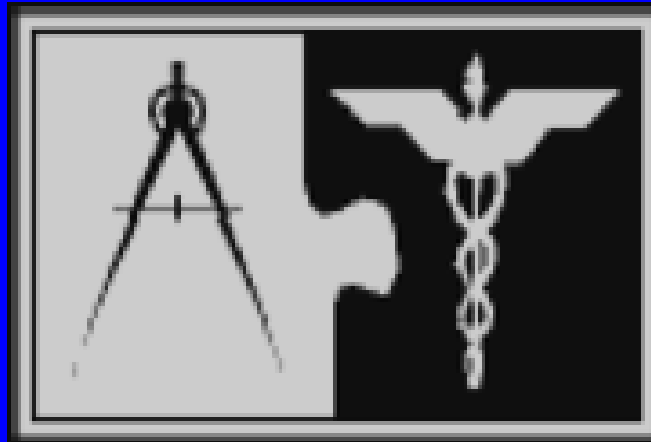


University of
Virginia



Honda Inova Fairfax Hospital CIREN Team

HONDA



INOVA REGIONAL
TRAUMA CENTER



The Role of Vehicle Size in Side Impact Head Injuries



Honda Inova Fairfax Hospital CIREN Center

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



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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

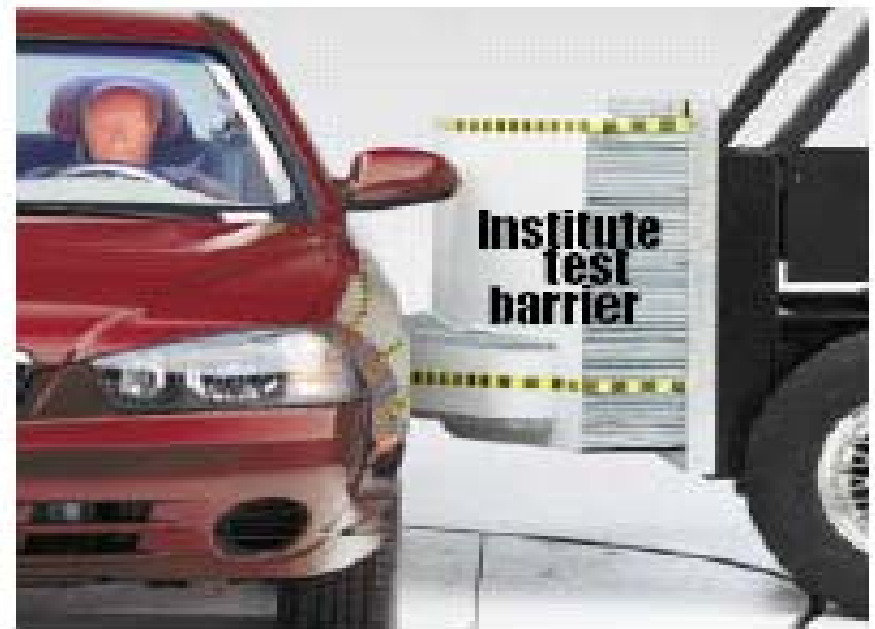
Typical F150 & Grand Marquis Test Results



