

University of  
Virginia



# Honda Inova Fairfax Hospital CIREN Team

**HONDA**



**INOVA REGIONAL  
TRAUMA CENTER**



# The Role of Vehicle Size in Side Impact Head Injuries



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# Team Members:

- Samir M. Fakhry, MD, Principal Investigator
- Dorraine D. Watts, PhD, RN, Principal Investigator
- James D. Bean, Crash Reconstructionist
- Christine Burke, CIREN Study Coordinator
- Sharon Plater, Research Associate
- Capt. Christine Woodard, Fairfax County Fire and Rescue
- Detective J.J. Banachoski, Fairfax County Police CRU
- Christopher Sherwood, Auto Safety Lab, University of VA





0.10 1.50 8079  
0.20 1.50 9-55



# Definitions\*

## Small Vehicles

Automobile: Subcompact, Compact, Intermediate and Full Size

## Large Vehicles

Utility Vehicles, Light Conventional Trucks, Other Light Trucks,  
Van Based Light Trucks, Mini Vans:  $\leq 4,536$  kg GVWR

and

Medium/Heavy Trucks:  $\geq 4,536$  kg GVWR

*\*Corresponds with Body Category in NASS*



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# Introduction

- Percentage of Large Vehicles in fleet is increasing
  - 22 % in 1992 to 30 % in 2001
- Larger Vehicles
  - Heavier
  - Higher ride/bumper height
  - Higher front end stiffness
- Injuries to near side, driver
- Effect of vehicle size on injuries especially TBI

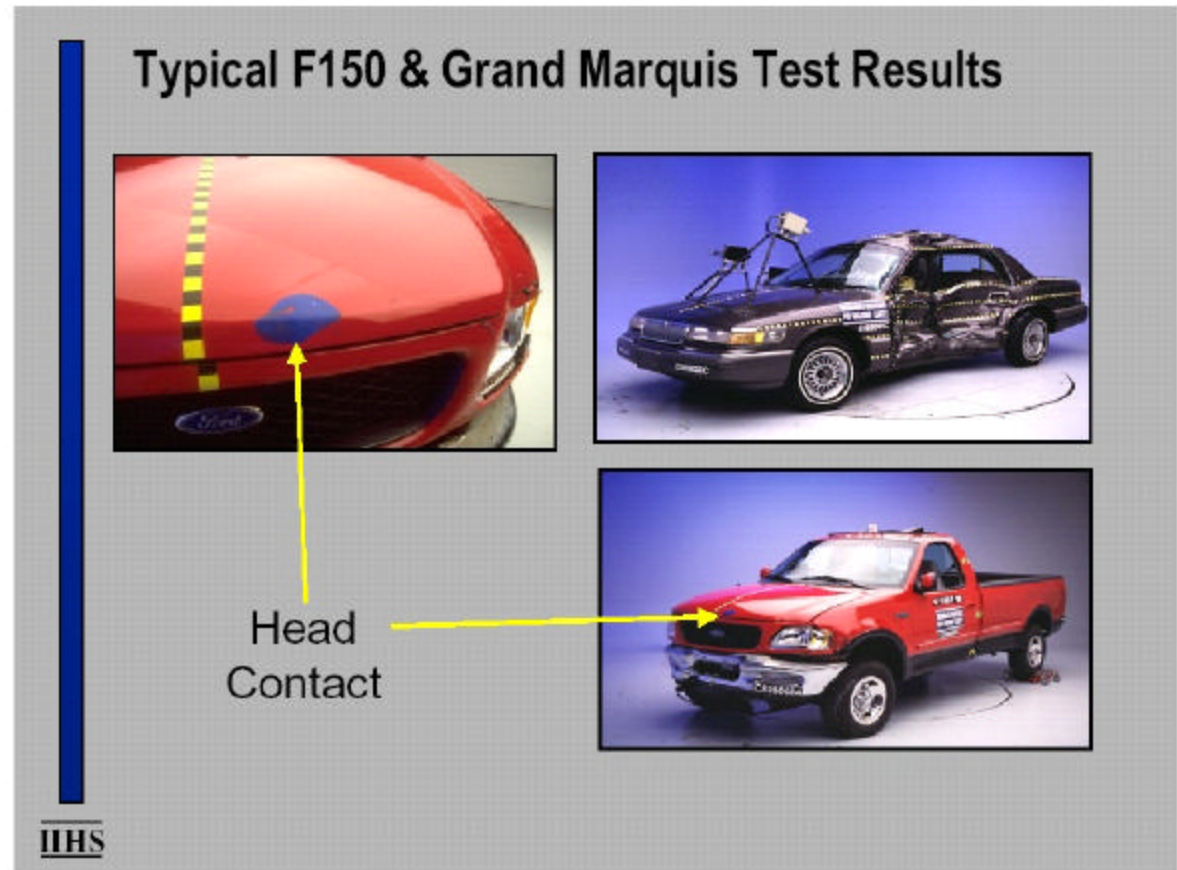


# Introduction

- Research has shown that the higher ride height causes over-representation of large vehicles as striking vehicles in front-to-side crashes in which outboard passengers are seriously injured (Nolan et al. 1999, Rattenbury et al. 2001)

- Head contacted by striking vehicle in 38% of cases and “light trucks were most frequently the source of the injuring head strikes.”

Augenstein et al.  
2001





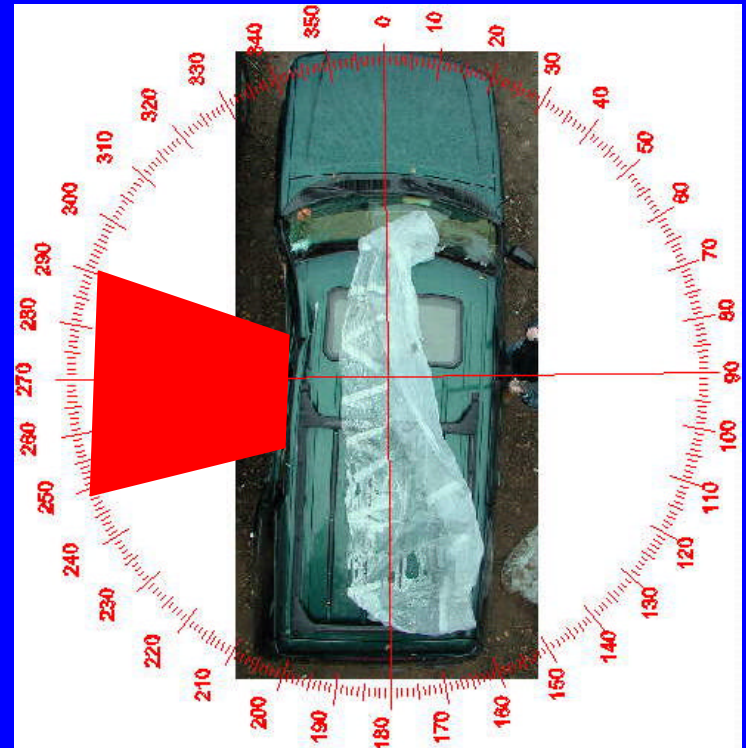
# Introduction

- Insurance Institute for Highway Safety new Side Impact Test Program with Barrier higher and heavier than FMVSS 214 to better represent trucks and SUVs

