Injury Patterns in SUVs

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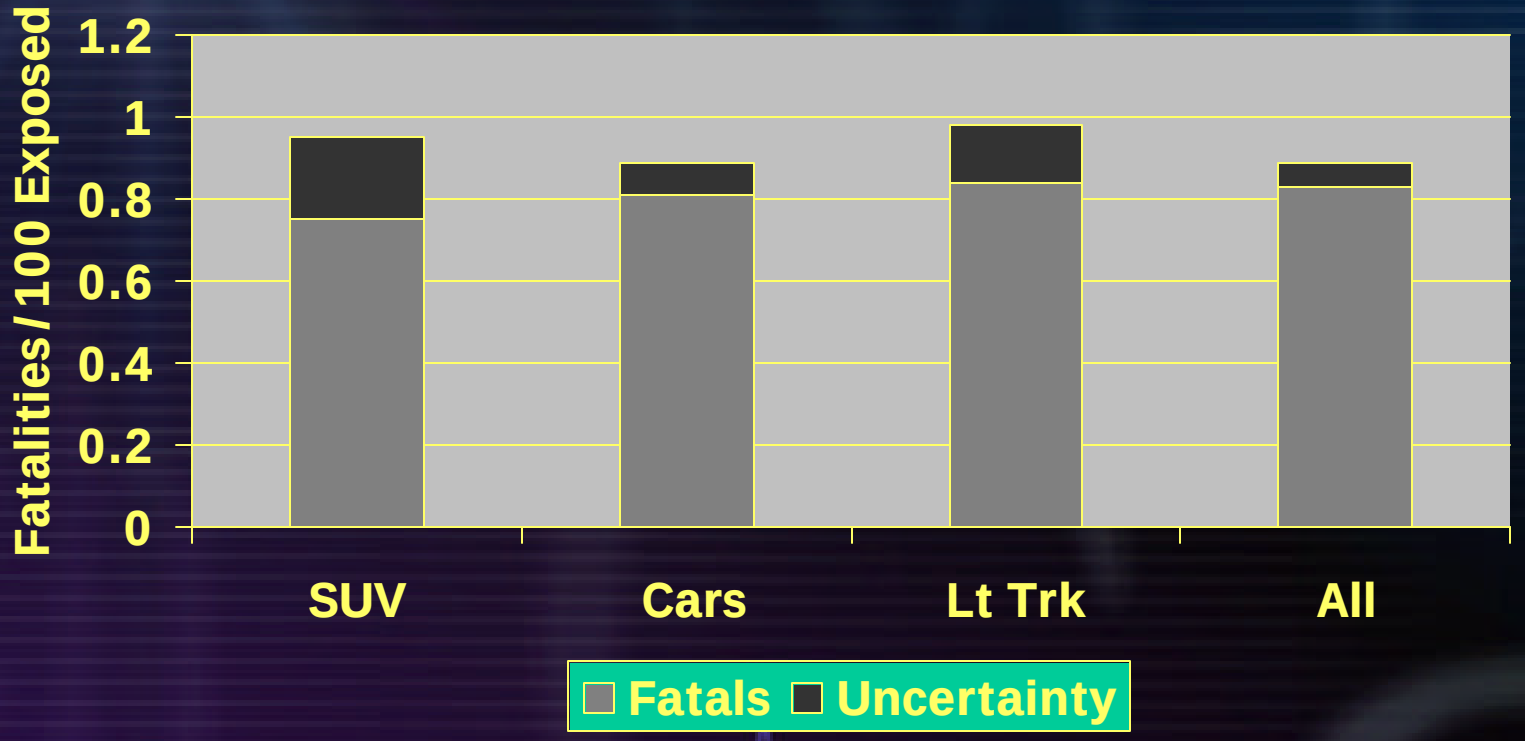
Occupant Fatalities per 100 Crash Exposed



NASS 1988-96

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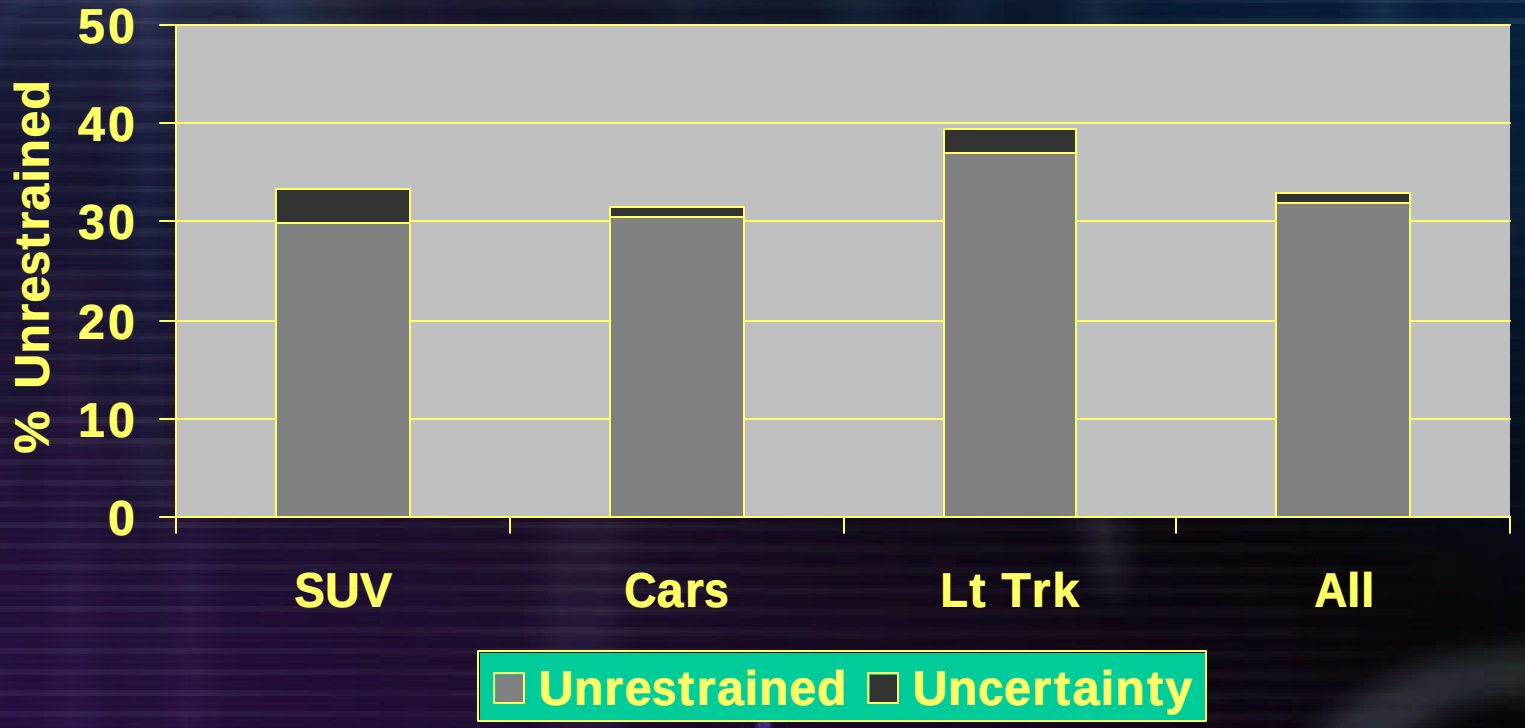
Percent of Occupants Unrestrained



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NASS 1988-96

Research Questions

- Why does the data indicate that SUVs are not safer than passenger cars?
- What are the crash and injury patterns in SUVs?

Analysis Approach

- Data Source -NASS/CDS 1988 -1996
  - FARS 1975-1996
- Compare SUVs with Passenger Cars
- Differences in:
  - **Exposure**
  - **Restraint Use**
  - **Rollover Frequency**
- Examine Injury Rates by Restraint Use

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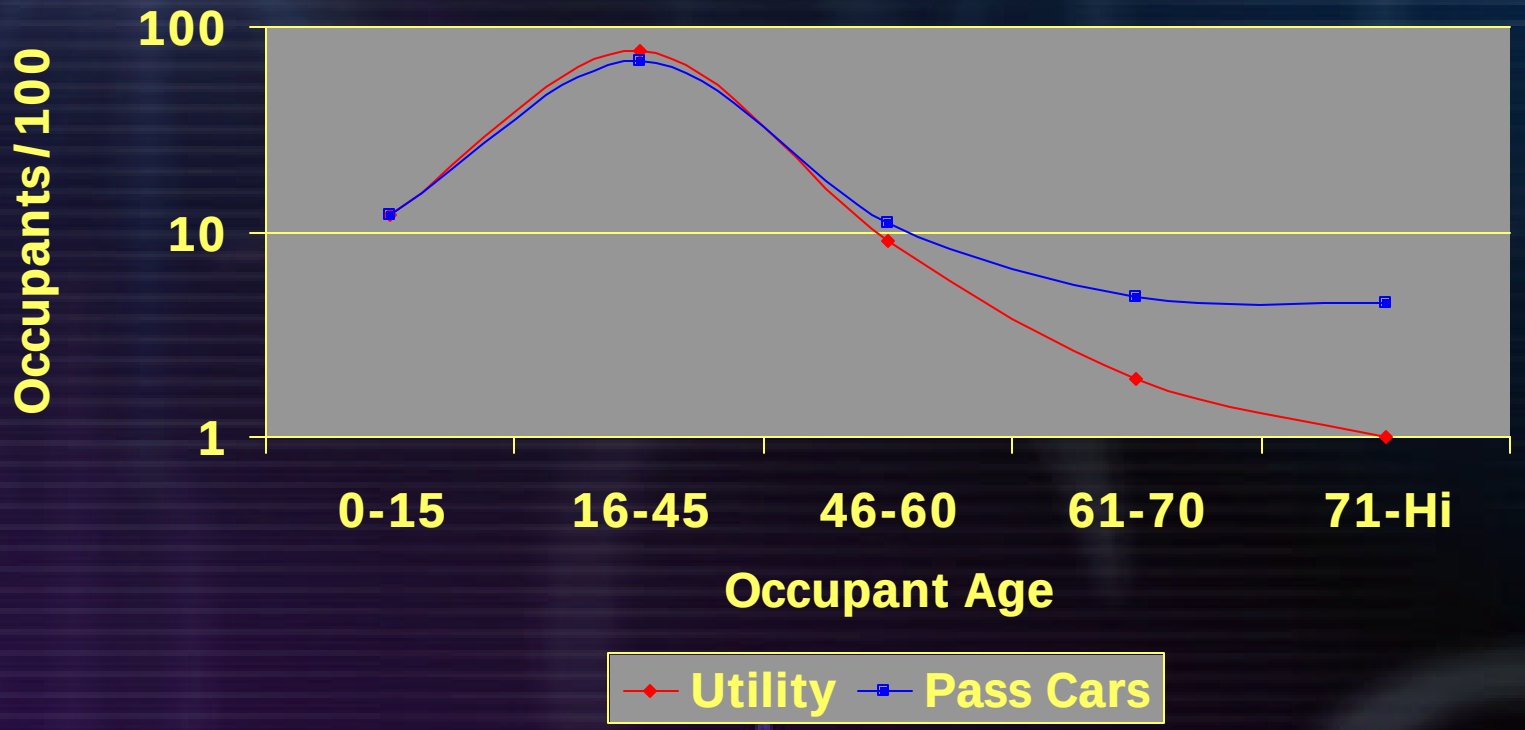
Occupant Exposure by Age Exposure per 100 Crash Involved