Head
Contact

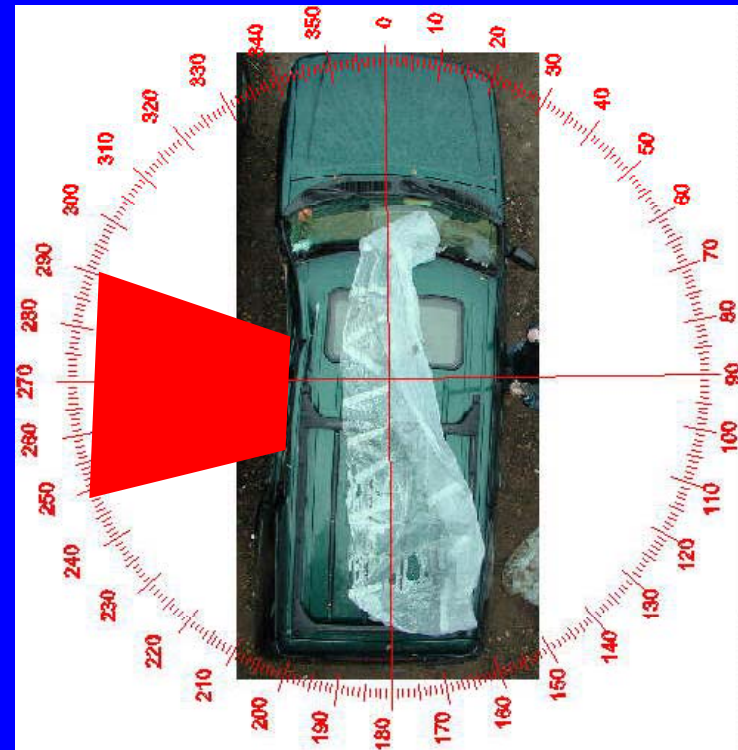
Introduction

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

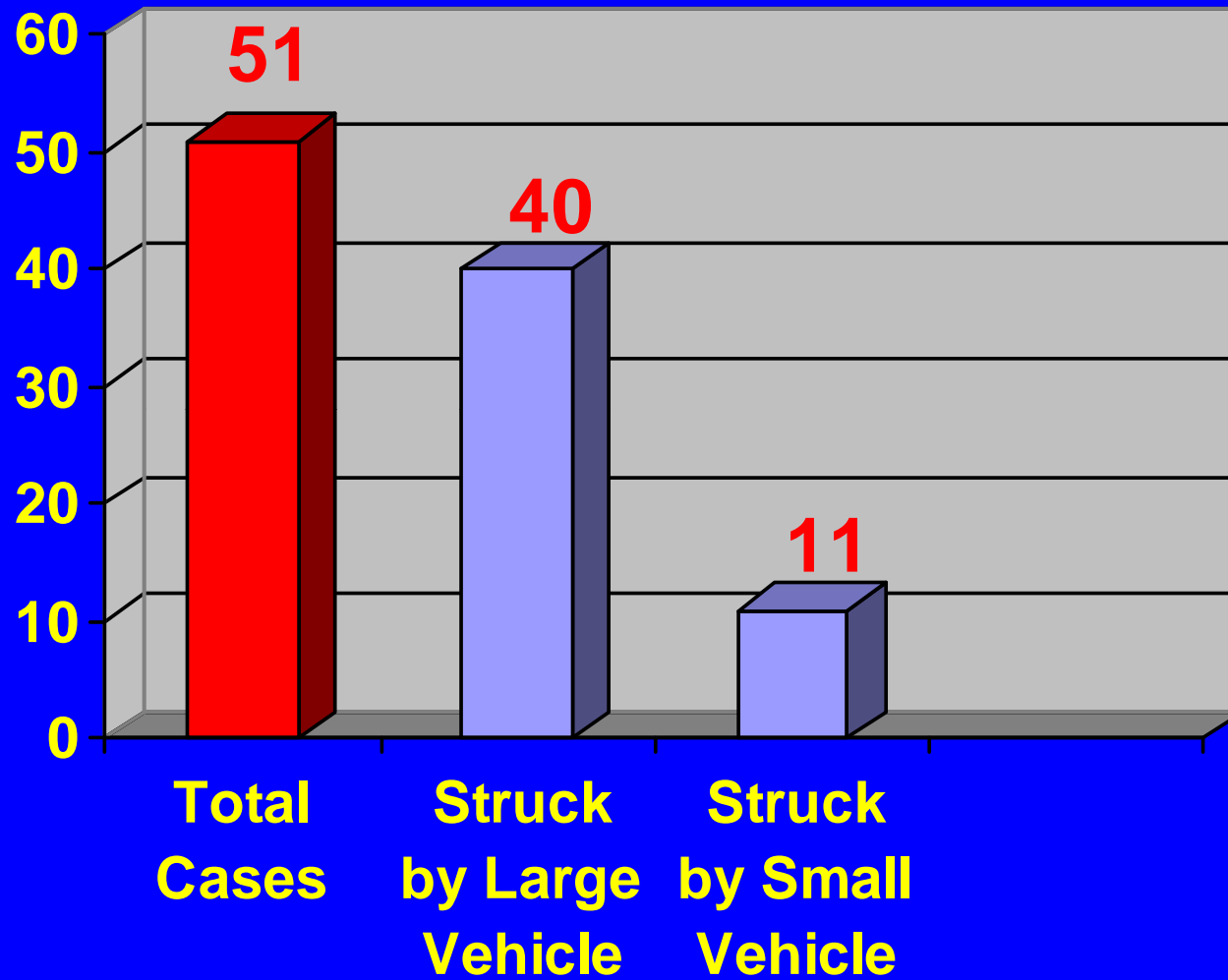


Search Parameters

- Inclusion Criteria
 - Principle Direction of Force: 250° to 290° (Near Side Crash)
 - Vehicle to vehicle
 - Driver Injured (AIS ≥ 2)
 - Complete case