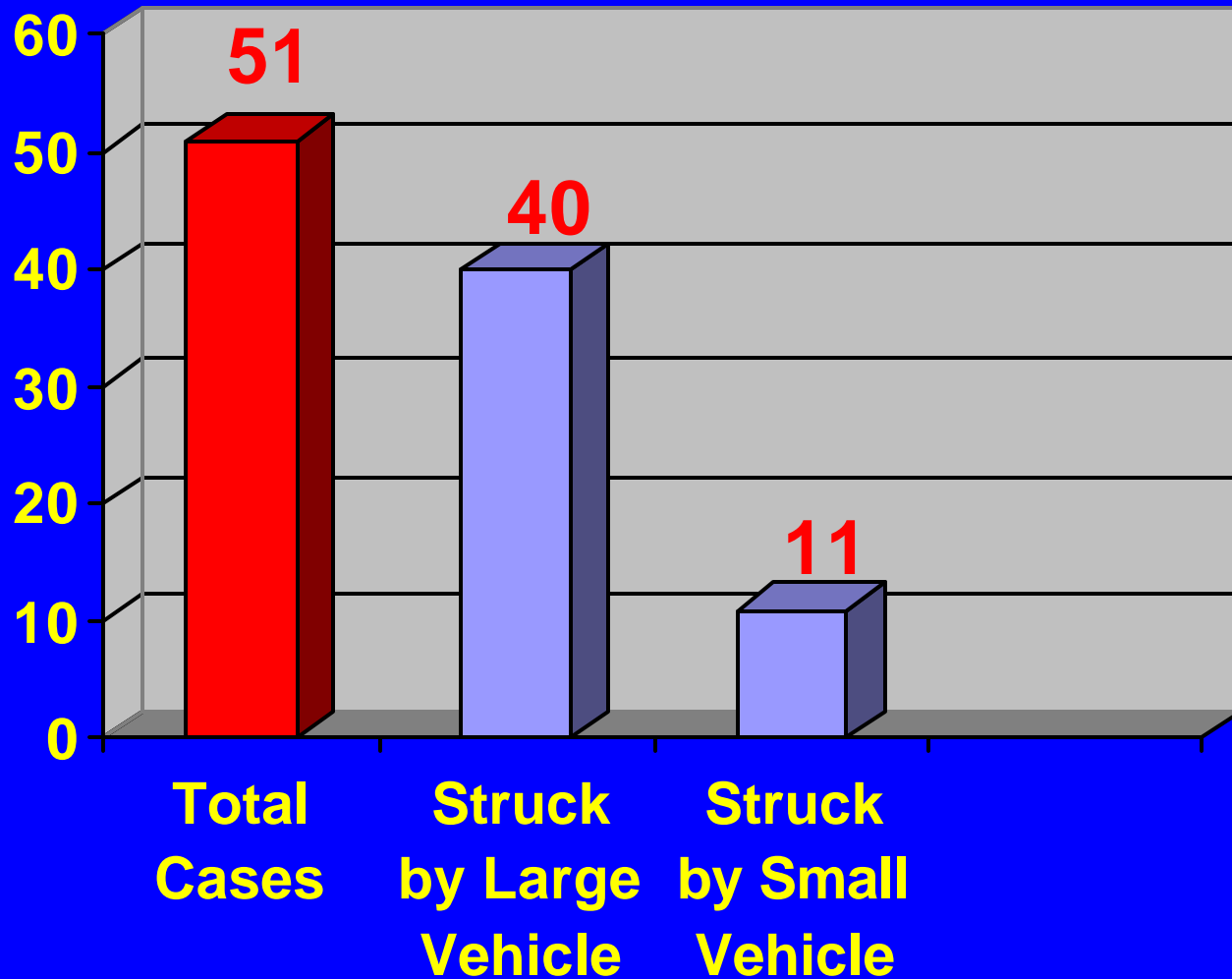


# Search Parameters

- Inclusion Criteria
  - Principle Direction of Force:  $250^{\circ}$  to  $290^{\circ}$  (Near Side Crash)
  - Vehicle to vehicle
  - Driver Injured (AIS  $\geq 2$ )
  - Complete case

