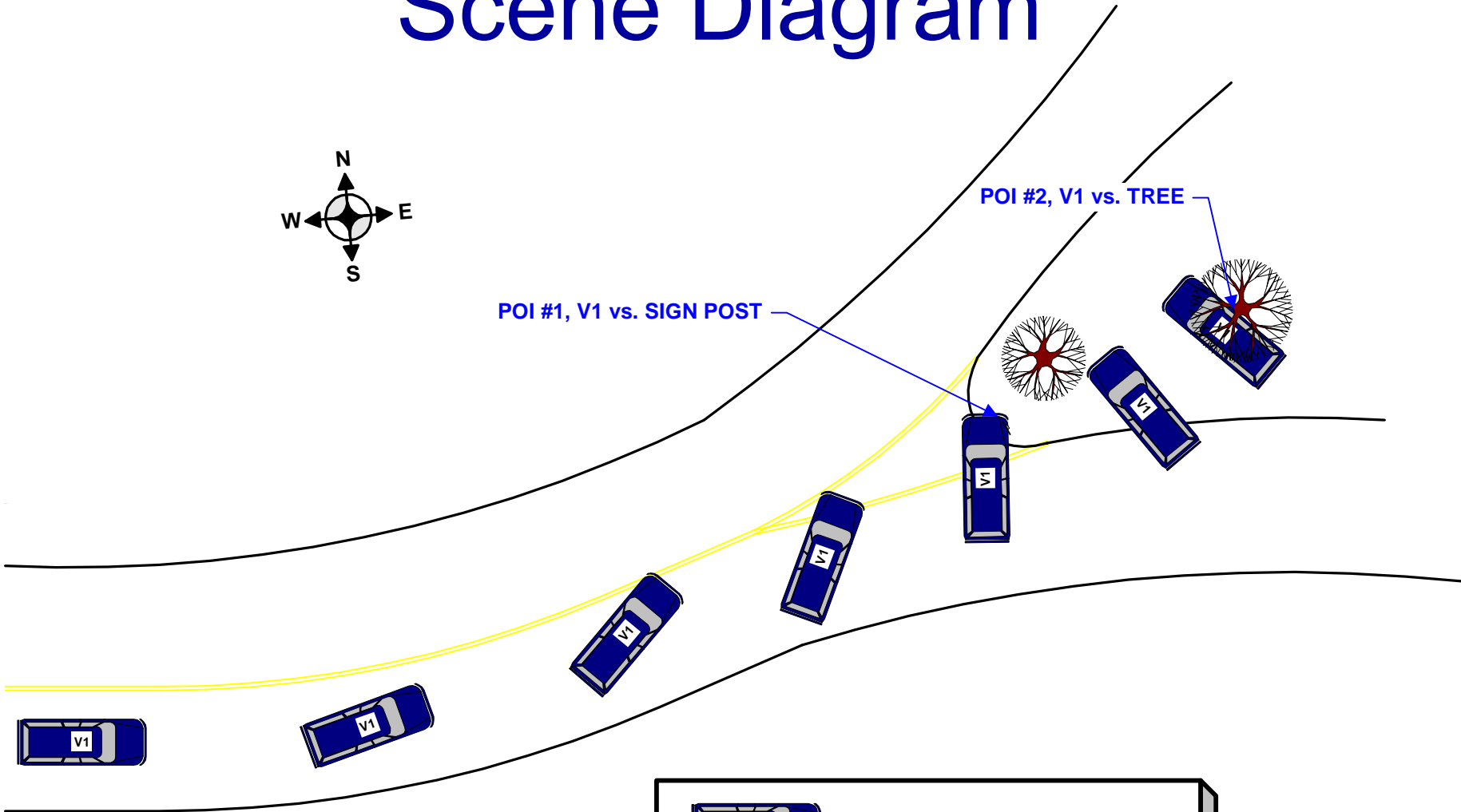
- Delta V= 40 kph (25 mph)
- CDC= 62RPAW4
- PDOF= 60 degrees
- Intrusions (right): Door Panel (50 cm lat); Roof Side Rail (39 cm lat); Seat Back (41 cm lat); B-pillar (31 cm lat); Sill (27 cm lat); Seat Cushion (27 cm lat); A-pillar (35 cm lat)