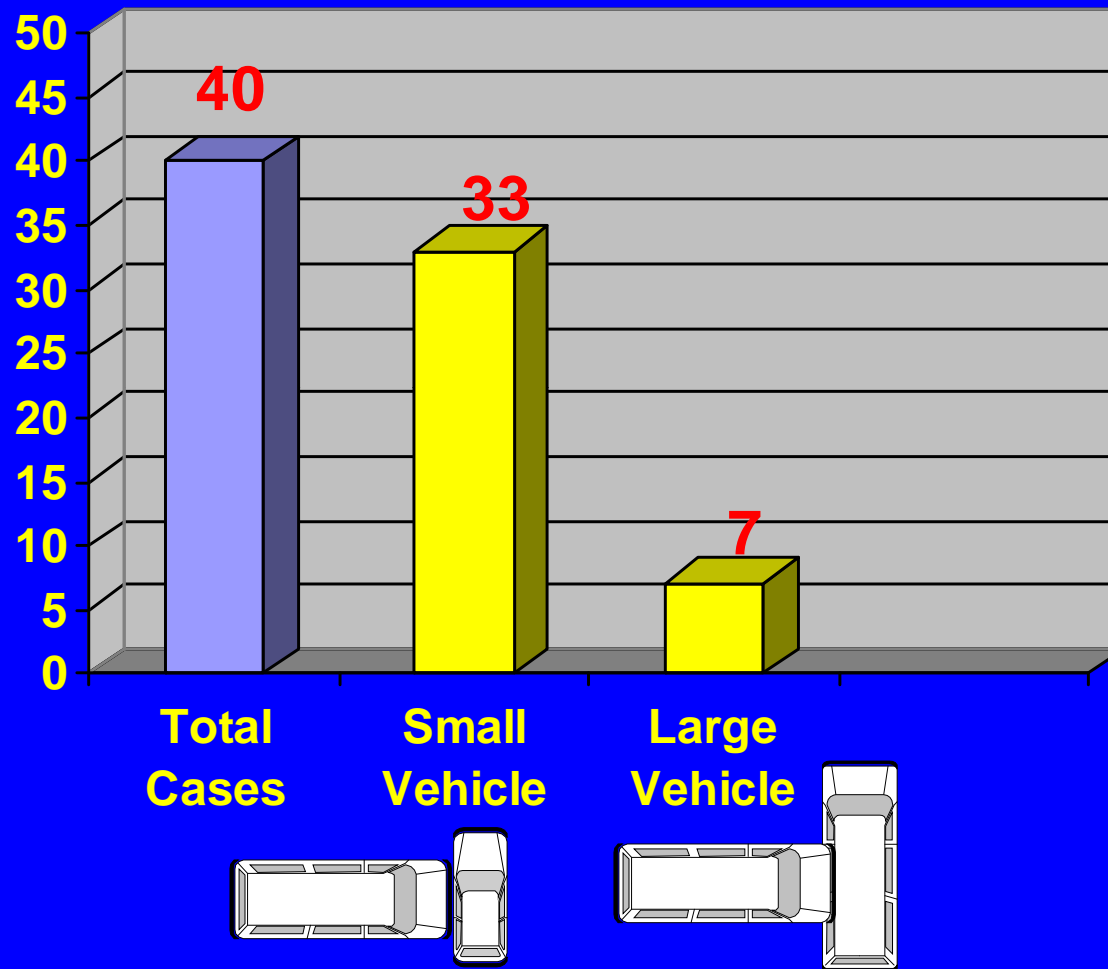


Total Cases



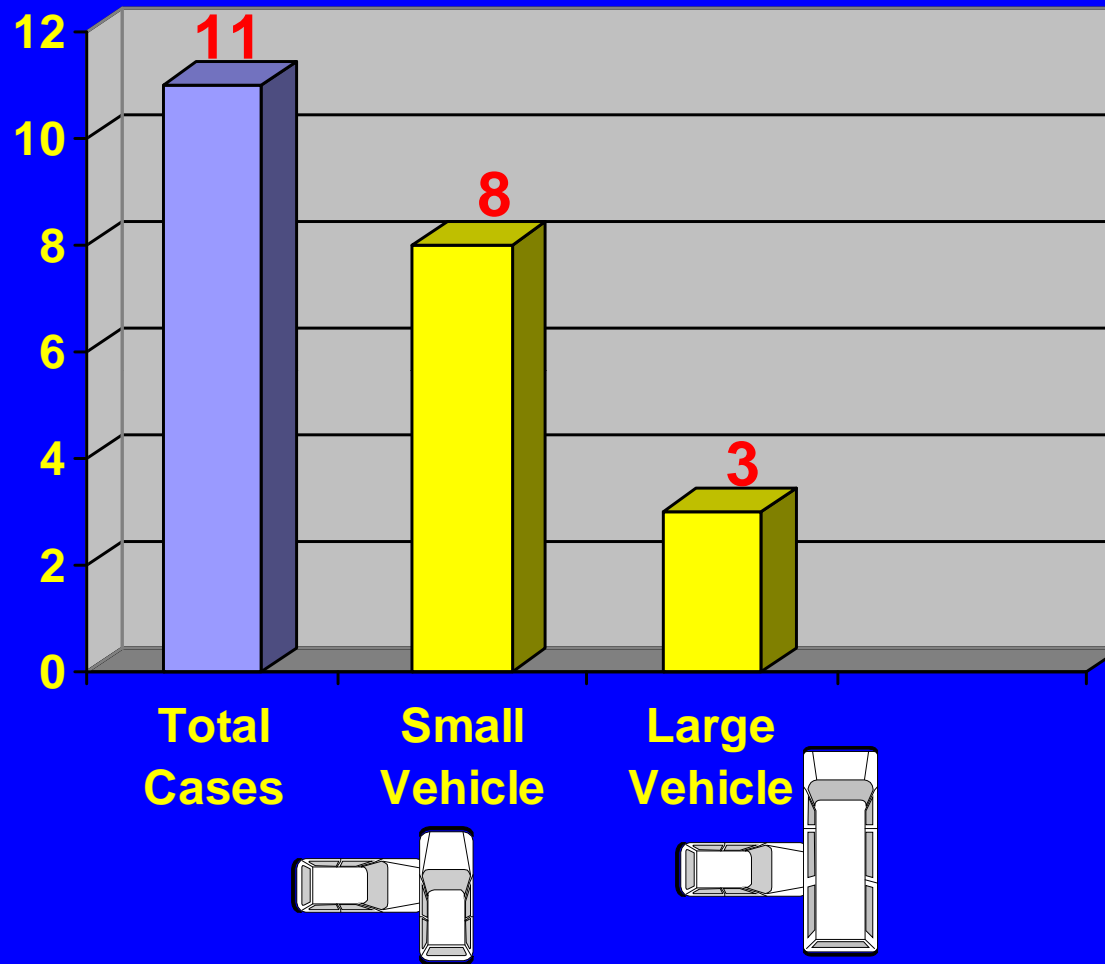
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Struck by a Large Vehicle



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Struck by a Small Vehicle



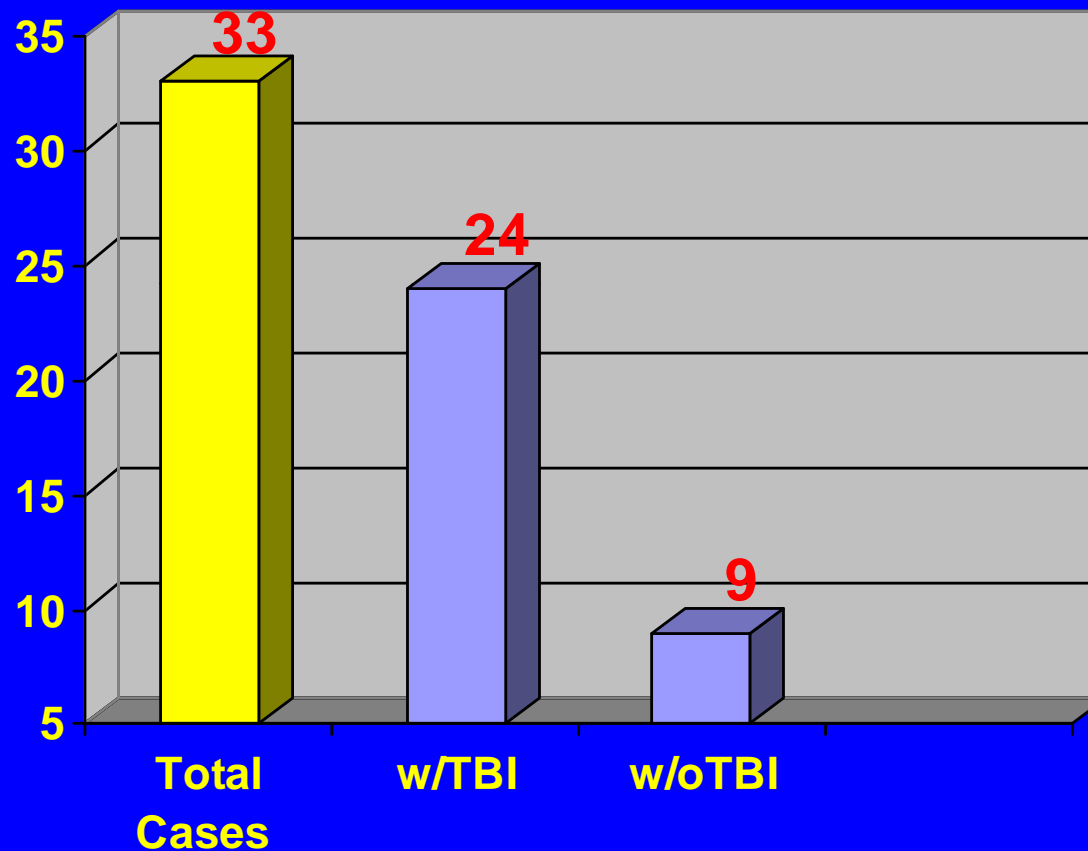
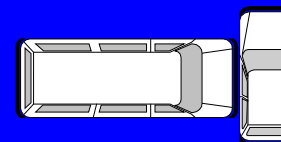
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TBI occurrences

- 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%)

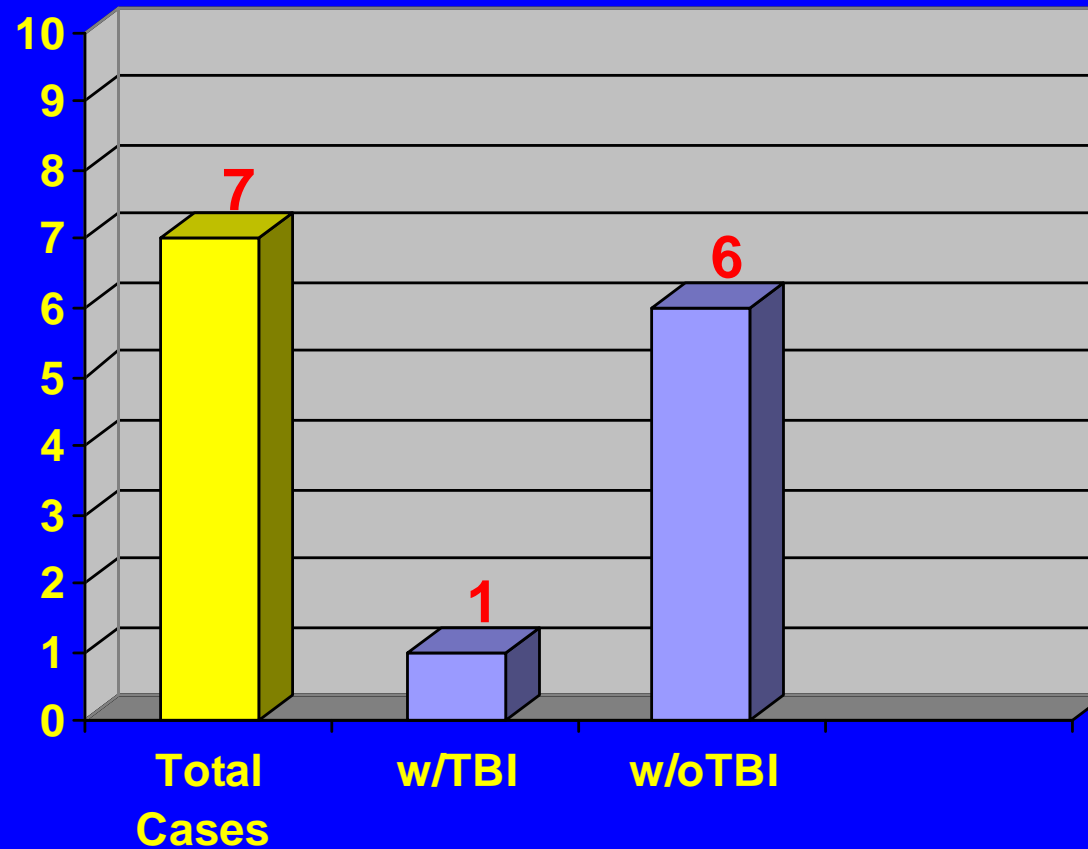
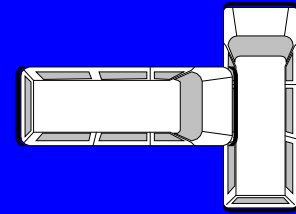