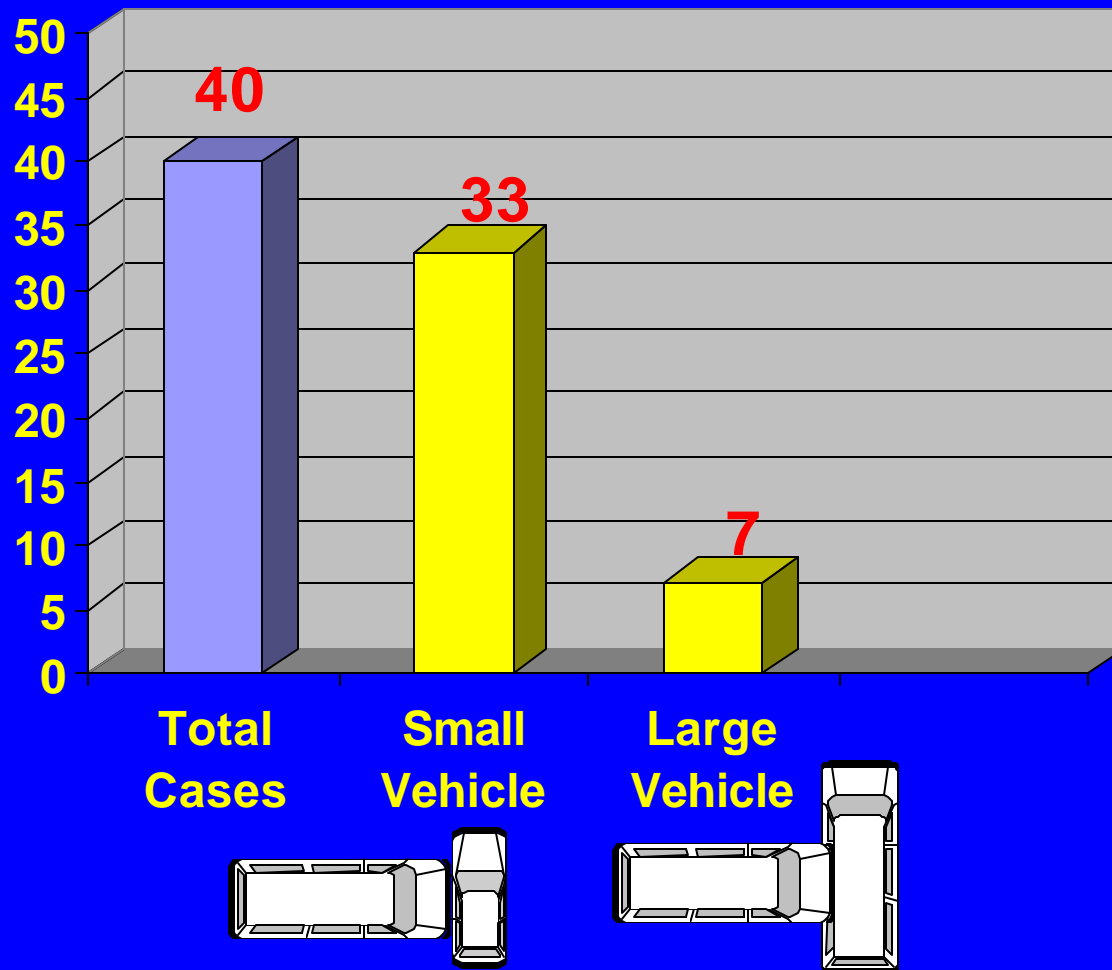


# Total Cases



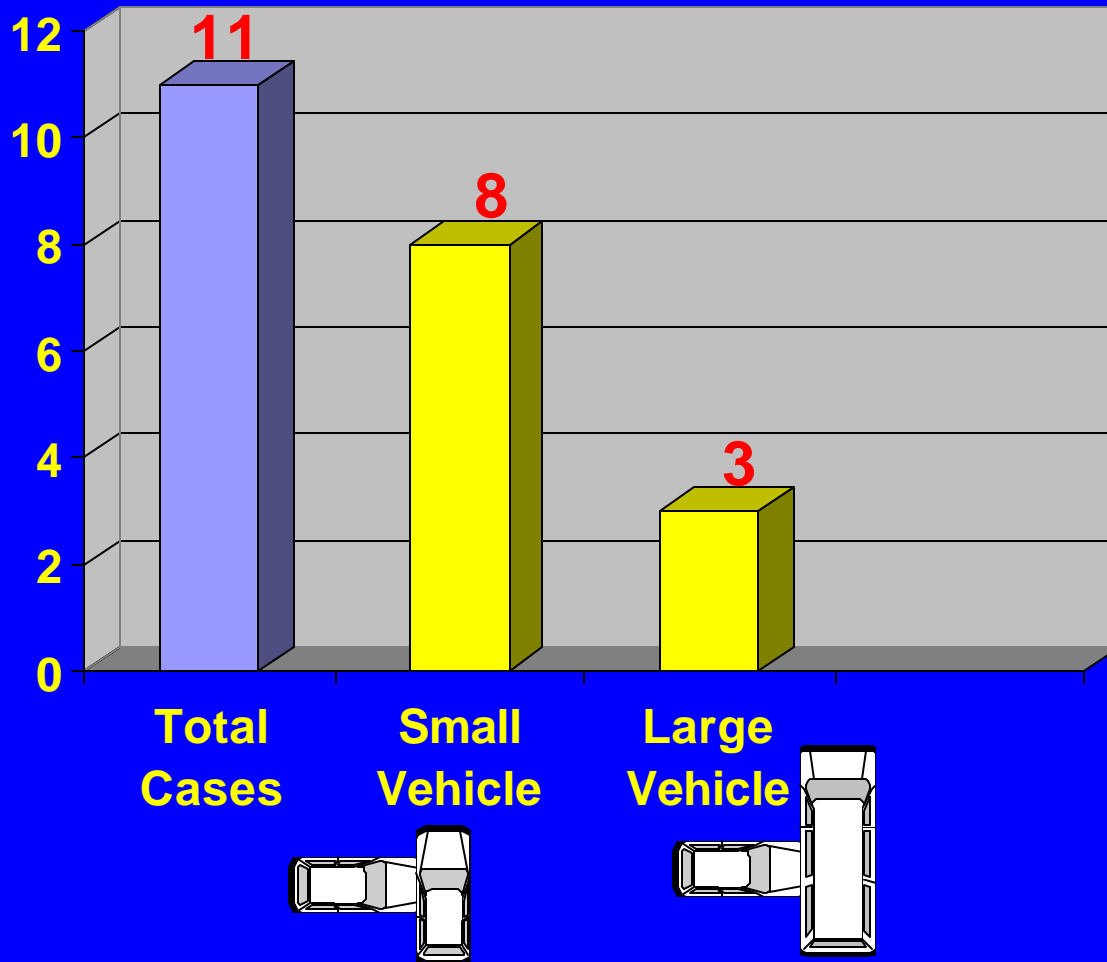
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# Struck by a Large Vehicle



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# Struck by a Small Vehicle



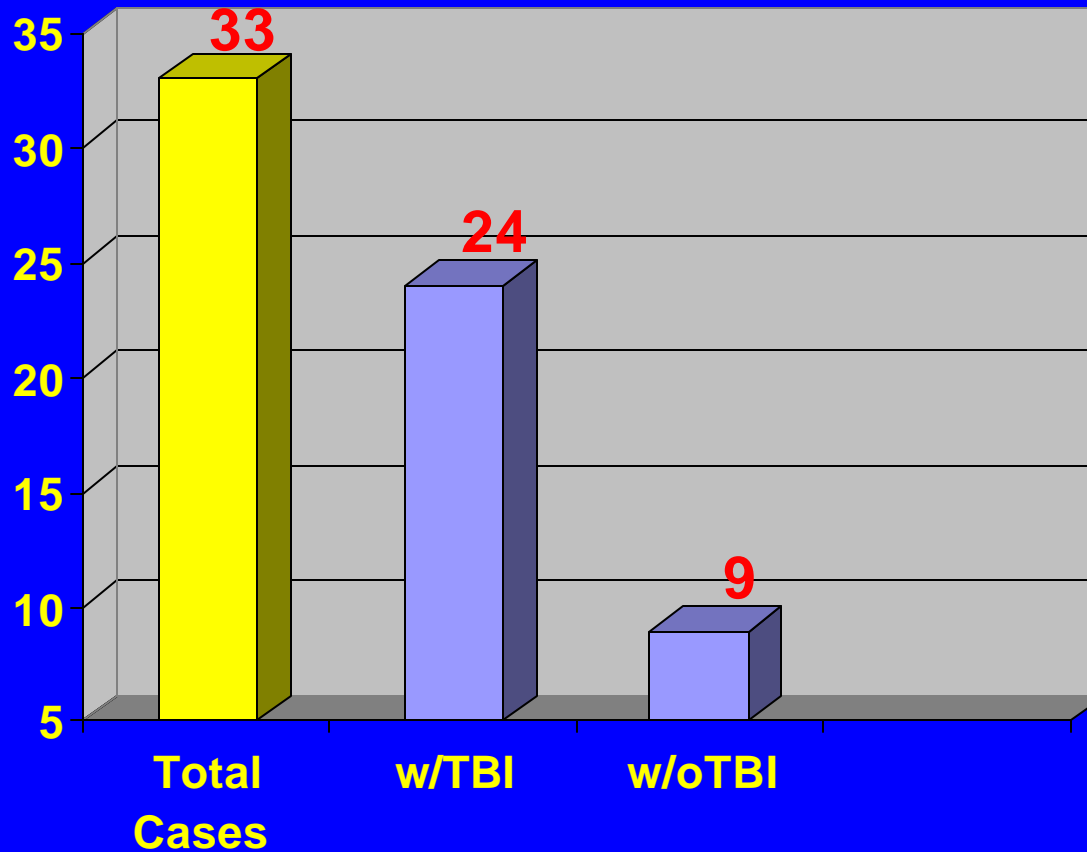
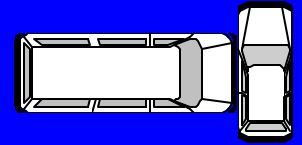
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# TBI occurrences

- Total number of cases: 51 patients
- Number with Traumatic Brain Injury (TBI): 40/51 (78.4%)
- Types of TBI:
  - Subarachnoid hem. in 12/51 patients (23.5%)
  - Basilar skull fx. in 6/51 patients (11.7 %)
  - Cerebral contusion in 3/51 patients (5.8%)
  - Intraventricular hem. in 4/51 patients (7.8%)