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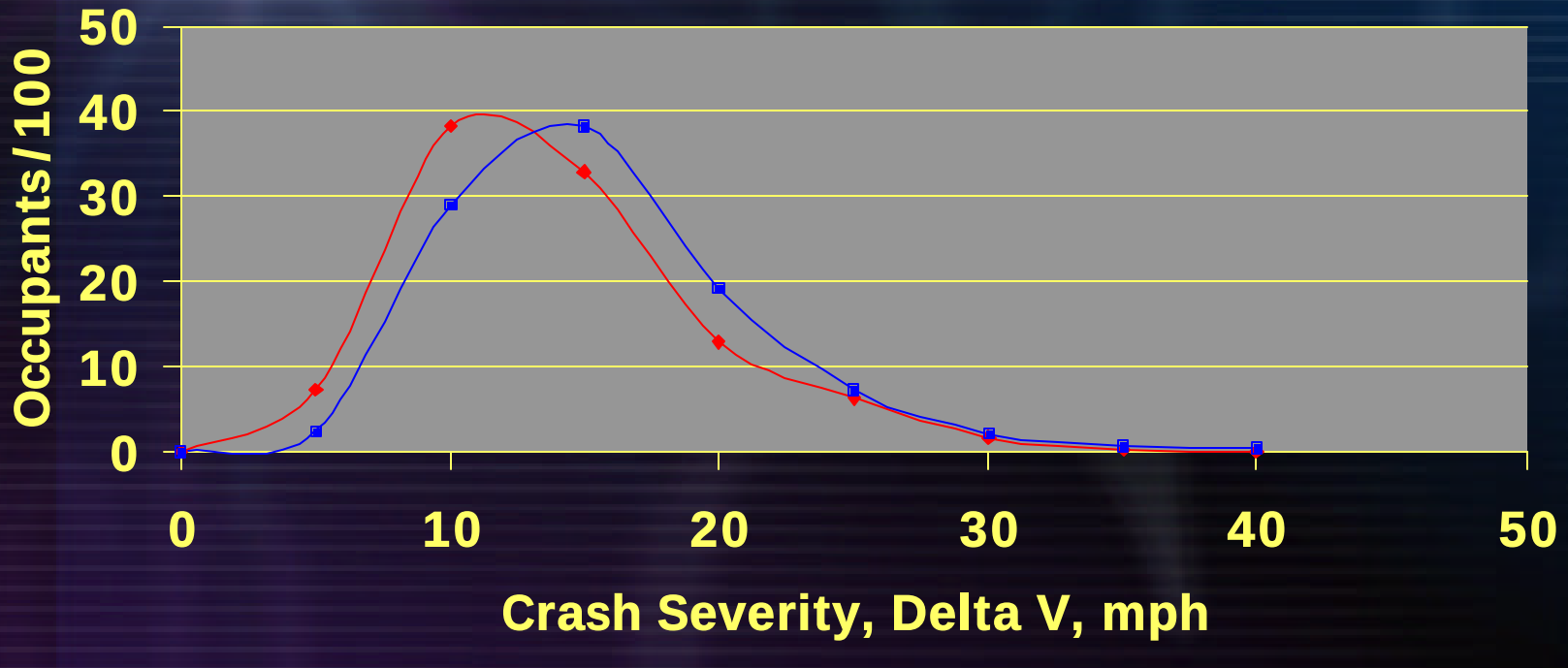
Crash Severity Distribution
Occupants per 100 Crash Involved



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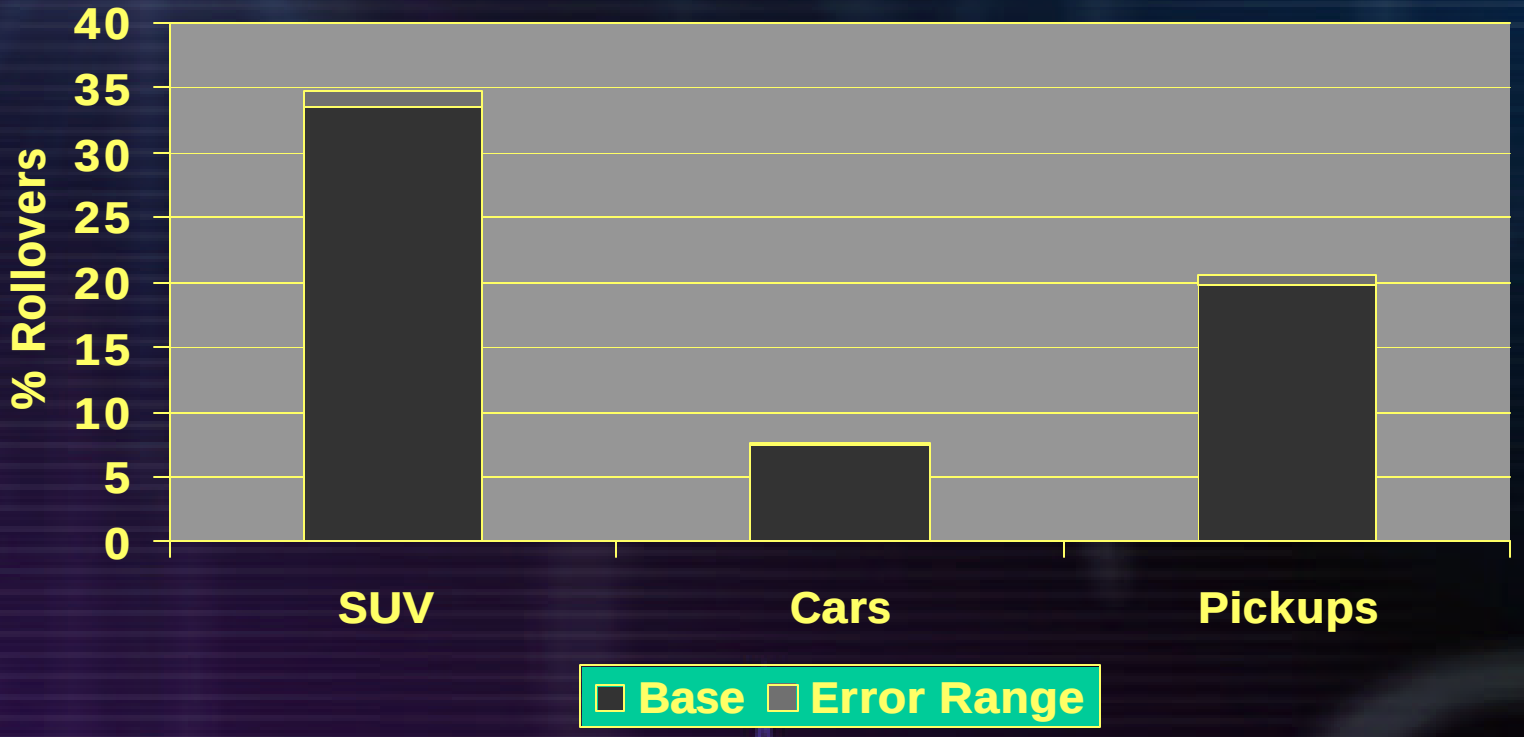
Percent of Crashes with Rollover