Small Vehicle Struck by a Large Vehicle: TBI



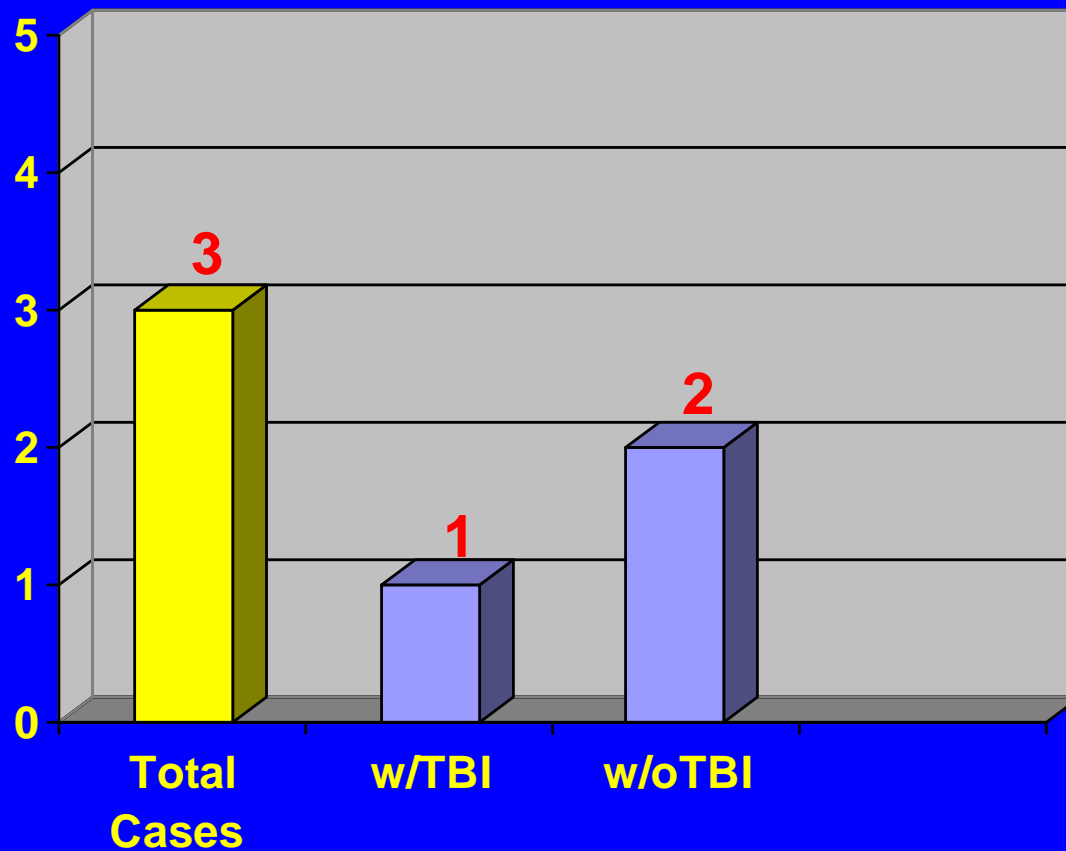
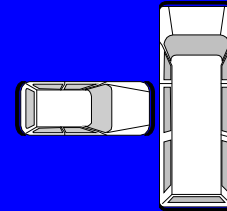
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Large Vehicle Struck by a Large Vehicle: TBI



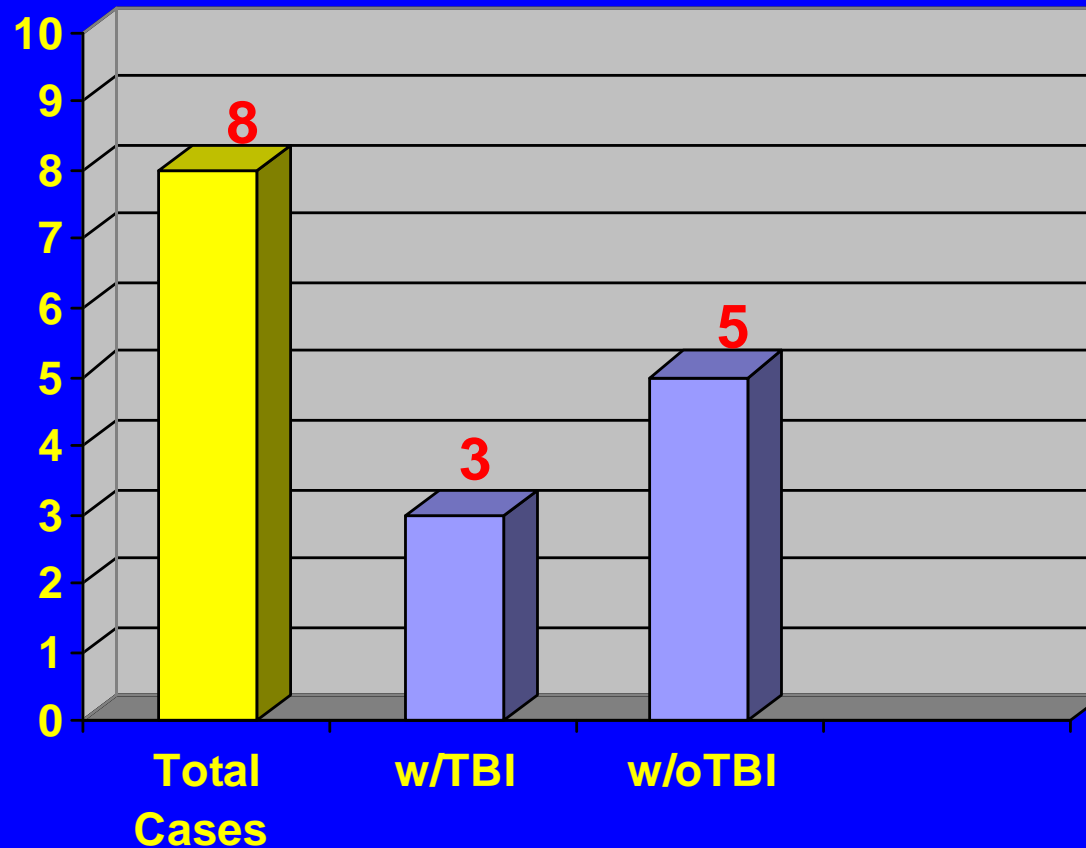
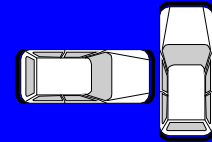
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Large Vehicle Struck by a Small Vehicle: TBI