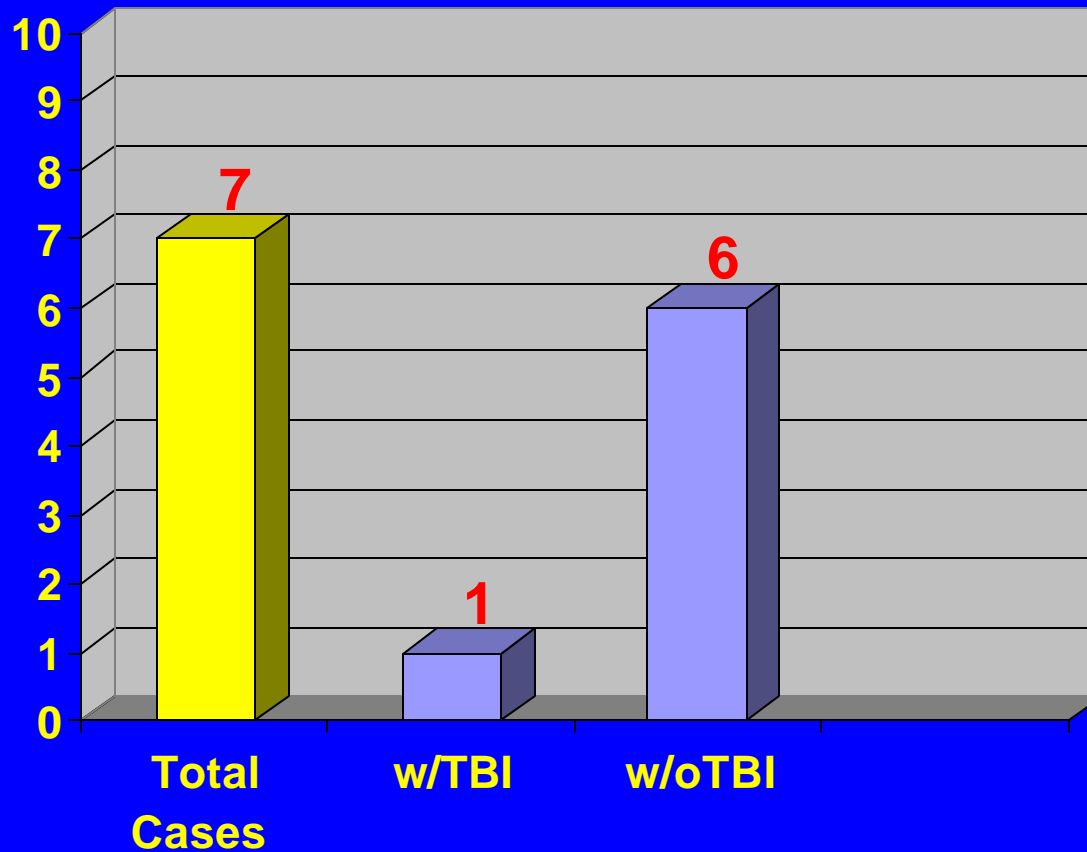
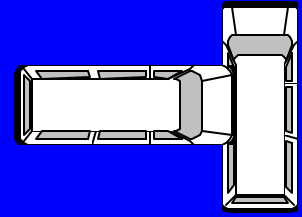


# Small Vehicle Struck by a Large Vehicle: TBI



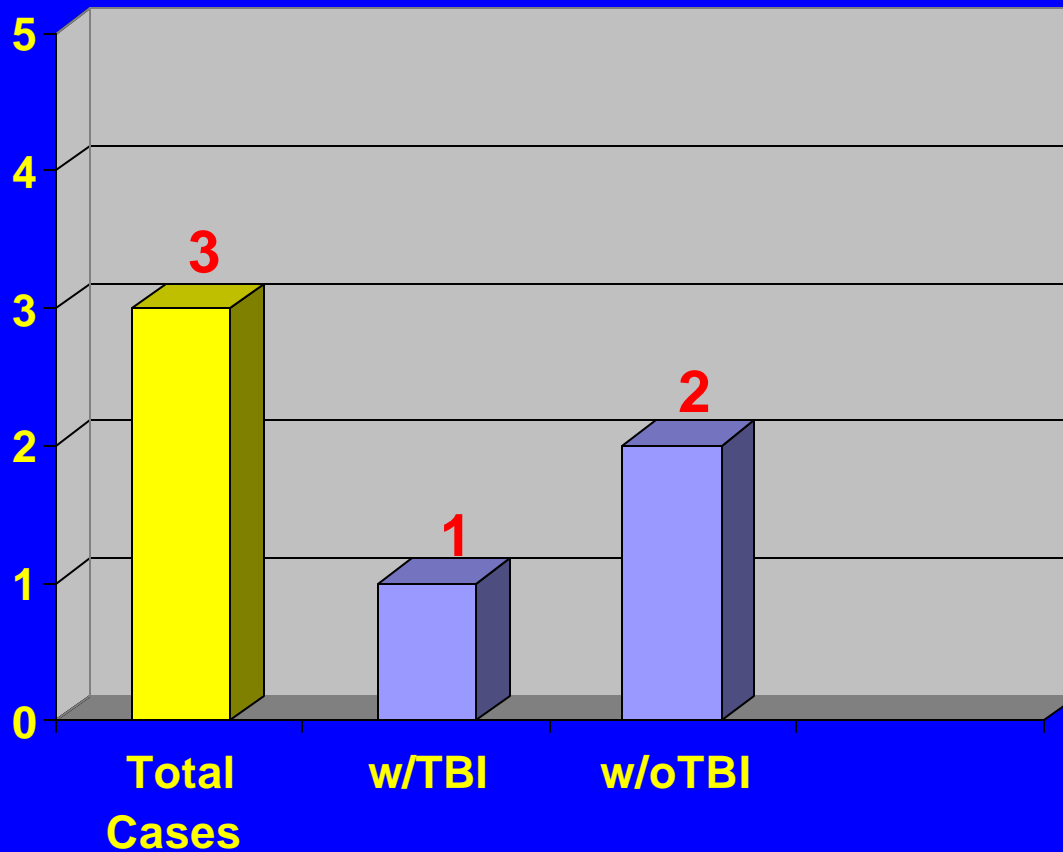
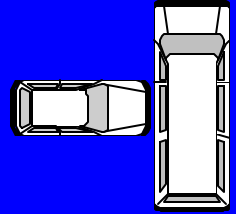
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# Large Vehicle Struck by a Large Vehicle: TBI



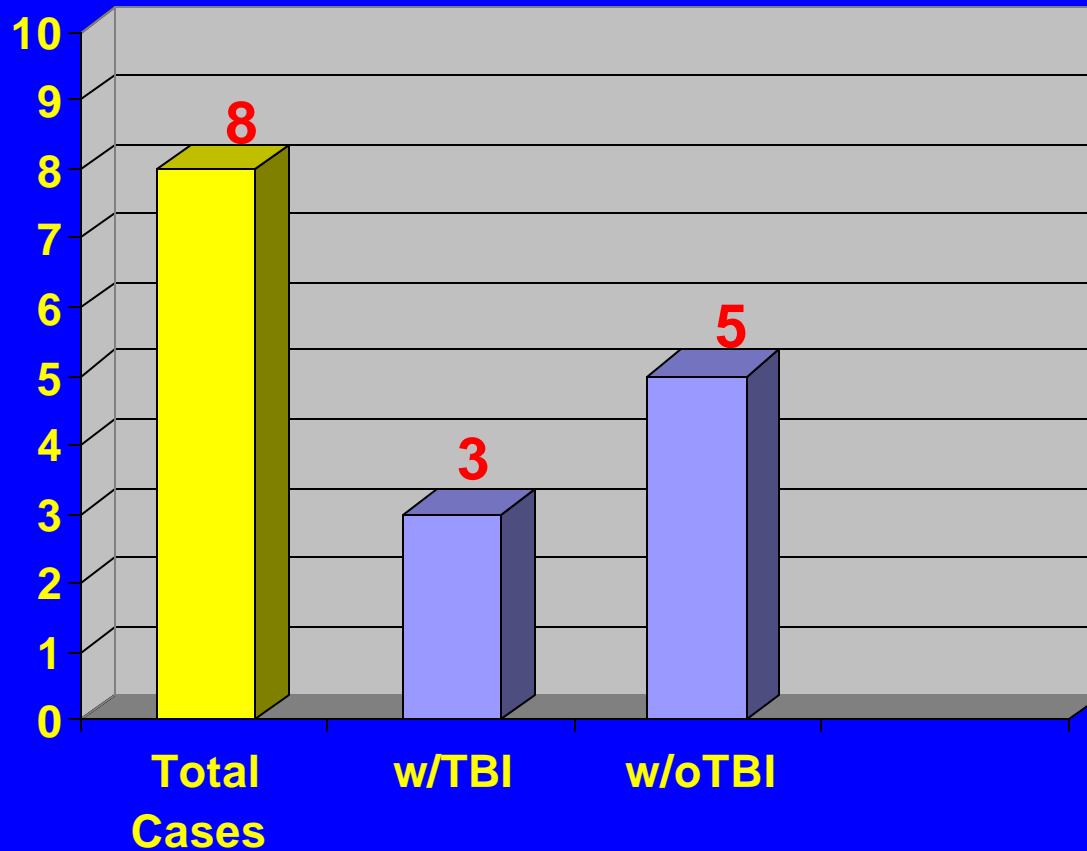
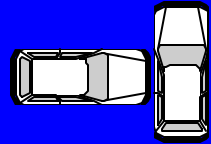