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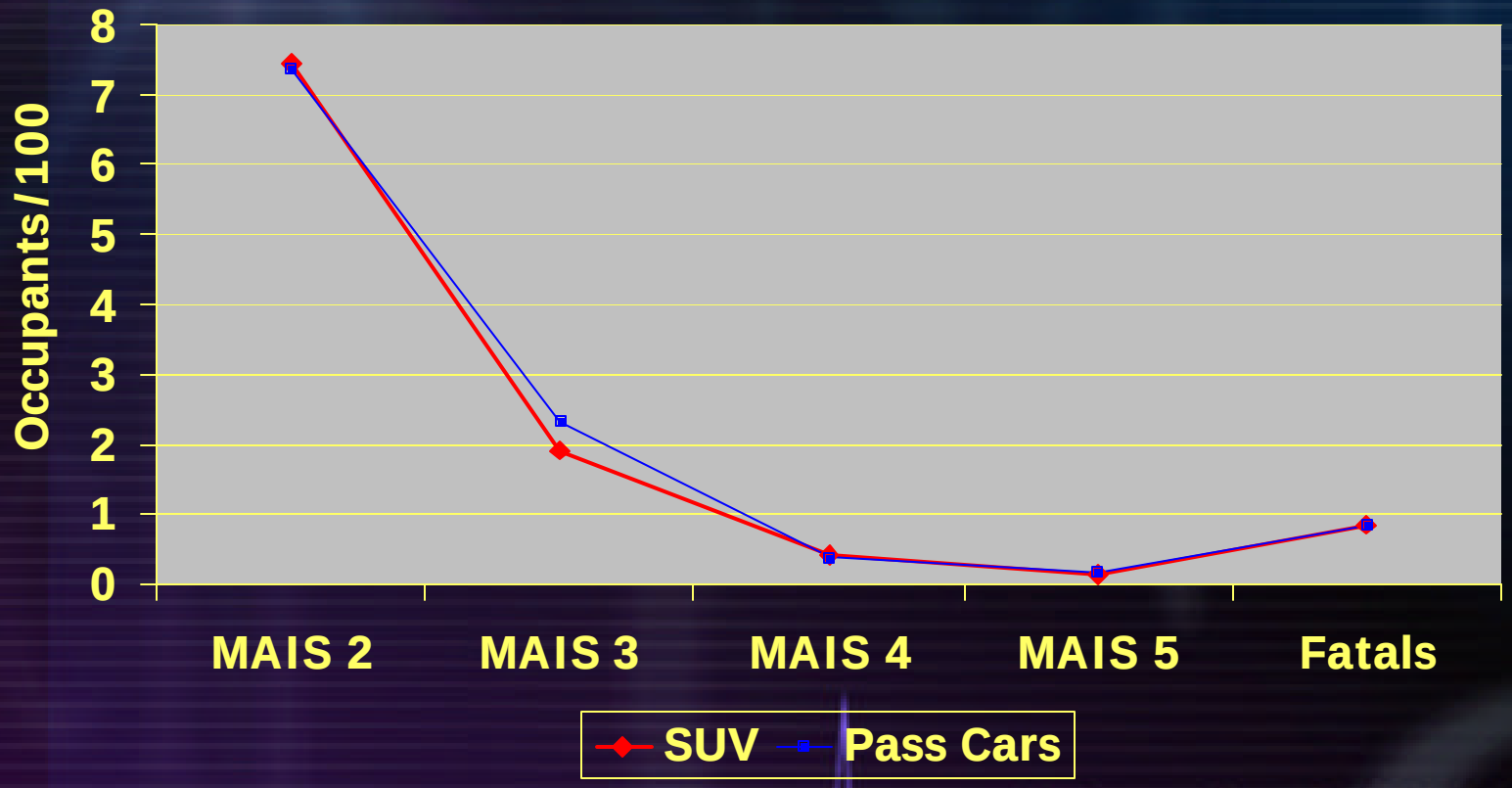
Injured per 100 Crash Exposed

NASS/CDS 1988-96



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Observations
SUVs v Passenger Cars

- SUV Planar Crashes are Less Severe
- SUVs Have Fewer Older Occupants
- SUVs Have Similar Belt Use Rates
- SUVs Have Higher Rollover Rates
- SUVs Have Similar Fatality Rates
- SUVs Have Lower AIS 3 Injury Rates

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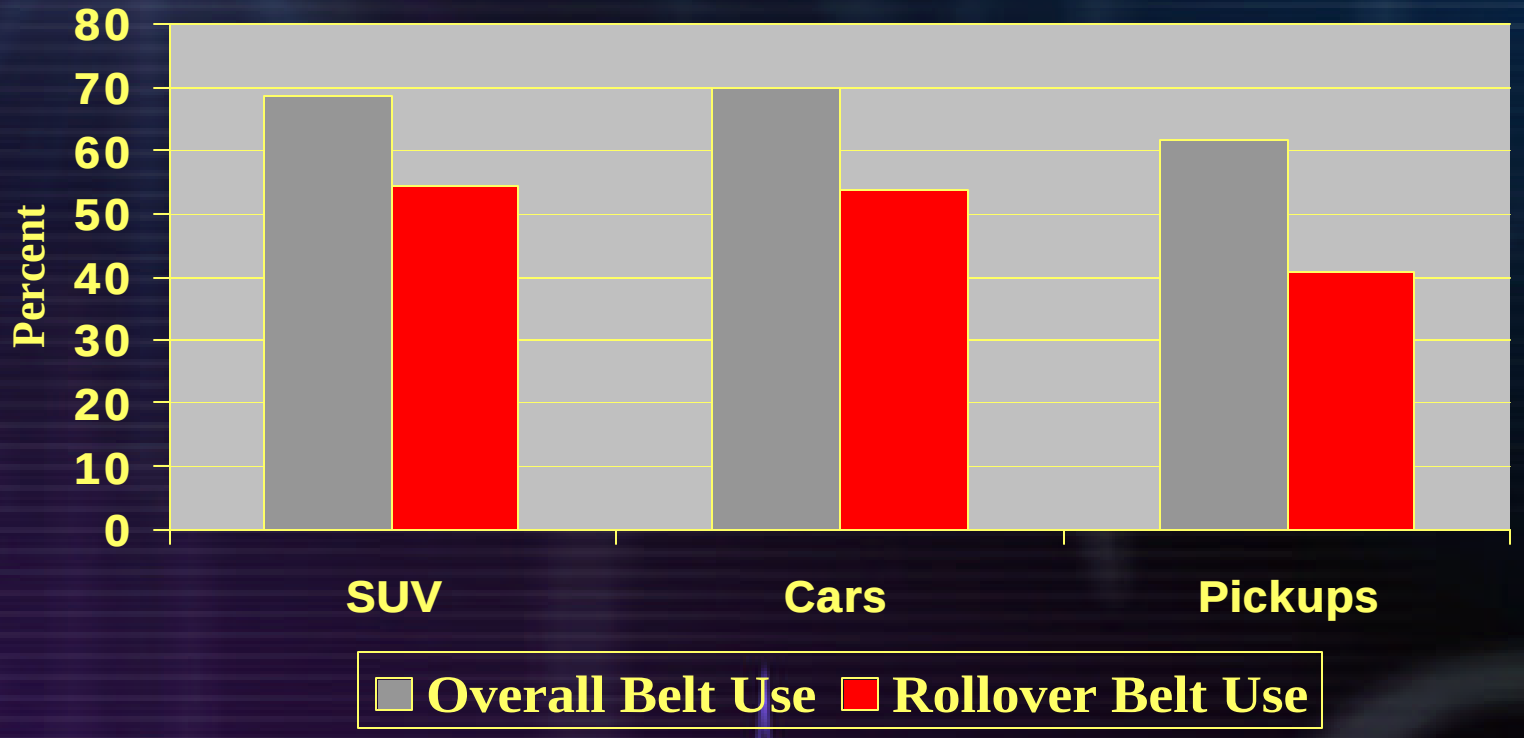
Comparison of SUVs and Other Vehicles

Examine:

- Belt Use in Rollovers
- Differences in Injury Rates for
  - Restrained
  - Unrestrained

Overall and Rollover Belt Use



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Observations

- Belt Use in Rollovers is Lower Than in Planar Crashes
- Rollovers are More Frequent in SUVs

Examine Serious Injury and Fatality Rates in Planar Crashes & Rollovers

- Belted
- Unbelted

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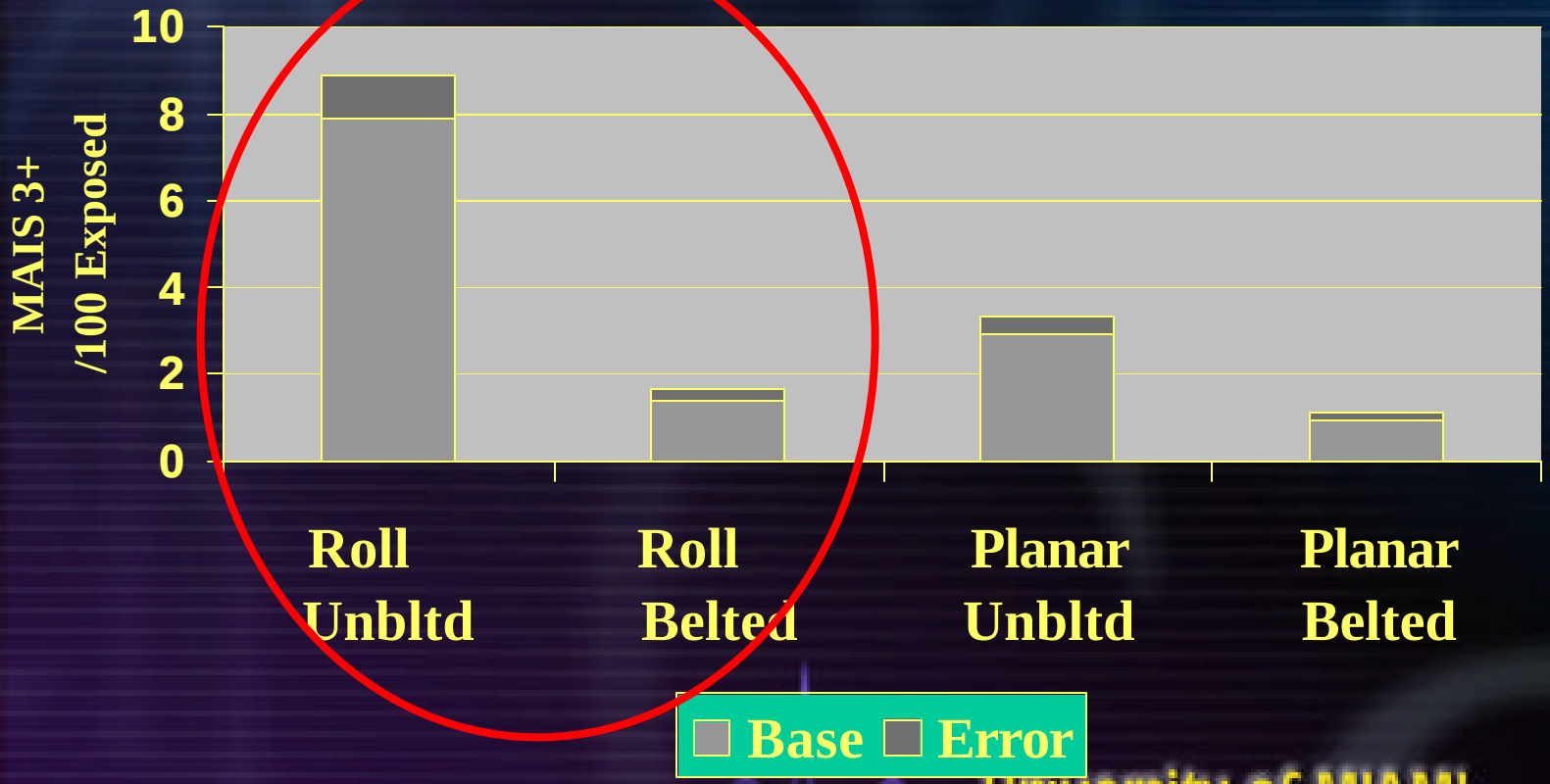
Definition of Injury Rate, Ri