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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
NO TBI	Count	6	9	15
	% within Size of Struck Vehicle	85.7 %	27.3%	37.5%
TBI	Count	1	24	25
	% within Size of Struck Vehicle	14.3%	72.7%	62.5%
Total	Count	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		
		Large	Small	Total
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)

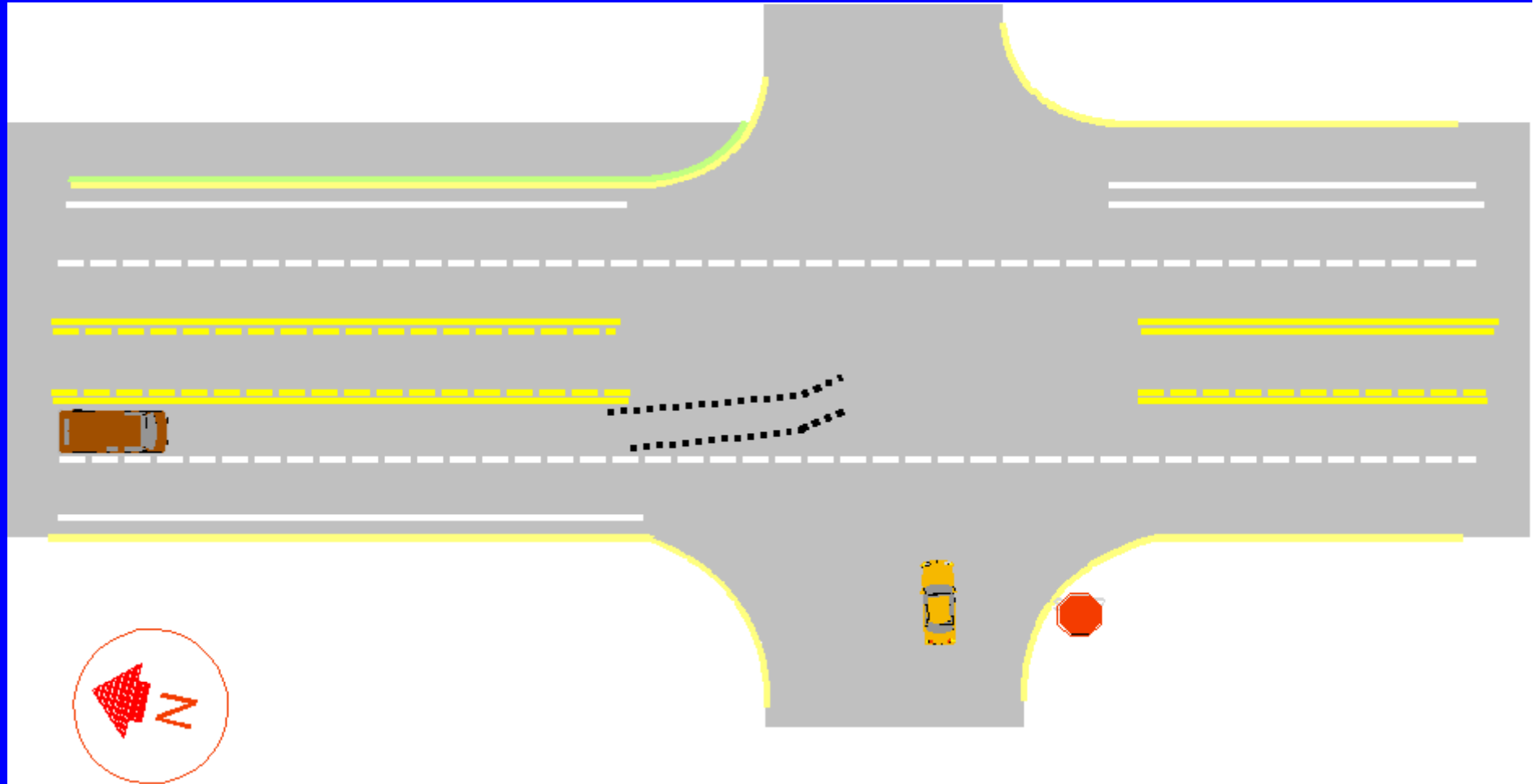
Vehicle 2:

Driver: Male, age 32



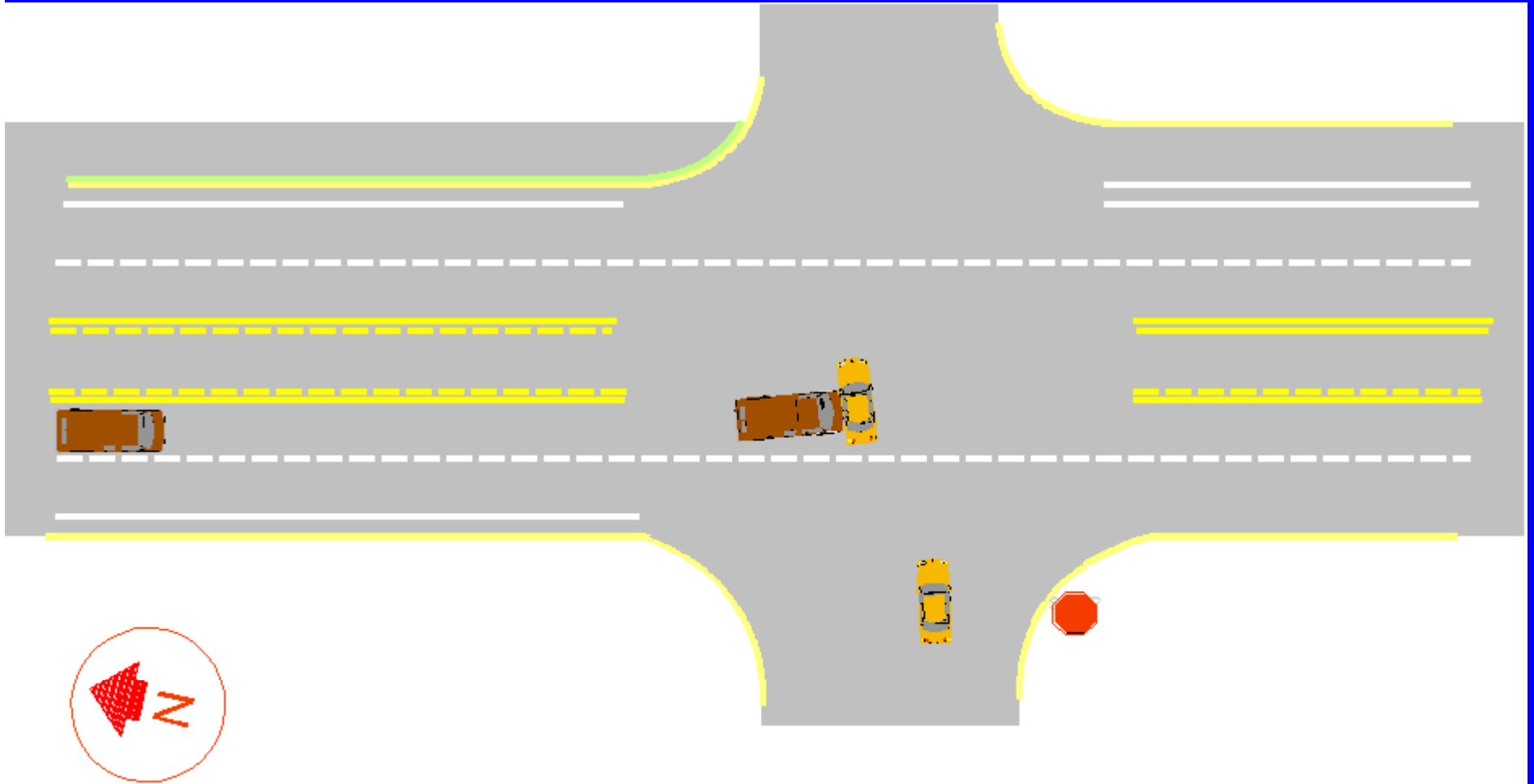
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Scene Evidence