# Large Vehicle Struck by a Small Vehicle: TBI



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# Small Vehicle Struck by a Small Vehicle: TBI



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# Struck by Large Vehicle

		Size of Struck Vehicle		
		Large	Small	Total
<b>NO TBI</b>	<b>Count</b>	6	9	15
	% within Size of Struck Vehicle	85.7 %	27.3%	37.5%
<b>TBI</b>	<b>Count</b>	1	24	25
	% within Size of Struck Vehicle	14.3%	72.7%	62.5%
<b>Total</b>	<b>Count</b>	7	33	40
	% within Size of Struck Vehicle	100.0%	100.0%	100.0%



# Struck by Large Vehicle

## Odds & Risk Estimates

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for TBI? (No/Yes)	16.000	1.684	152.009
For Cohort Size of Struck Vehicle=Large	10.000	1.329	75.226
For Cohort Size of Struck Vehicle=Small	.625	.410	.952
N of Valid Cases	40		



# Struck by Small Vehicle

		Size of Struck Vehicle		Total
		Large	Small	
NO TBI	Count	2	5	7
	% within Size of Struck Vehicle	66.7 %	62.5%	63.6%
TBI	Count	1	3	4
	% within Size of Struck Vehicle	33.3%	37.5%	36.4%
Total	Count	3	8	11
	% within Size of Struck Vehicle	100.0%	100.0%	100.0%



# Struck by Small Vehicle

## Odds & Risk Estimates

	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio for TBI? (No/Yes)	1.200	.073	19.631
For Cohort Size of Struck Vehicle=Large	1.143	.145	8.987
For Cohort Size of Struck Vehicle=Small	.952	.457	1.985
N of Valid Cases	11		



# TBI Occurrences: Summary

- SMALL vehicle struck by LARGE vehicle: 24/33 (72.7 %)
- LARGE vehicle struck by LARGE vehicle: 1/7 (14.3 %)
- LARGE vehicle struck by SMALL vehicle: 1/3 (33.3 %)
- SMALL vehicle struck by SMALL vehicle: 3/8 (37.5 %)



# Case #1



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# Vehicle(s)

Vehicle 1: 1995 Saturn SCI, 2 door

Weight 1: 1191 kgs/2625 lbs.

Vehicle 2: 1997 Ford Econoline, E250

Cargo Van, loaded with Electrical  
Equipment

Weight 2: 2198 kgs/5067 lbs.

Est. Equipment: 318 kgs/700 lbs.



# Occupant(s)

Vehicle 1:

Driver: Female, age 21 (Case Study)

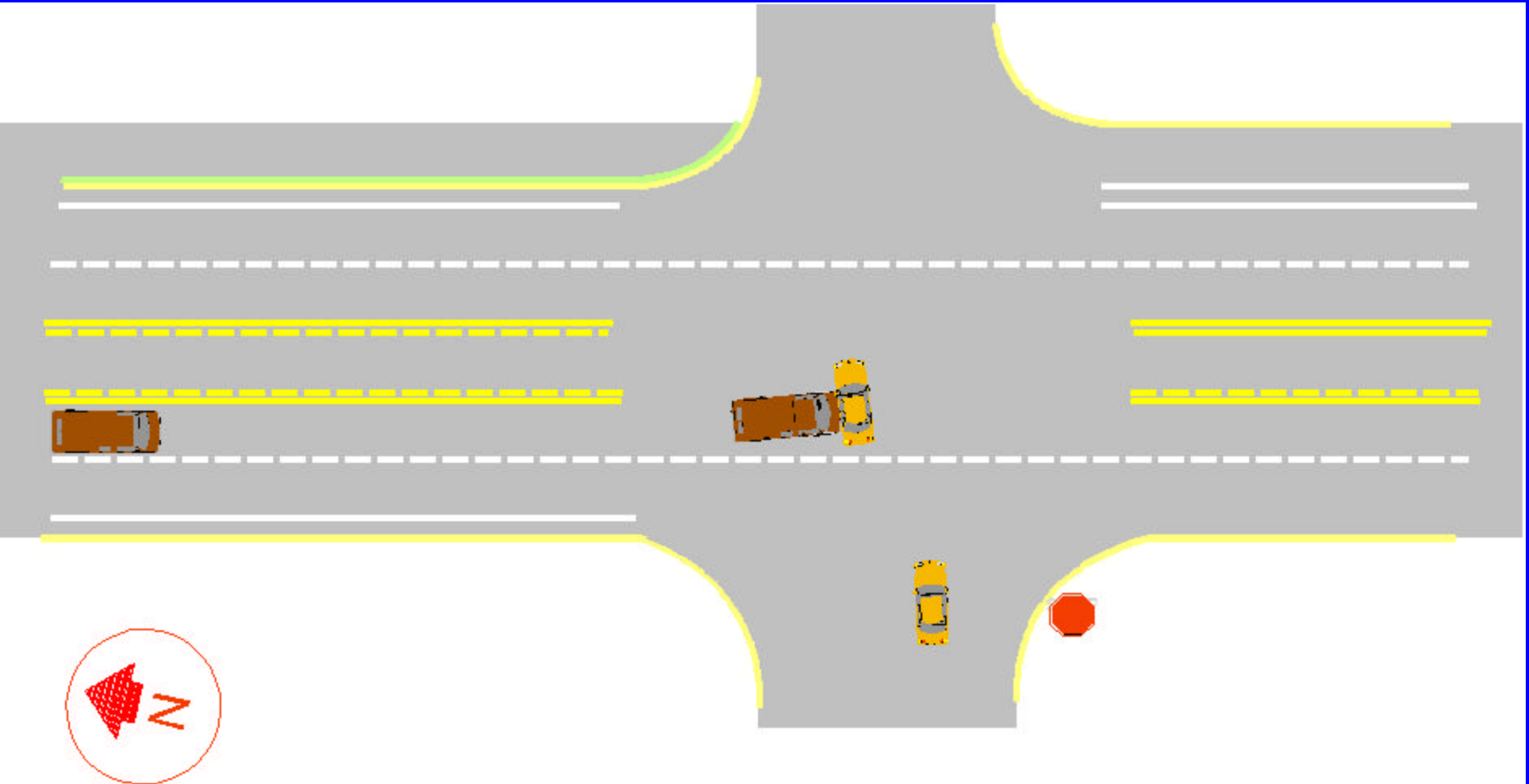
Vehicle 2:

Driver: Male, age 32





# Scene Impact



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# Crush Analysis

Vehicle 1:

CDC: 09LDYW3

PDOF: 280 degrees

Delta V: Beyond scope of Winsmash

BES: 40 kmp/h/24 mph



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# Scene Photos



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# Scene Photos



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# Scene Photos



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# Scene Photos



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# Contacts



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# Contacts



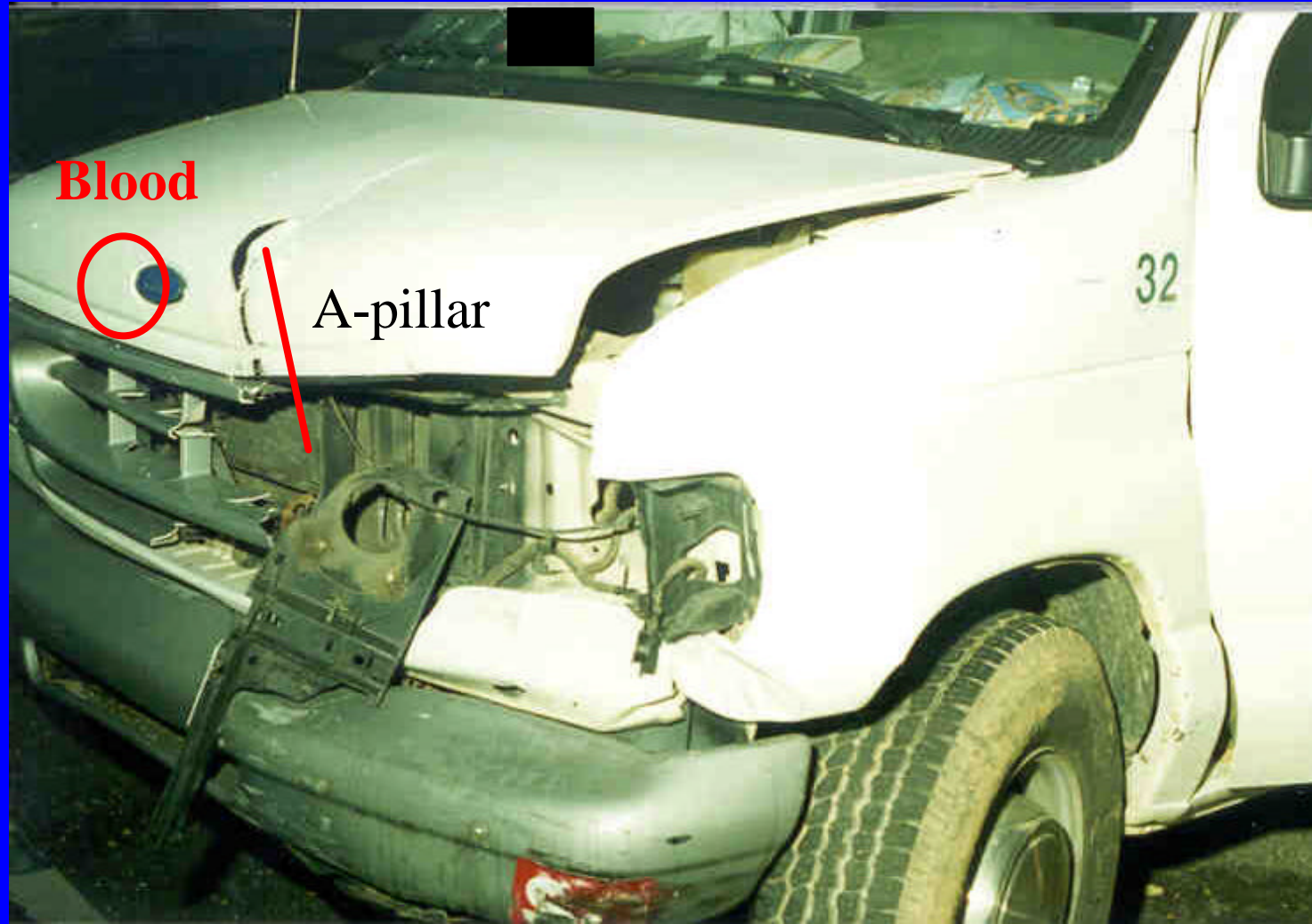
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# Contacts



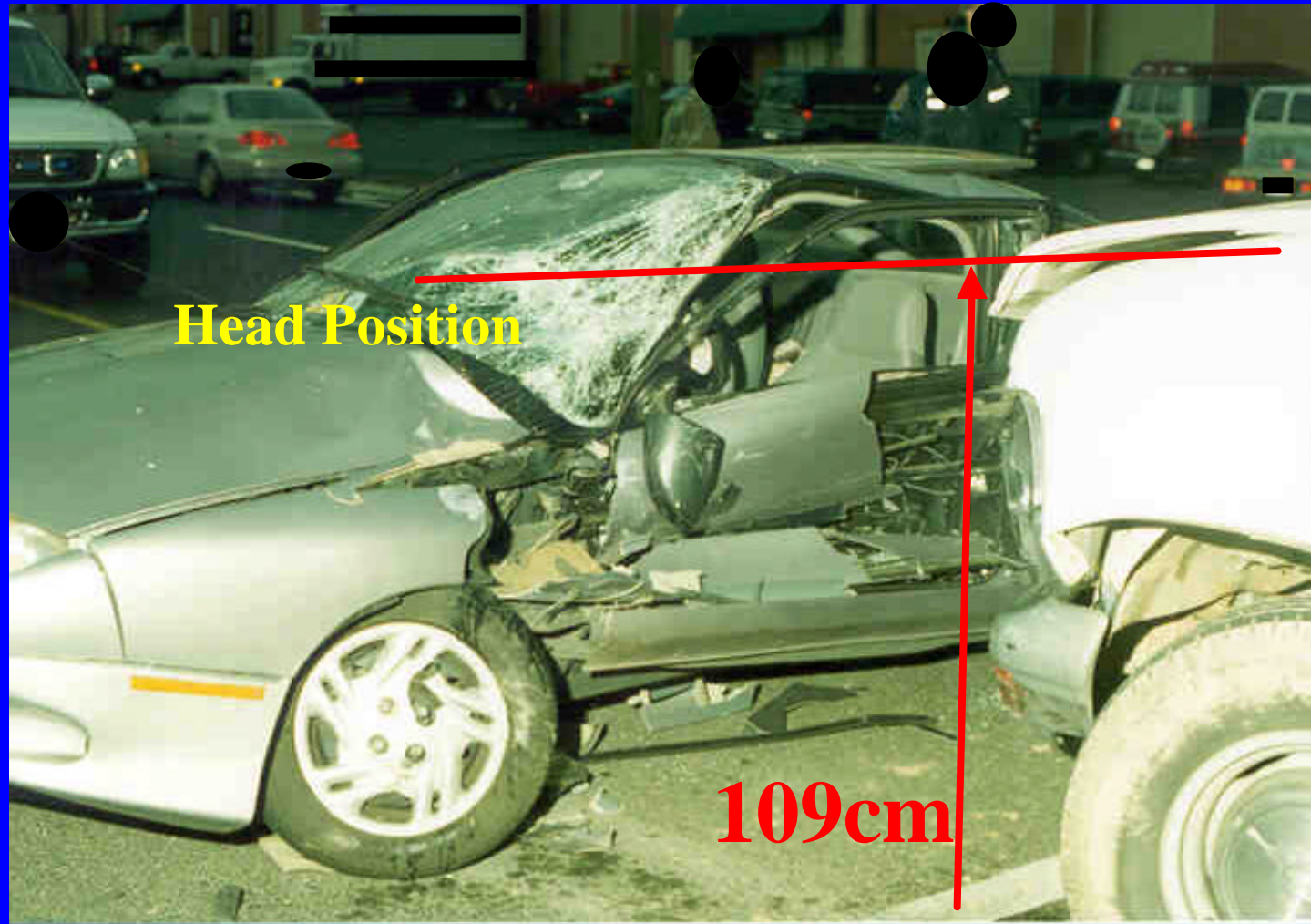
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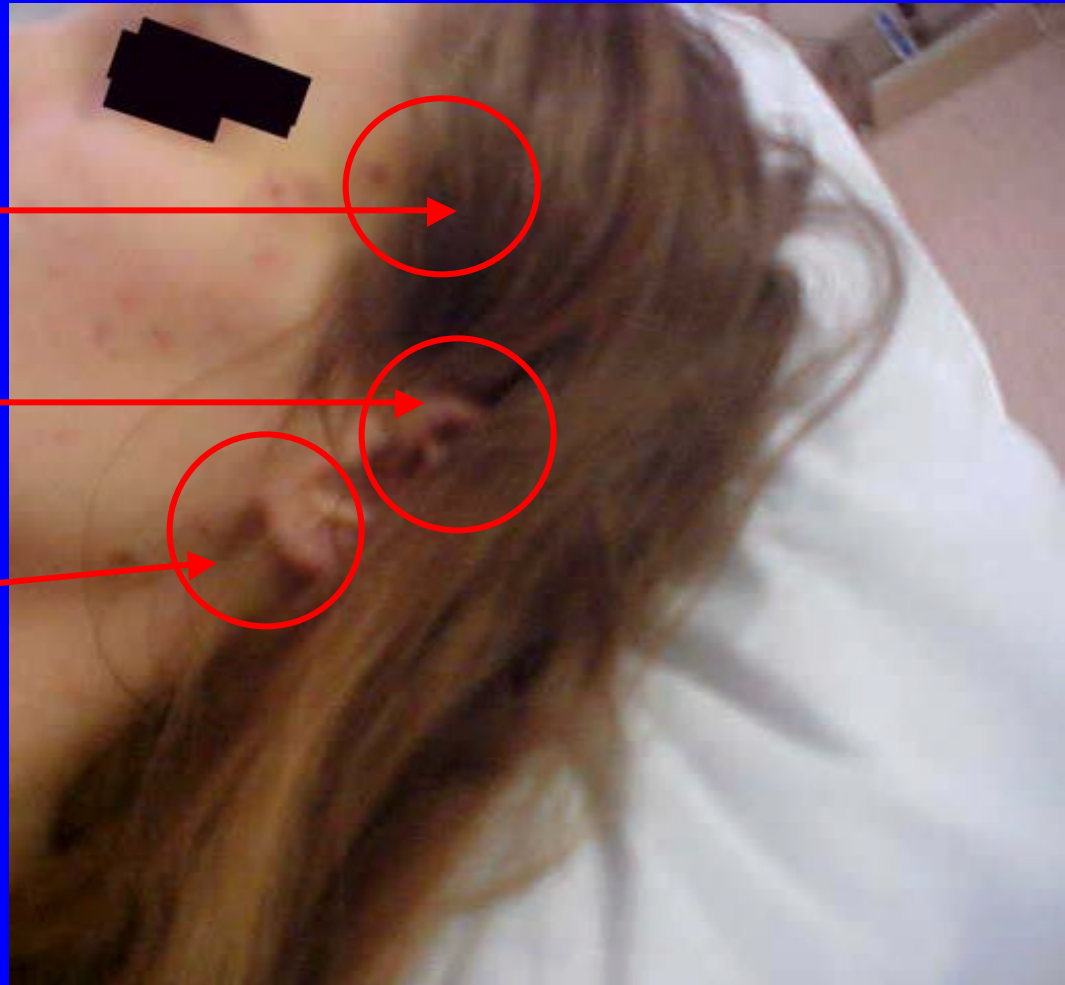
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# Injuries