# Scene Diagram



POI #1, V1 vs. SIGN POST

POI #2, V1 vs. TREE



1997 SUBARU IMPREZA OUTBACK

NOT TO SCALE









Vehicle 1  
Exemplar



OUTBACK  
SPORTS





Vehicle 1  
Exemplar



3-Point  
Belt Use

# V1 Interior



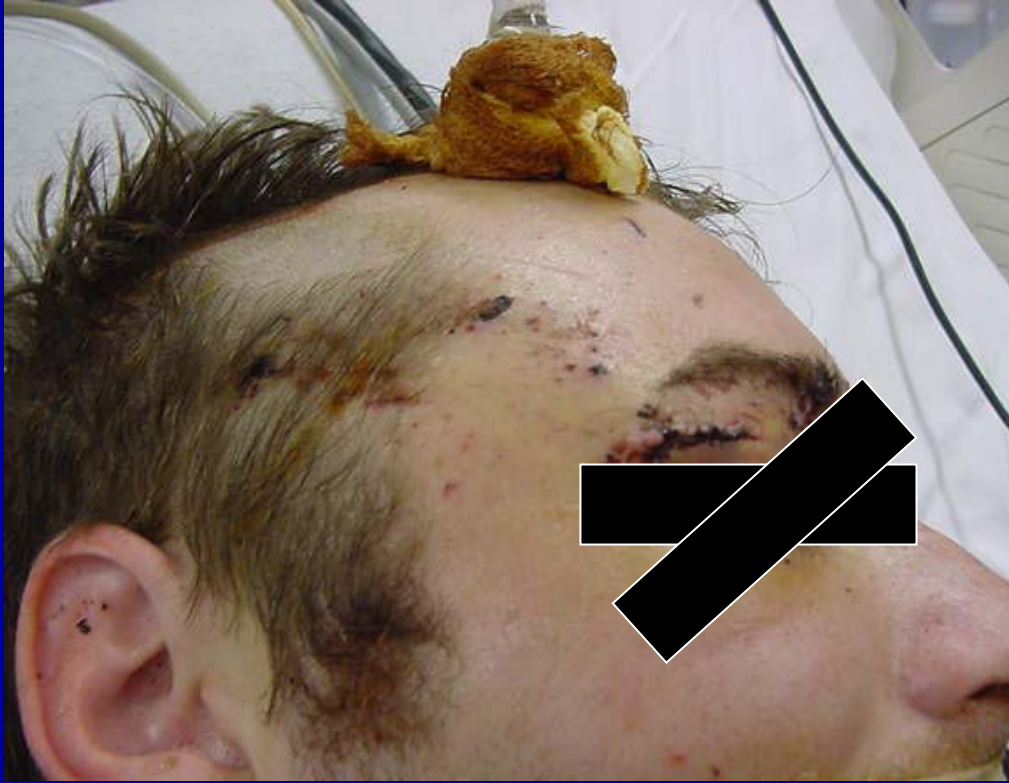


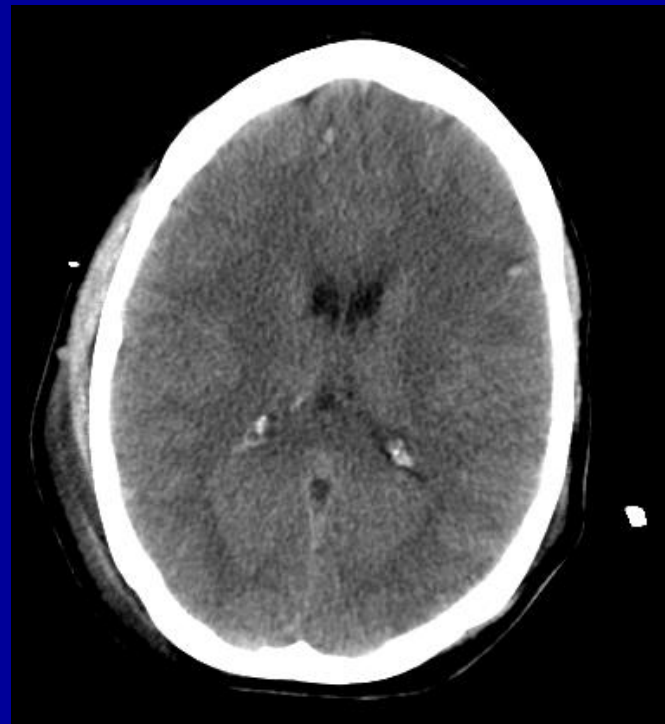
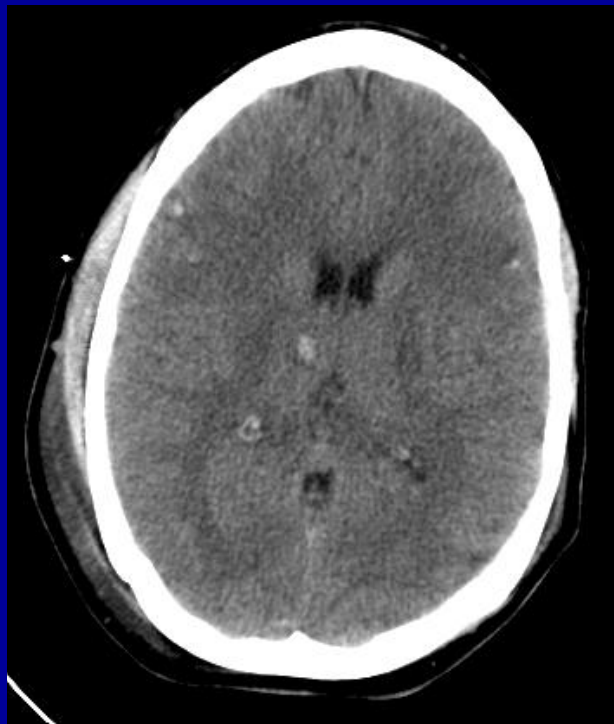