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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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Scene Photos



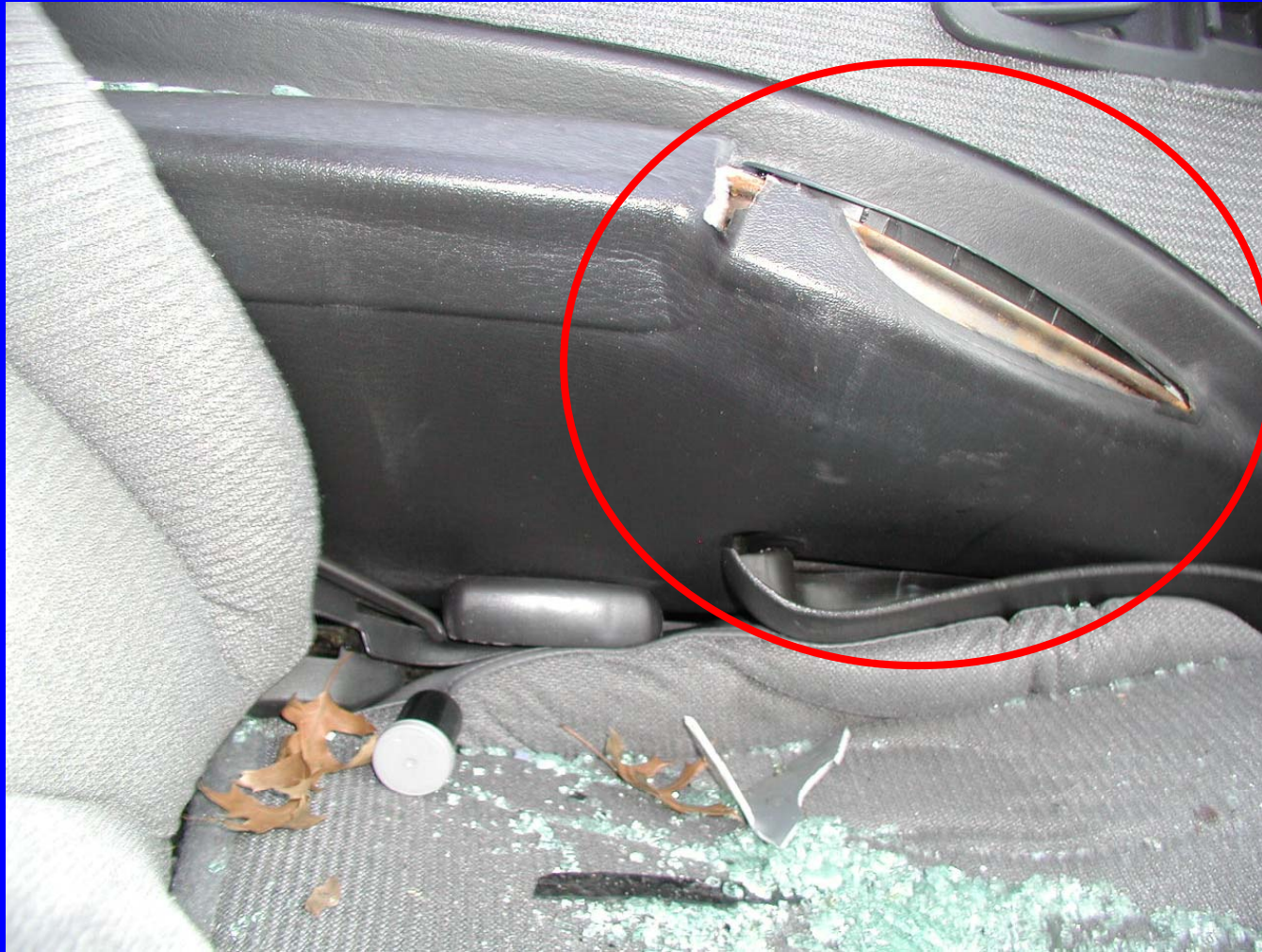
Honda Inova Fairfax Hospital CIREN Center