Fading contusion  
at left temple

Ear laceration

Dicing lacerations





# Injuries

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Cerebral concussion (850.1)	161000.2	Clinical	Whole	2 <sup>nd</sup> vehicle
Ear lacerations (872.0)	290602.1	Exam	Left	2 <sup>nd</sup> vehicle
Facial lacerations - dicing 873.41	290602.1	Exam	Left – temple/cheek	Glass
Facial contusions (920)	290402.1	Exam	Left – temple/cheek	Glass



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# Injuries

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Rib fracture (807.01)	450212.1	CT	Left	Door – Armrest
Splenic laceration – grade III (865.03)	544224.3	CT	Left	Door into rib rib into spleen
Renal laceration – grade III (866.0)	541624.3	CT	Left	Door – Armrest
Abrasion hip (916.0)	890202.1	Exam	Left	Door – Armrest



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# Injuries

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Obturator artery laceration (902.8)	521402.3	Angio	Left pelvis	Door panel
Inferior & Superior pubic rami fractures (808.2)	852602.2	X-ray	Left	Door panel
Pubic symphysis fracture (808.2)	853000.3	X-ray	Right	Door panel
Iliac wing fracture (808.41)	852602.2	X-ray	Left	Door panel
Diastasis - sacroiliac joint (839.42)	852602.2	X-ray	Left	Door panel



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# Case #2



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## Vehicle(s)

Vehicle 1: 1996 Ford Explorer 4 door

Weight 1: 1890 kg/4166 lbs.

Vehicle 2: 1994 Chevrolet Truck body/Van

Weight 2: +4091 kg/+9001 lbs.



# Occupant(s)

Vehicle 1:

Driver: Male, age 59 (Case Study)

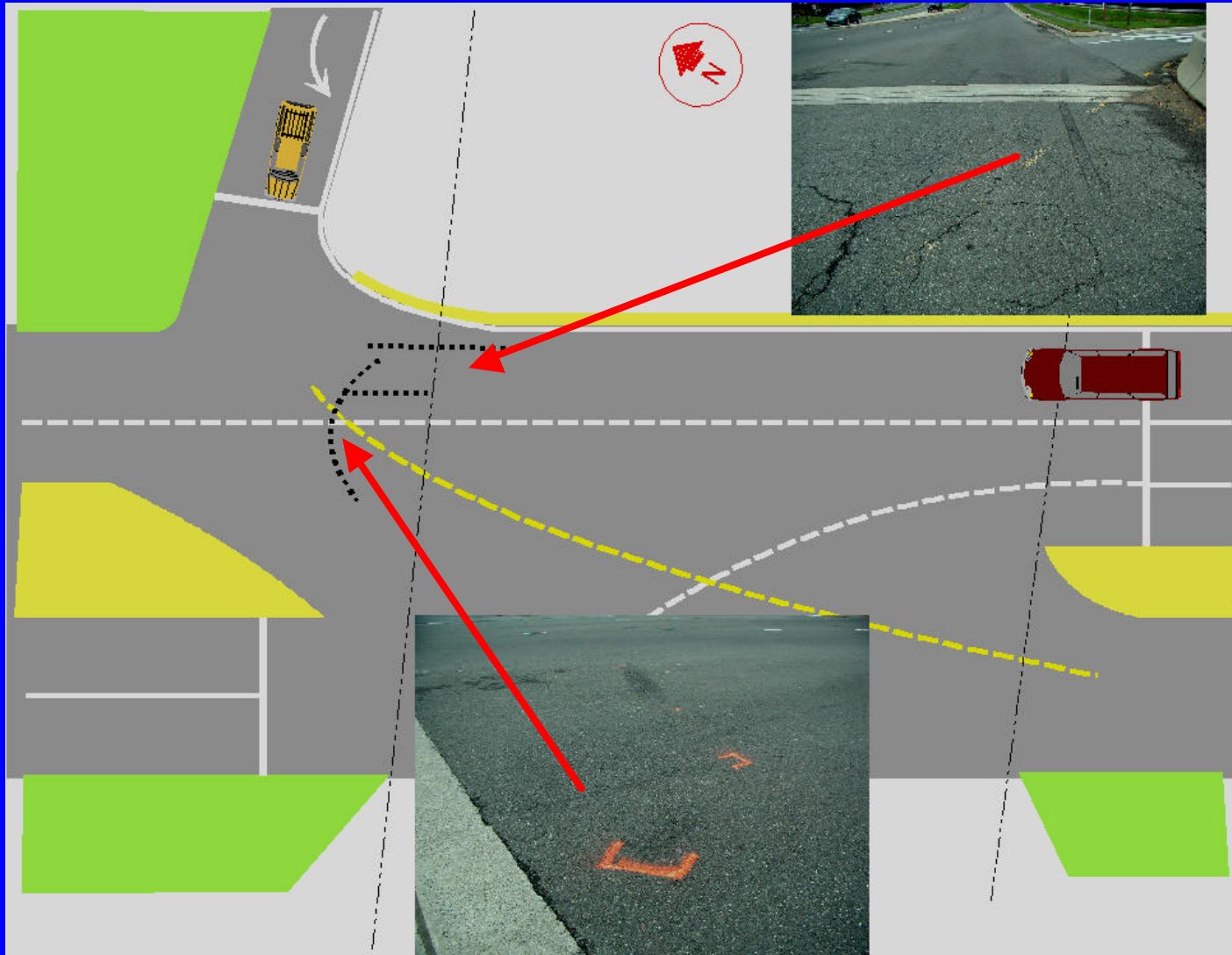
Vehicle 2:

Driver: Male, age 18



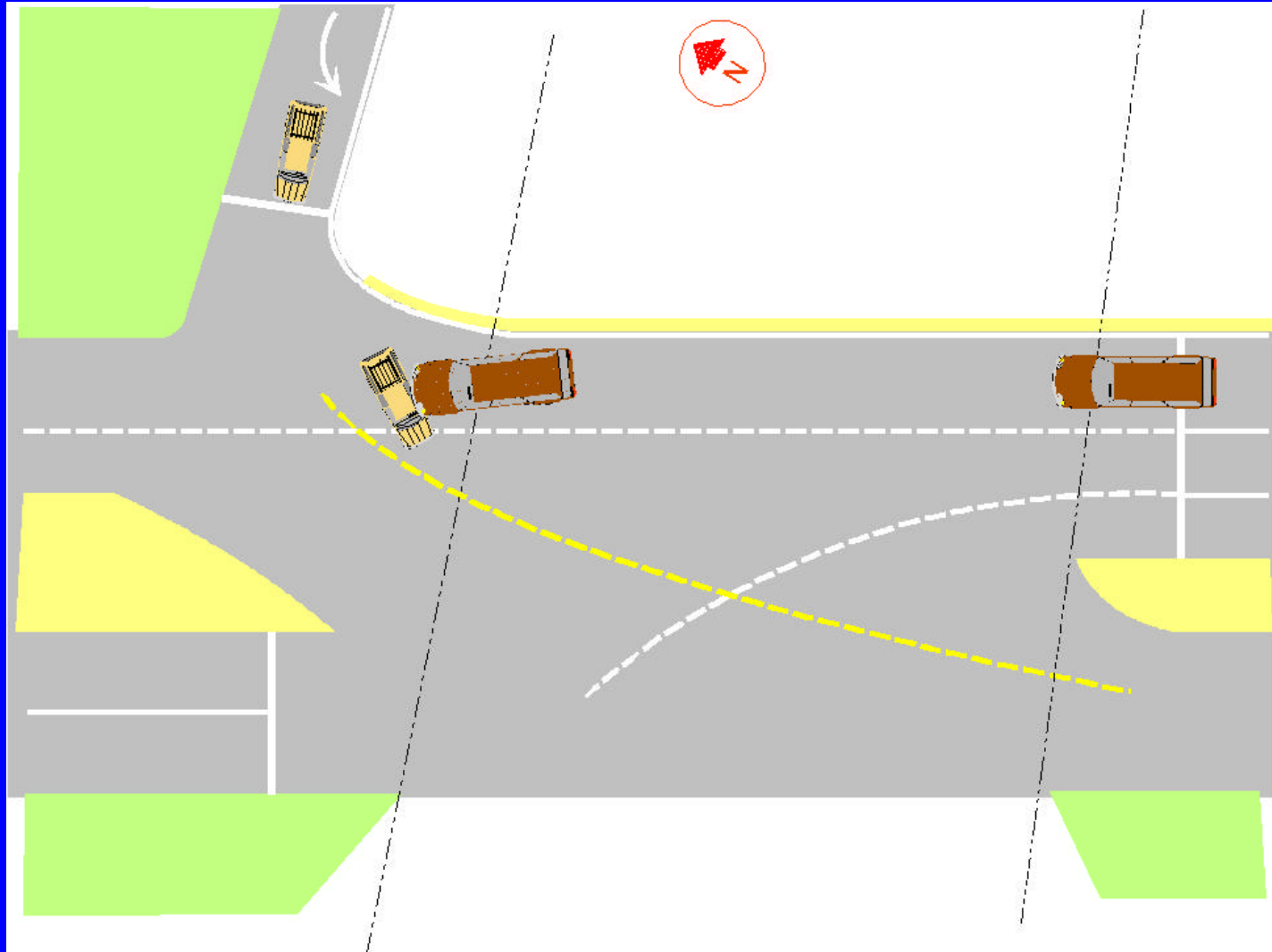
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# Scene



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# Scene



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# Crush Analysis

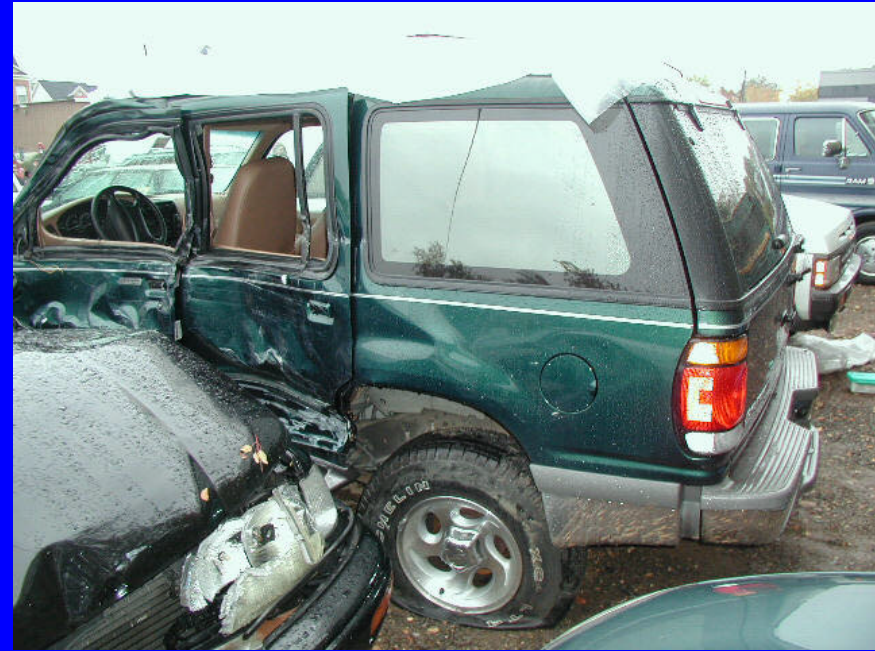
Vehicle 1:

CDC: 09LYAW3

PDOF: 270 degrees

Beyond scope of Winsmash

BES: 19 kmp/h/12 mph



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# Vehicle 1 Approach



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# Vehicle 1 Approach



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# Vehicle 2 Approach



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# Vehicle 2



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# Vehicle 1



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# Contacts



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# Contacts



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# Contacts



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# Injuries



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# Injuries



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# Injuries

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
PTX w lung contusion (860.0)	450214.3	CT	Left	Door panel – arm rest
Rib fracture x 1 (807.01)	450214.3	CT	Left – 8 <sup>th</sup> posterior	Door panel – arm rest



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# Injuries

Injuries (ICD)	AIS Severity	Info Source	Aspect (R,L,bilat,etc)	Contact Area (door, seat,etc)
Grade IV spleen laceration (865.04)	544226.4	CT	Left	Door panel – arm rest



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# Conclusions

- Large vehicles pose a unique risk to smaller vehicles in side impact crashes
- Head injury appears significantly more likely under these conditions
- Limited clinical data available for correlation
- An opportunity for CIREN Centers