$$Ri = 100 * Ni/N$$

Ni = Number of MAIS 3+ injuries and/or fatalities

N = Number of crash involved occupants for crash mode, irrespective of outcome

SUV Occupants in Crashes; MAIS 3+/100 - Belted v Unbelted



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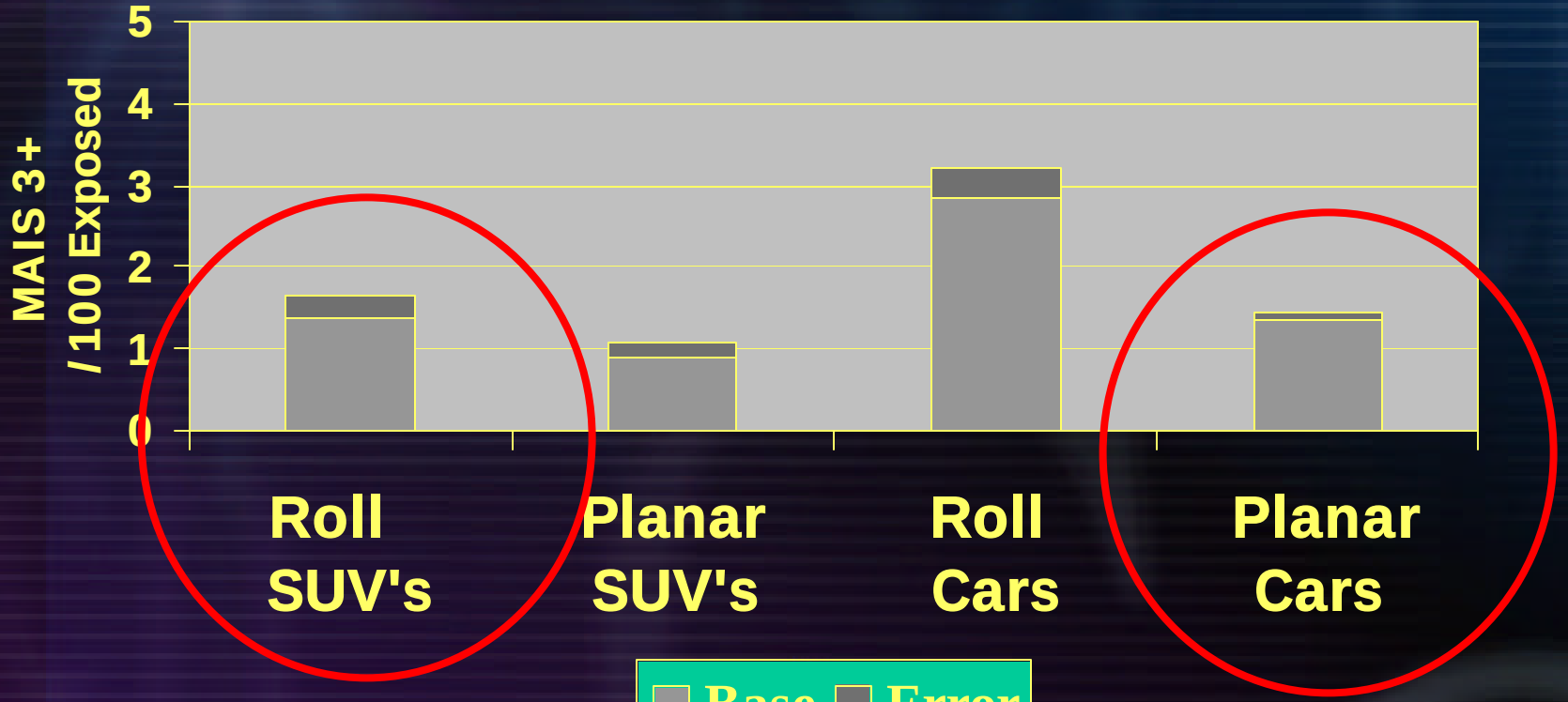
Belted Occupants in Crashes; MAIS 3+/100 - SUVs v Cars; Roll vs. Planar



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Belted Occupants; MAIS 3+ and Fatal All Crash Modes, SUVs v Cars

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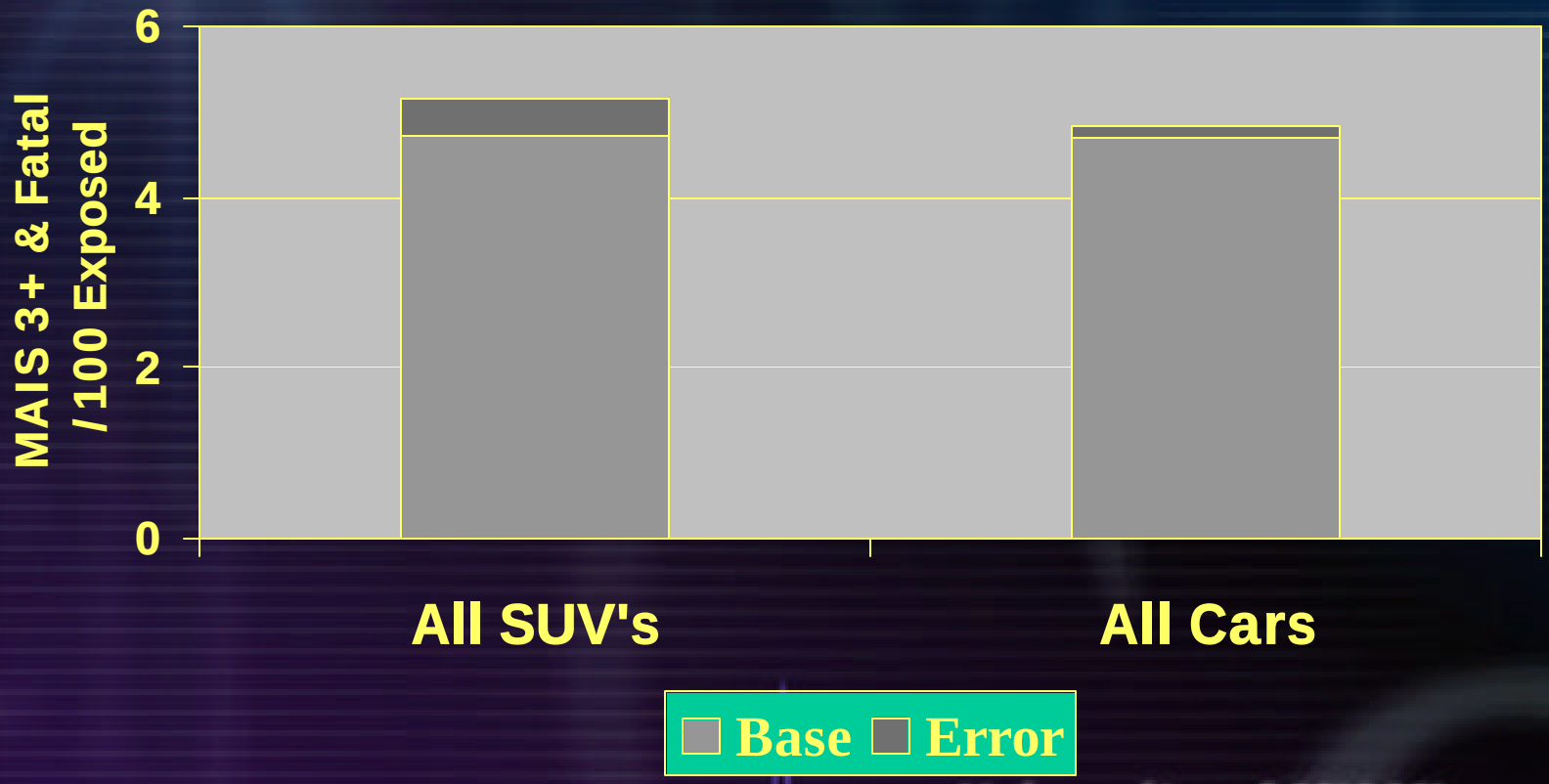
Unbelted Occupants
MAIS 3+ and Fatal
All Crash Modes, SUVs v Cars