Contacts



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Contacts



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Contacts



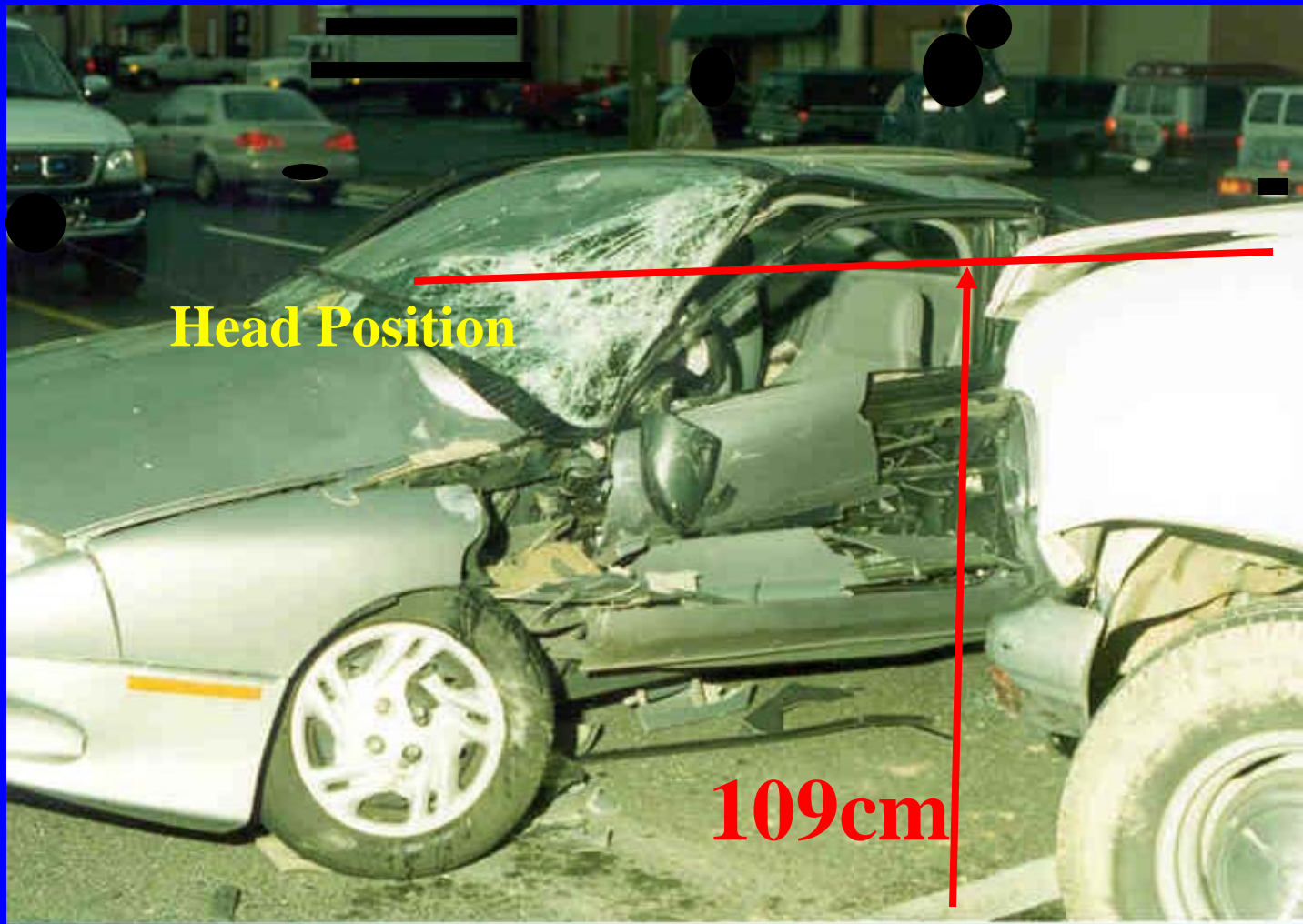
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Contacts



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Contact



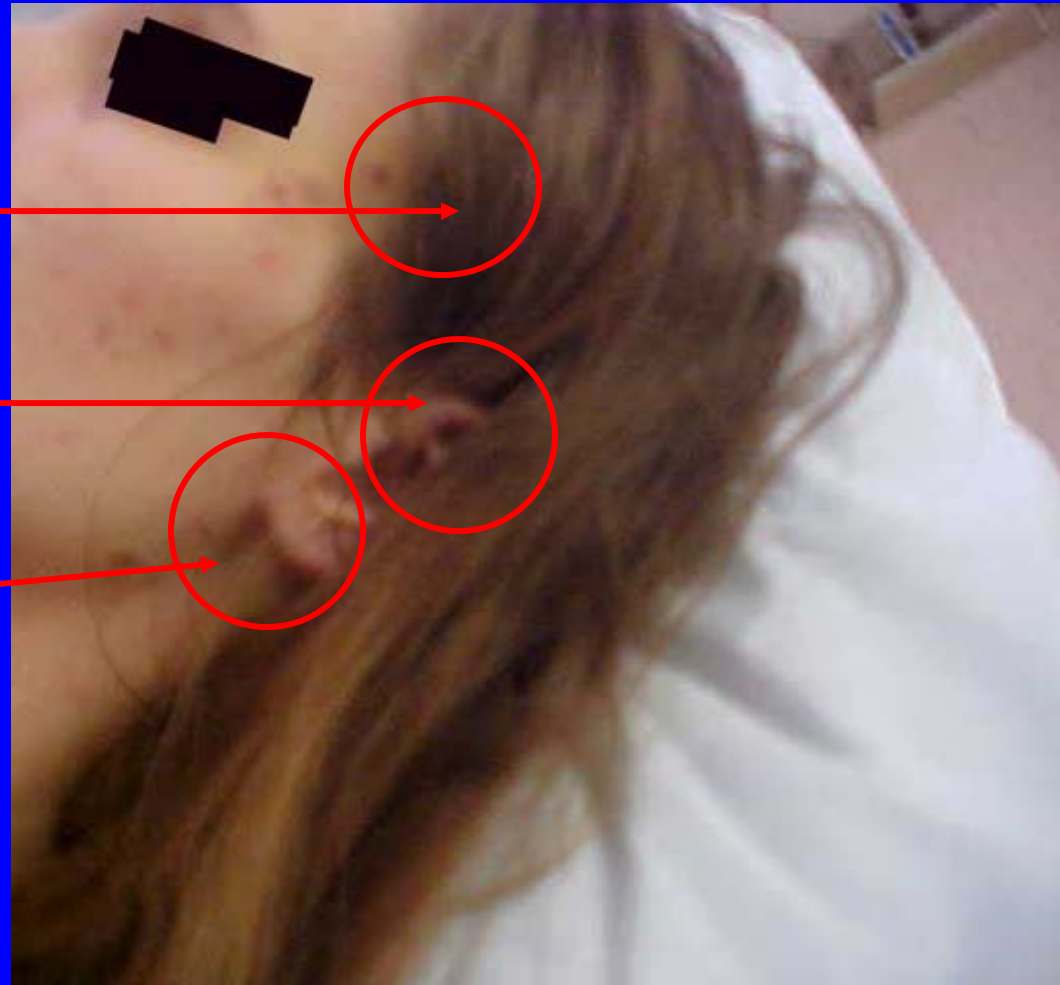
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Injuries

Fading contusion
at left temple

Ear laceration

Dicing lacerations



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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 nd vehicle
Ear lacerations (872.0)	290602.1	Exam	Left	2 nd 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	Info	Aspect	Contact Area
	Severity	Source	(R,L,bilat,etc)	(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)