# Injury List

- Diffuse axonal injury
- Cerebral hematoma
- Orbit fracture
- Maxilla fracture
- Loss of consciousness
- Eyelid contusion



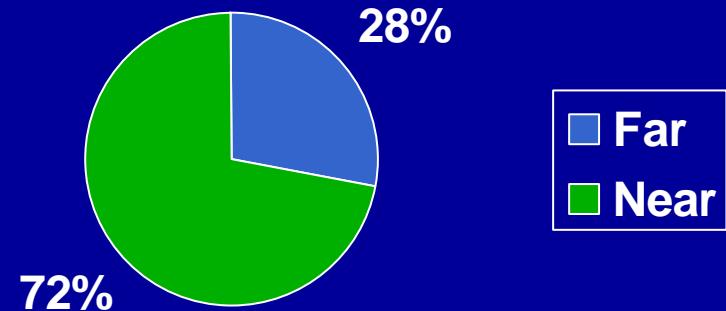


# CIREN

## Population (N=380)

- Exclusions:
  - 15 y/o or younger
  - frontal or rear collisions
  - back seat occupants
  - $\Delta v > 80$  km/h
  - unknown  $\Delta v$
  - unknown PDOF
  - lack of frontal airbags

### Occupant Position



# Occupant and crash characteristics

	Near (n=275)	Far (n=105)
Age (mean)	41.7 y.	41.6 y.
Male (%)	47	53
Seatbelt use (%) *	74	55
$\Delta v$ [(median (q1-q3))]	33 (24-41)	32 (23-42)
Airbag deployment (%) *	35	48
Other occupant (%)	40	36

\*  $p < 0.05$

# Outcomes

	Near (n=275)	Far (n=105)
ISS [(median (q1-q3)) *]	22 (14-34)	17 (10-29)
LOS [(median (q1-q3))]	6 (3-13)	5 (2-14)
Mortality (%)	16	17

\* p<0.05

# Body Region Injuries

Body region MAIS 3+	Near (%)	Far (%)
Thorax *	57	42
Abdomen *	32	14
Lower extremities *	44	21
Head	35	46

\* p<0.05

# Subgroup Analysis: Restraint

- Lower ISS in Far vs. Near was limited to restrained
  - some effectiveness of restraint
- Restrained: - similar head injuries
- Unrestrained (Far vs. Near):
  - higher head injuries 62% vs. 45% (p=0.08)
  - higher spine injuries 19% vs. 8% (p=0.09)
  - narrowing of the difference in thoracic injuries