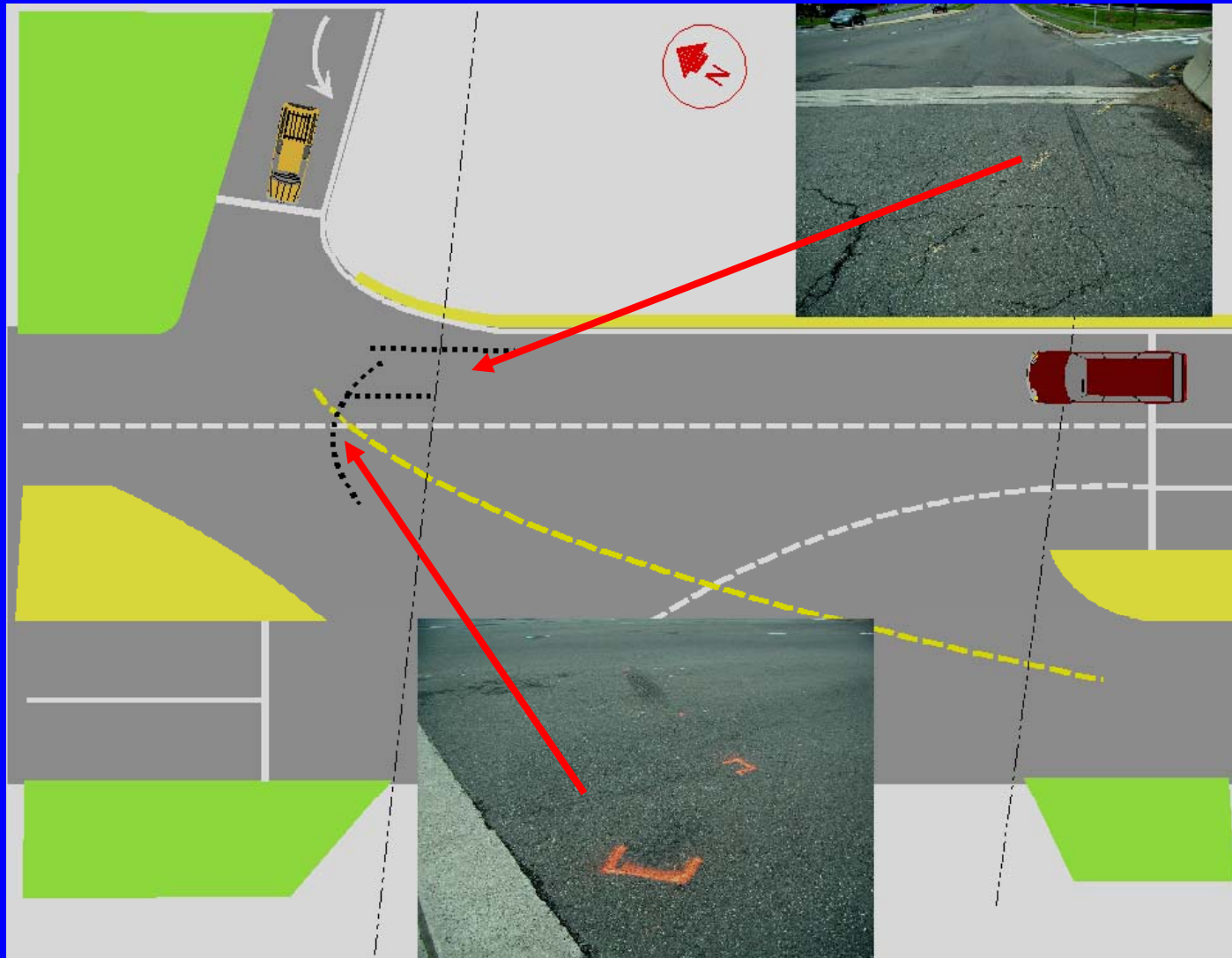
Vehicle 2:

Driver: Male, age 18



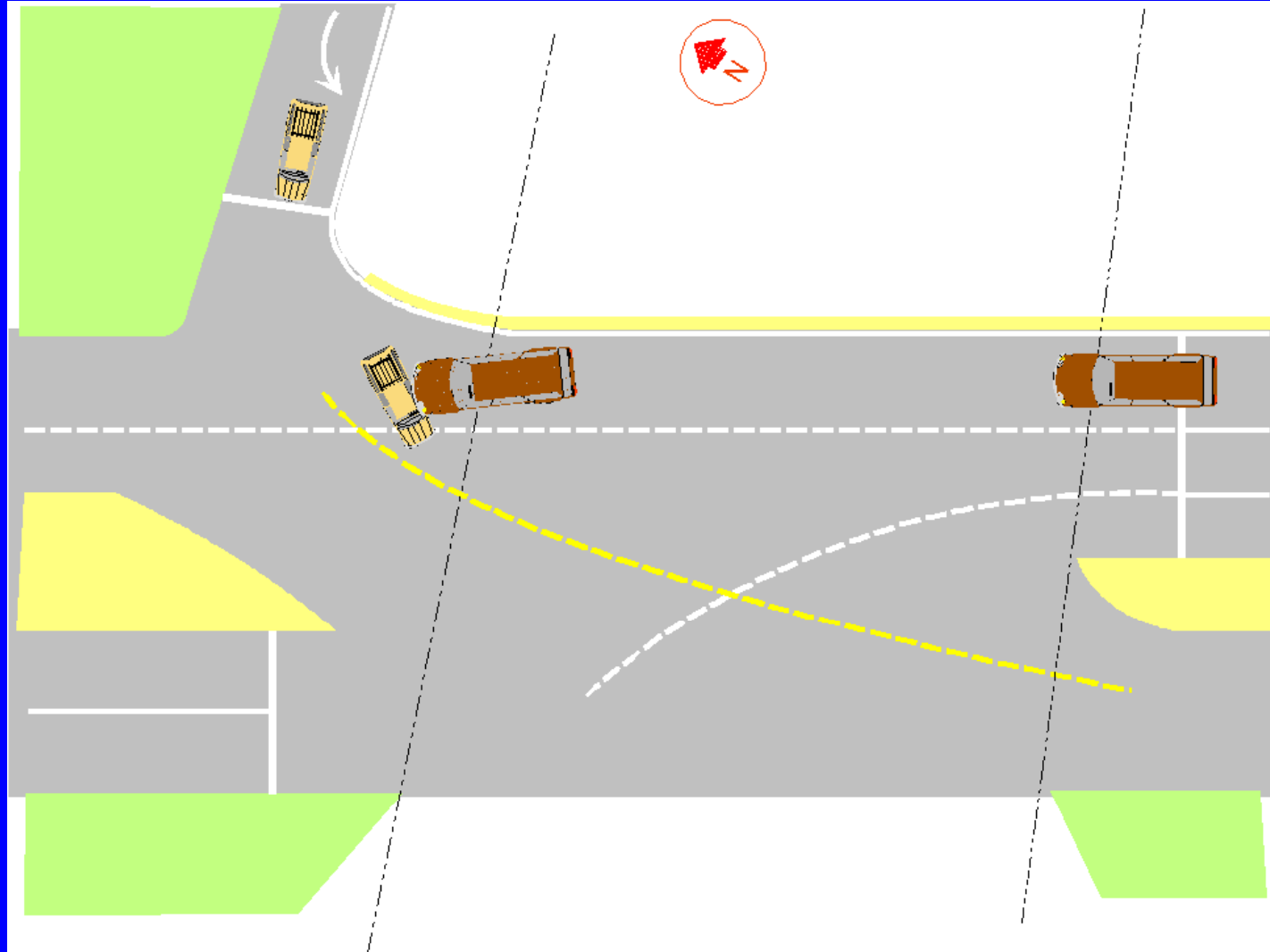
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Scene



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Scene



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Crash 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 th 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