# Multivariate analysis

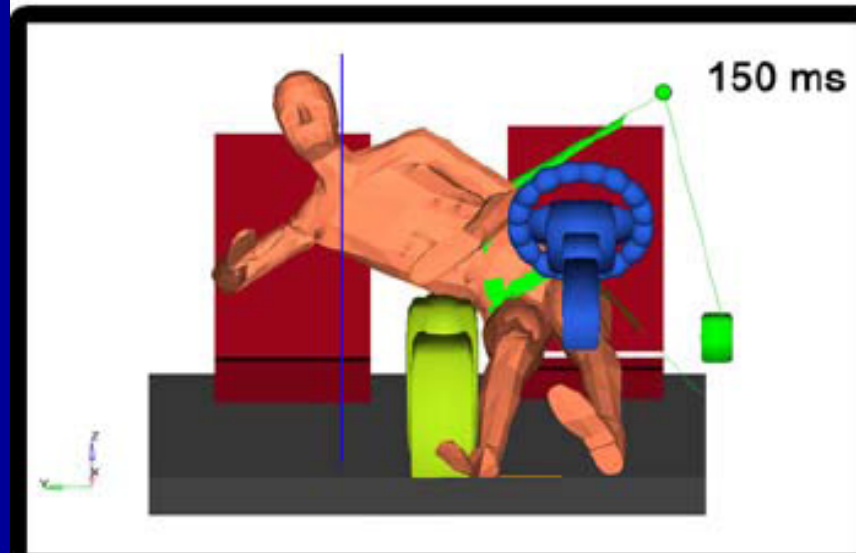
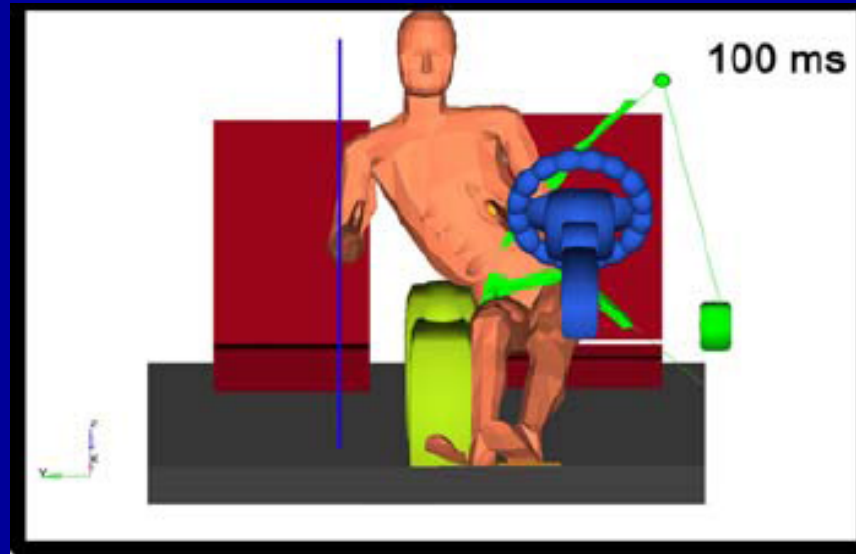
## MAIS 3+ Injury and Mortality

Outcome:	Adjusted OR for near lateral *
Thorax	2.14 (1.28-3.57)
Abdomen	3.39 (1.76-6.54)
Lower extremity	3.62 (2.04-6.44)
Head	0.72 (0.43-1.18)
Death	1.32 (0.64-2.75)

\*Far lateral used as reference. Age, gender,  $\Delta v$ , BMI, restraint, seat position (L/R) included in models.

# Contact points on MAIS 3+ head injuries: far side occupants

Contact point	%
Opposite side structures (i.e., interior surface, arm rest, window sill, A-pillar, B-pillar, and roof rail)	42
Opposite airbag	10
Other occupants	13
Windshield	5
Same side structures	5
Others/unknown	25



# Other occupant and Head Injury

- Frequency of other occupant presence similar in near and far crashes.
- Among accompanied occupants, with a head injury of known source
  - “other occupant” is more frequently the source of injury in Far (32%) than Near (6%) crashes ( $p=0.002$ ).
  - “other occupant” is the source of injury as often among restrained (13%) and unrestrained (11%) case occupants.

# Conclusions

- Far side occupants experience a lower ISS and are less likely to experience thoracic, abdominal and lower extremity injuries
- Mortality is similar for near and far side occupants
  - may be related to the similar occurrence of MAIS3+ head injuries
- Head injury occurs more frequently in the far lateral occupants in the absence of restraints

# Conclusions (continued)

- Contact patterns suggest that current restraint systems do not succeed in keeping far side occupant heads from striking structures in the opposite side of the vehicle or other occupants.
- Improvements in restraint systems should decrease this unexpectedly high mortality among far side occupants.
- CIREN findings are consistent with population based findings and richer in detail.

# Future Research

- True lateral (90° & 180°) vs. off-set lateral (60° & 300°)
- Intrusion
- Restraint status of the other occupant
- Effect of side airbags

# Disclaimer

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- Views expressed are those of the authors and do not represent the views of the NHTSA



WE WOULD LIKE TO THANK  
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