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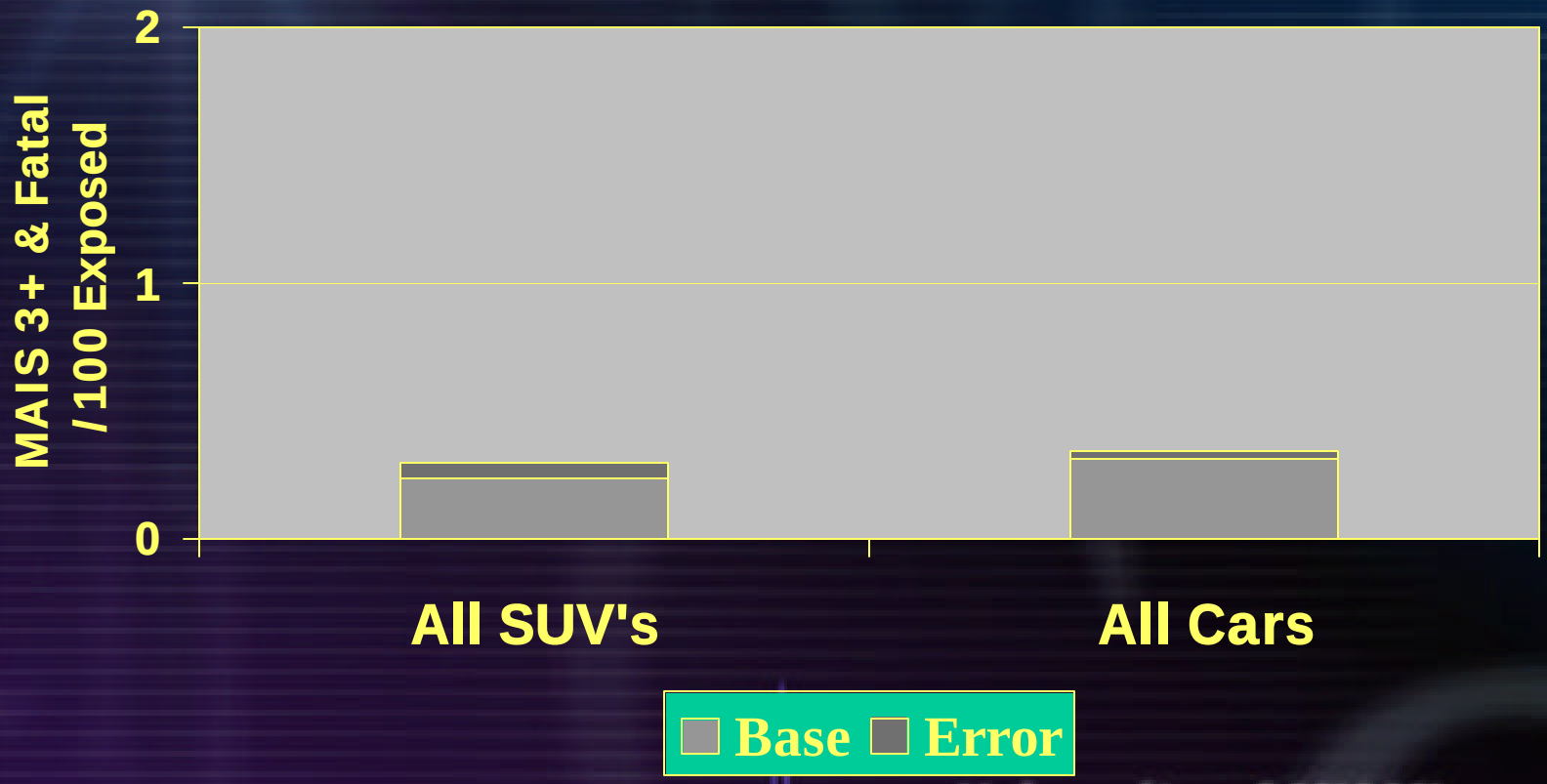
Belted Occupants; Only Fatal

All Crash Modes, SUVs v Cars



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Illustrative Cases from WLIRC Files

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Case

Belted Rollover Survivor
Frontal Crash + Rollover
AIS 1 Injury

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Scene

Case Vehicle:

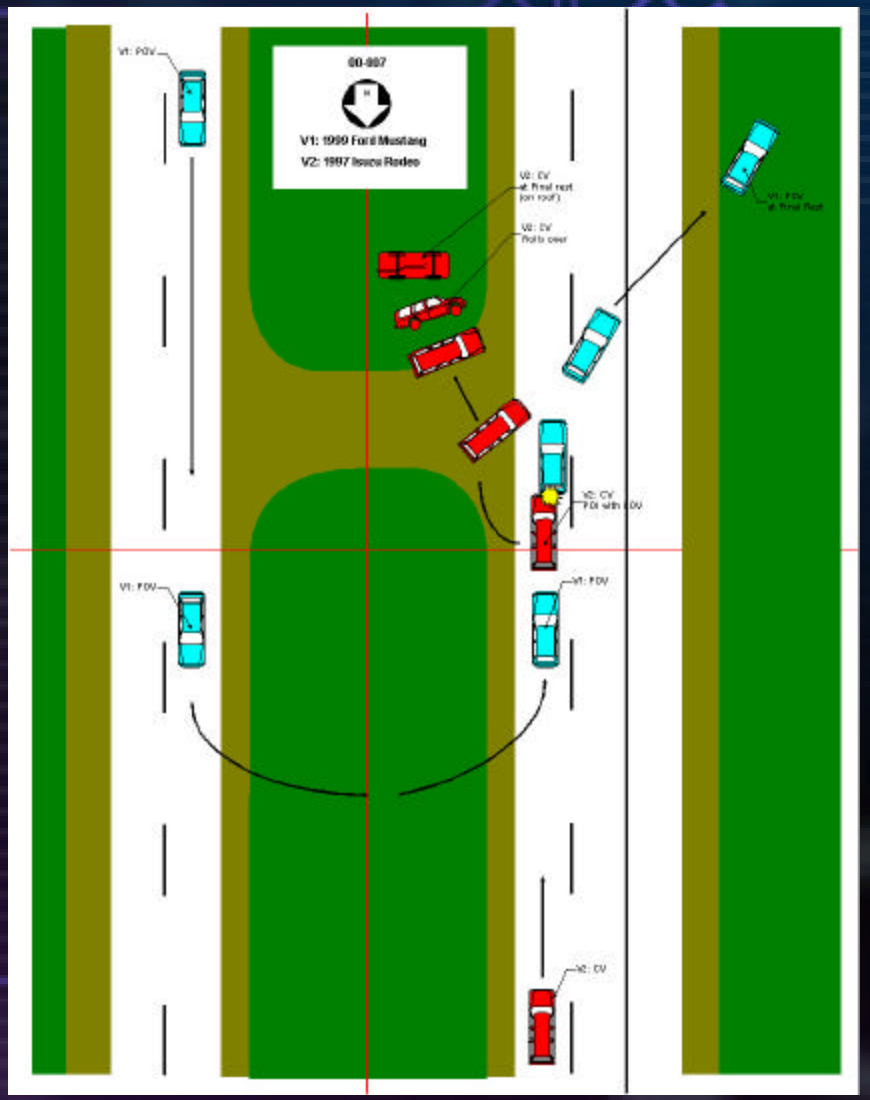
’97 Isuzu Rodeo

POV:

’99 Ford Mustang

PDOF: 12 o’clock

DV: 12 mph



’97 Isuzu Rodeo

Driver, 43 y/o male,

69”, 380 lbs

L & S belt

Airbag did not deploy

12 o’clock

Injuries:

AIS 1 Rib fx

’97 Isuzu Rodeo

Max Crush Frontal:

7.7”

DeltaV:

12 mph

2 Quarter-turn Rollover

Rollover Survivor - Belted

Injuries:

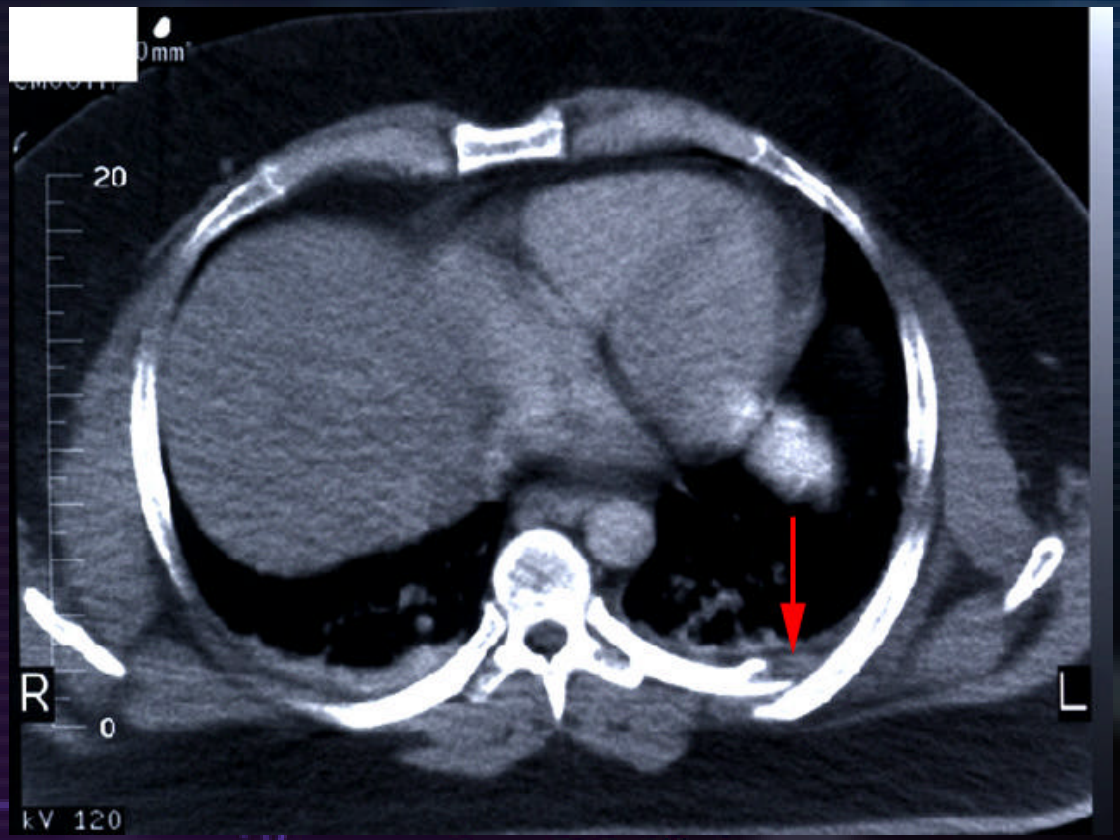
AIS 1 Rib fx

Contact:

Side Interior Surface

Trauma Criteria:

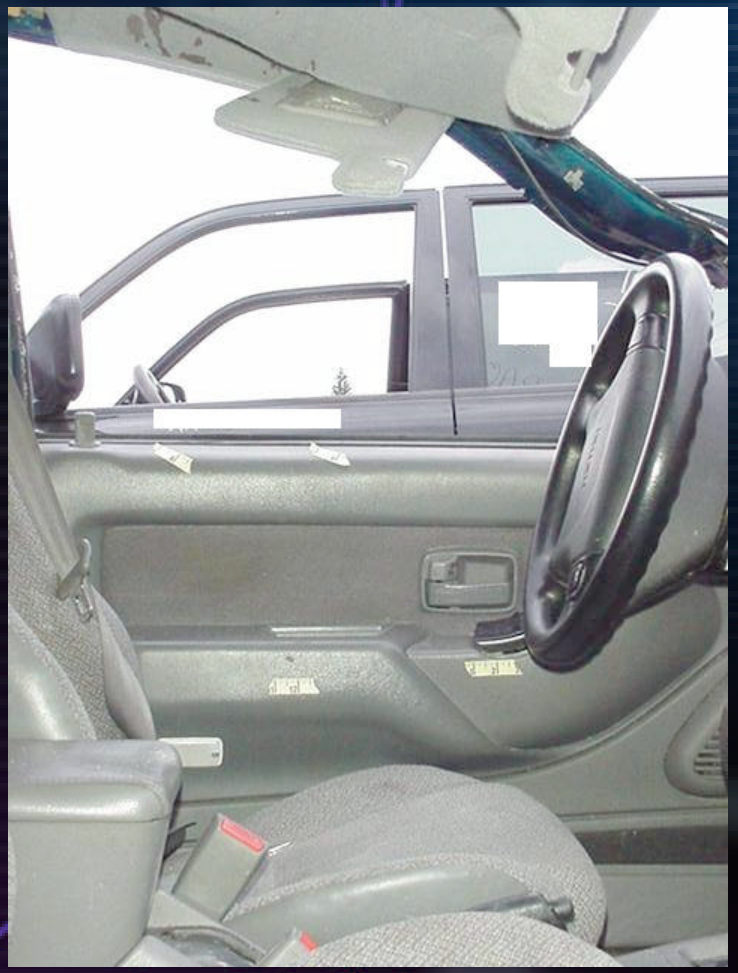
High Suspicion



Occupant Contacts

Source of Rib Fracture:

Side Door Panel



Case Highlights

- Very Large Occupant (380 lbs.)
- Belted
- No Head/Neck Injury
- A-pillar/Roof Intrusion
- Multiple Impacts - (Frontal Crash Followed by 2 Quarter-turn Rollover)

Belt is particularly helpful in multiple crashes and rollovers

Case
Unbelted Rollover Survivor
Frontal Crash + Rollover
Multiple AIS 3 Injuries

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Scene

Case Vehicle:

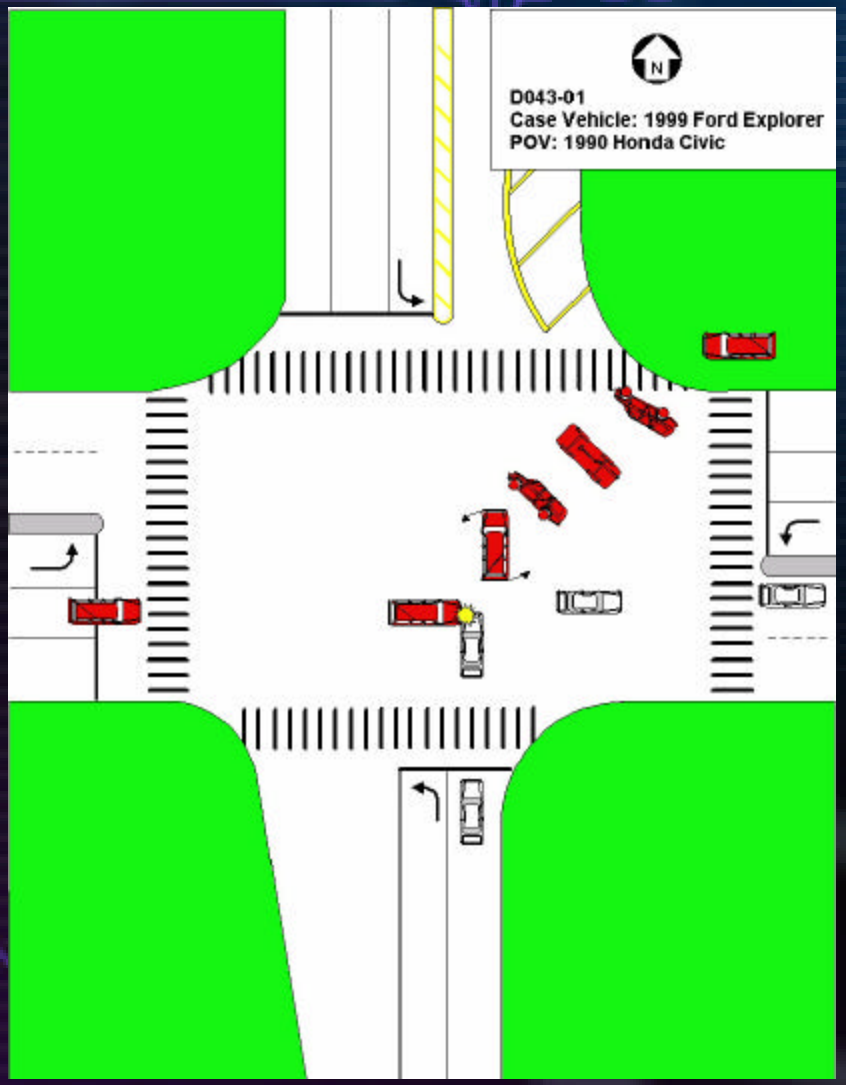
’99 Ford Explorer

POV:

’90 Honda Civic

PDOF: 1 o’clock

DV: 16 mph



Rollover Survivor - Unbelted

Driver, 60 y/o male,
69”, 168 lbs
Unrestrained
Airbag deployed
1 o’clock
Max crush: 13”
Injuries:
AIS 3 Brain (multiple)

’99 Ford Explorer

- Vehicle Damage
- 4 Quarter-turn Rollover

’99 Ford Explorer

- Final Occupant Position:
- Rear Seat
- Body Fluid on Right Rear Door

Rollover Survivor - Unbelted

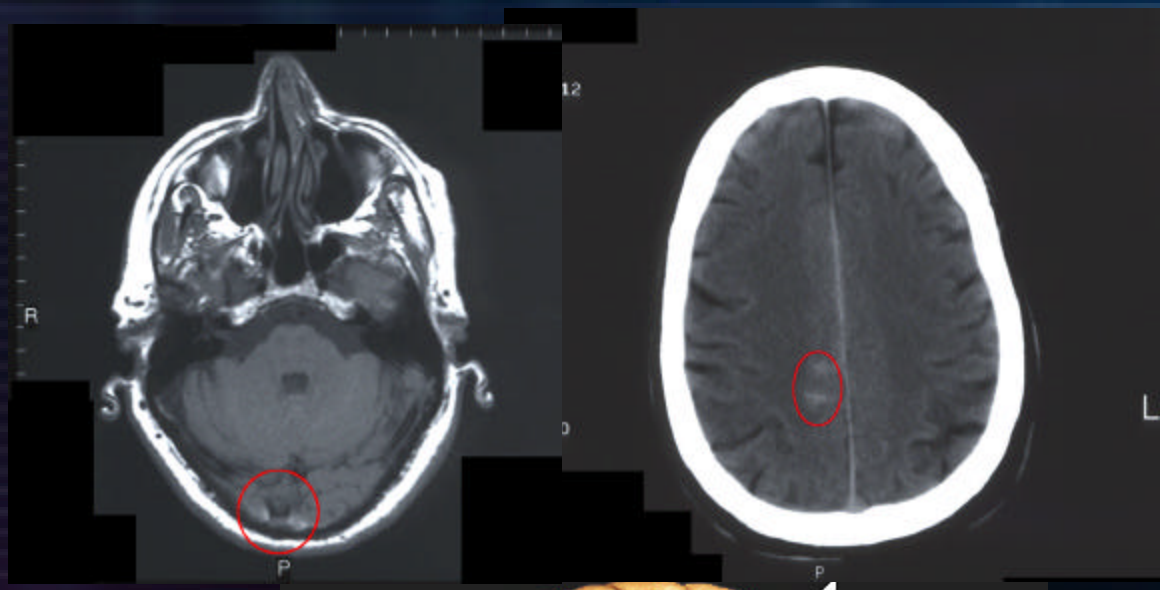
Injuries:

AIS 3 Brain Injuries:

Cont. Post. Occipital Lobe

Cont. Ant. Rt. Parietal Lobe

Subarachnoid Hemorrhage



’99 Ford Explorer

Probable Head Contact:

Roof Console

Rollover Survivor - Unbelted

Injuries:

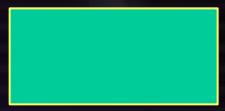
AIS 1 Injuries:

Fx. Nasal spine

Abrasions, Face

Trauma Criteria:

High Suspicion



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’99 Ford Explorer

Probable Facial Contact: Airbag (2 o’clock)

Case Highlights

- Older Occupant - Unbelted
- MAIS 3 Brain Injury
- Minor Roof Damage
- Multiple Impacts - (Frontal Crash Followed by 4 Quarter-turn Rollover)
- Complex Vehicle Post Crash Motion
- Complex Occupant Kinematics

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Case
21 mph Fatality
Side Impact + Rollover

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Scene

Case Vehicle:

’97 Ford Explorer

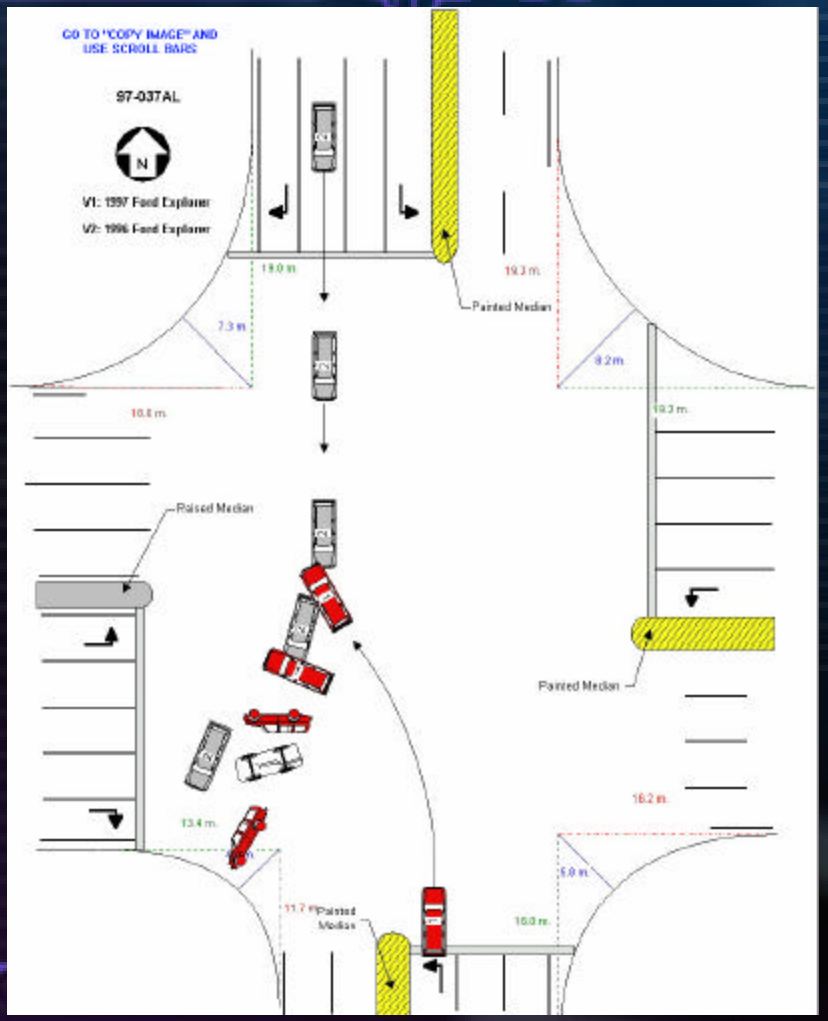
POV:

’96 Ford Explorer

PDOF: 2 o’clock

DV: 21 mph

3 Quarter-turn Rollover



’97 Ford Explorer

RF Passenger, 34 y/o female,
67”, 225 lbs
L & S belt
Airbag deployed
2 o’clock
Max crush: 24”
Injuries:
  Multiple AIS 4

’97 Ford Explorer

Max Crush :

24”

DeltaV:

21 mph

’96 Ford Explorer

Principle Other Vehicle

Max Crush :

24.5”

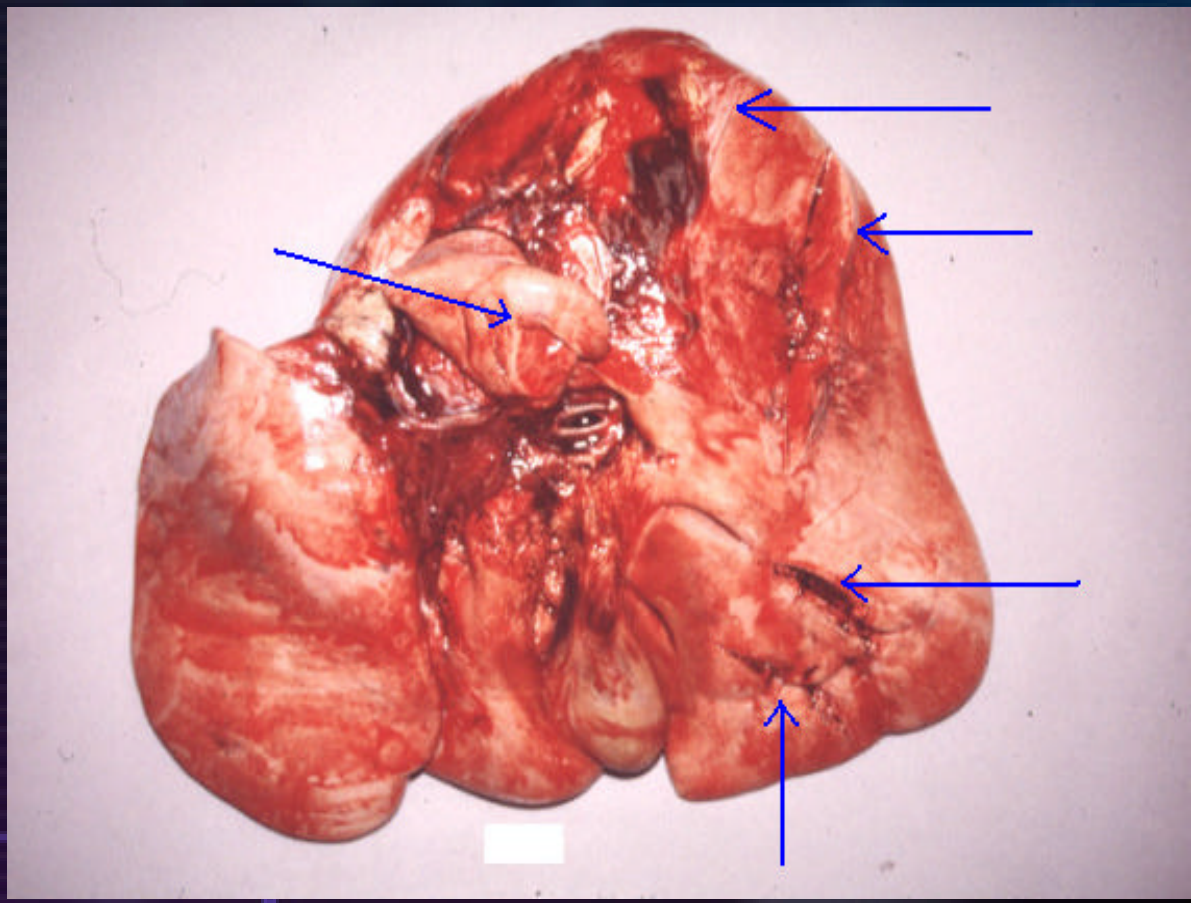
DeltaV:

21 mph

21 mph Fatality

Injuries:

- AIS 4 Liver lac
- AIS 4 Rib fx



Interior View

Injuries:

AIS 4 Liver lac

AIS 4 Rib fx

Trauma Criteria:

SBP < 90

Interior View

Injuries:

AIS 2 Head Lac

Passenger Final Rest

Case Highlights

- Female Occupant - Belted
- Fatal Chest/Abdominal Injuries
- No Brain Injuries
- Multiple Impacts - (Side Crash Followed by 3 Quarter-turn Rollover)
- Side Crash Most Harmful
- Complex Vehicle Post Crash Motion

Case
Unrestrained Survivor
Multi-impact Frontal Crash

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Scene

Case Vehicle:

’97 Suzuki Sidekick

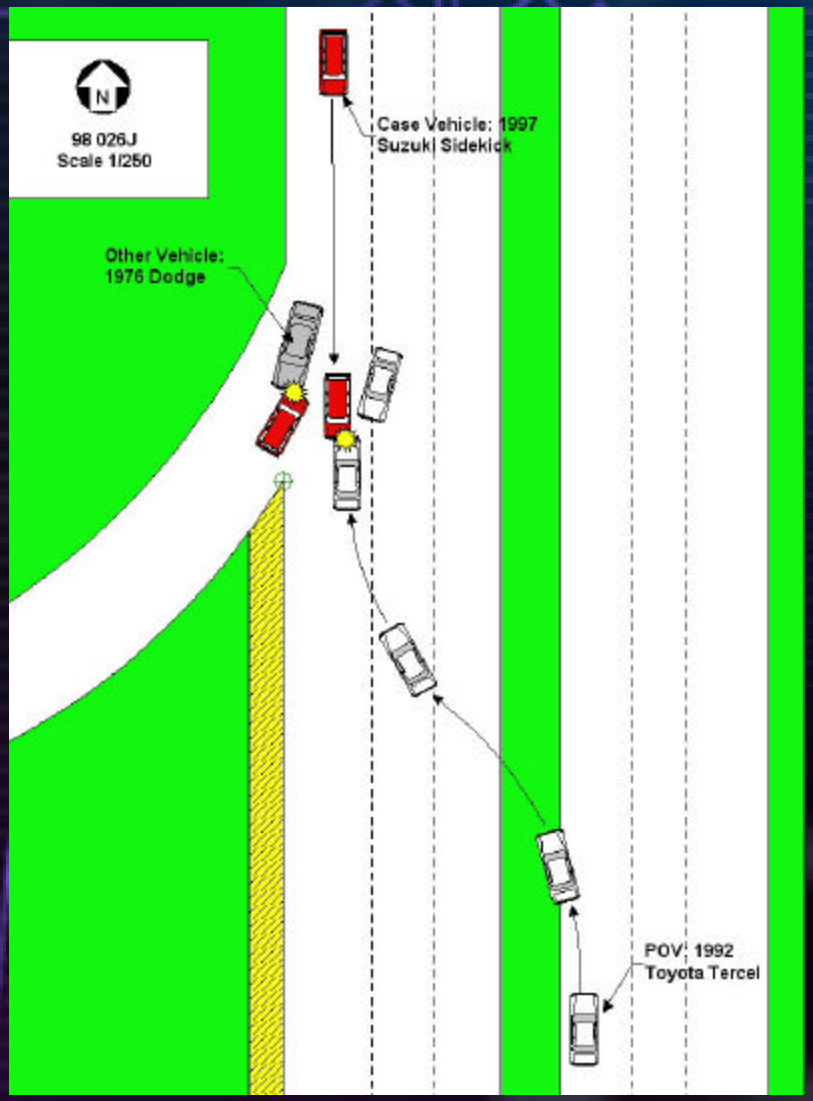
POV:

’92 Toyota Tercel

’76 Dodge

PDOF: 12 o’clock

DV: 20 mph



’97 Suzuki Sidekick

Driver, 21 y/o female,
65”, 190 lbs
Unrestrained
Airbag deployed
12 o’clock
Max crush: 28.5”
Injuries:
AIS 3 Femur fx

’97 Suzuki Sidekick

Max Crush:

28.5”

DeltaV:

20 mph

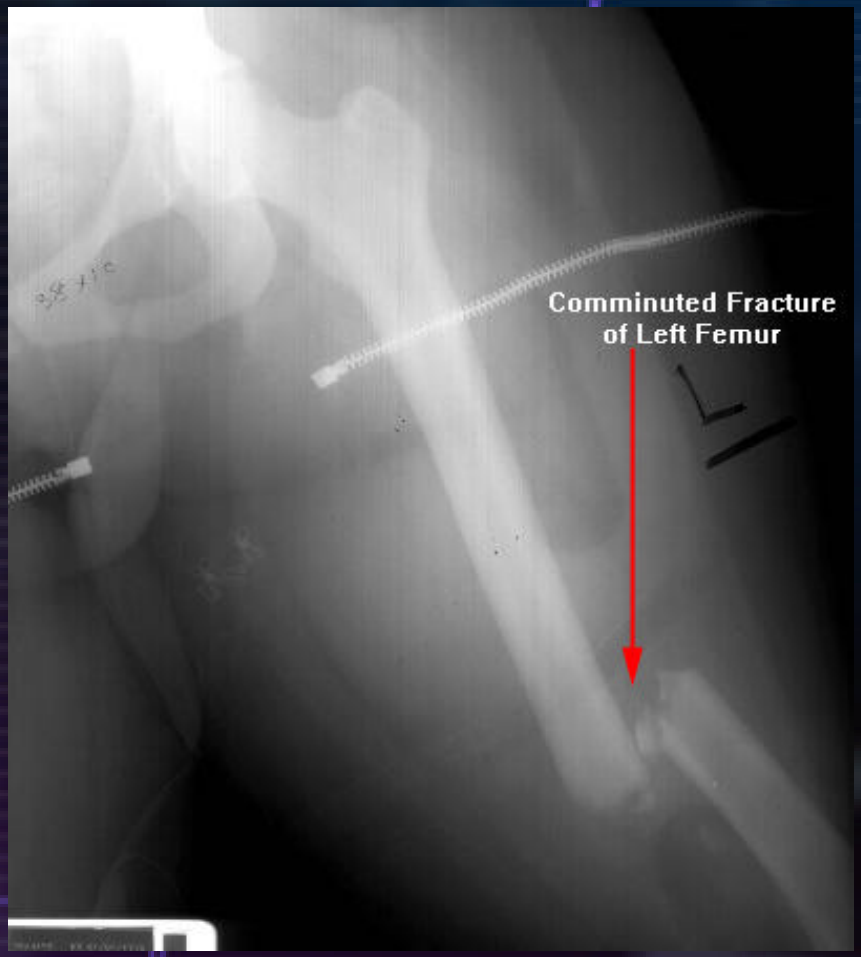
20 mph Survivor

Injuries:

AIS 3 Femur fx

Trauma Criteria:

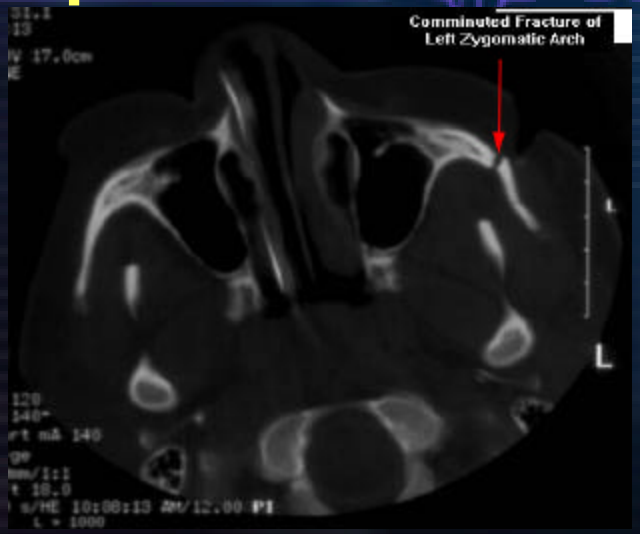
High Suspicion



Interior View

Left Knee Bolster:
AIS 3 Femur fx

20 mph Survivor



Injuries:

AIS 2 Facial fx

AIS 2 Facial lac

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Interior View

Left “A” Pillar:

AIS 2 Facial fx

AIS 2 Facial lac

Case Highlights

- Female Occupant - Unbelted
- Frontal Impact - Air Bag Deployed
- No Chest Injuries
- Multiple Impacts - (Frontal Crash Followed by Lower Severity Frontal Crash)
- Complex Vehicle Post Crash Motion

Case
14 mph Fatality
Side Impact, Rollover, Frontal Impact

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Scene

Case Vehicle:

’97 Ford Explorer

POV 1:

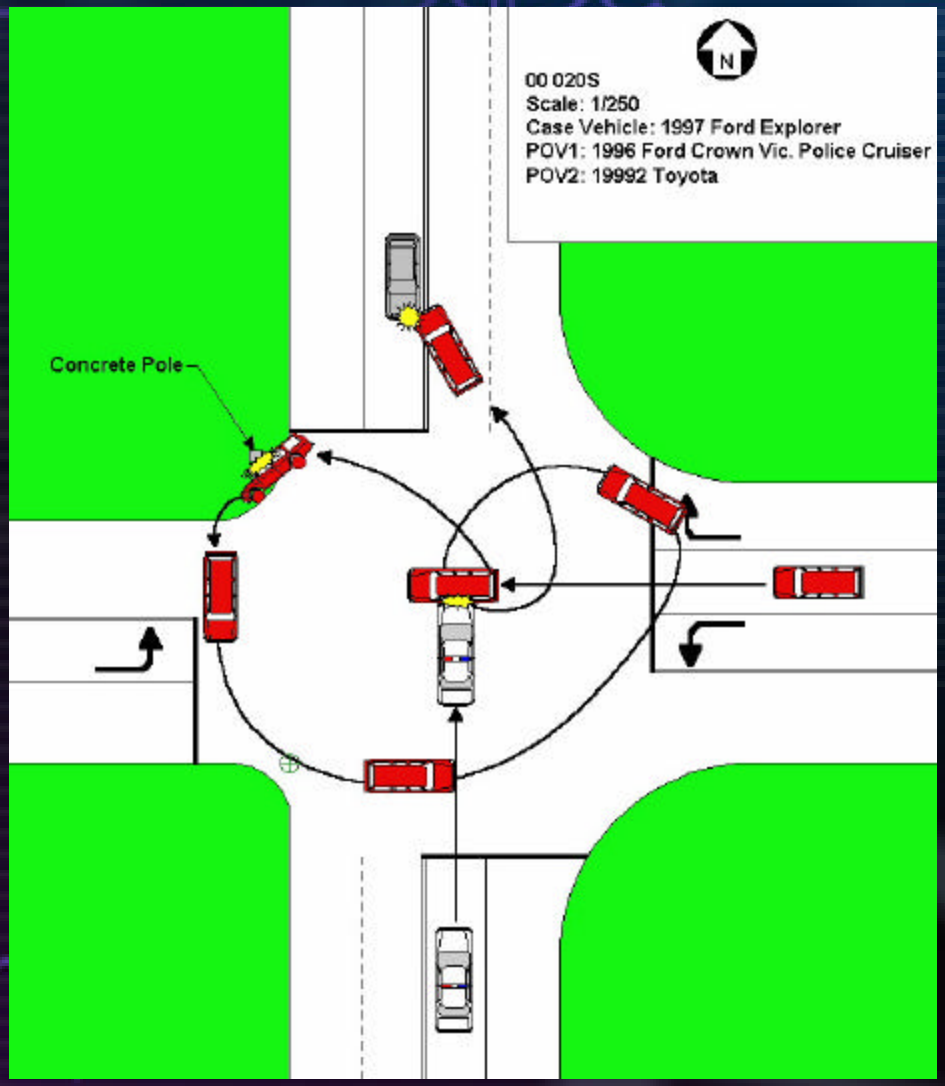
’96 Crown Victoria

PDOF: 10 o’clock

DV: 14 mph (side)

POV 2:

’92 Toyota



’97 Ford Explorer

Driver, 29 y/o male,

71”, 203 lbs

Unrestrained

Airbag did not deploy

10 o’clock

14 mph Fatality

Max Crush:

Side: 14”

Top: 27”

DV:

14 mph (side)

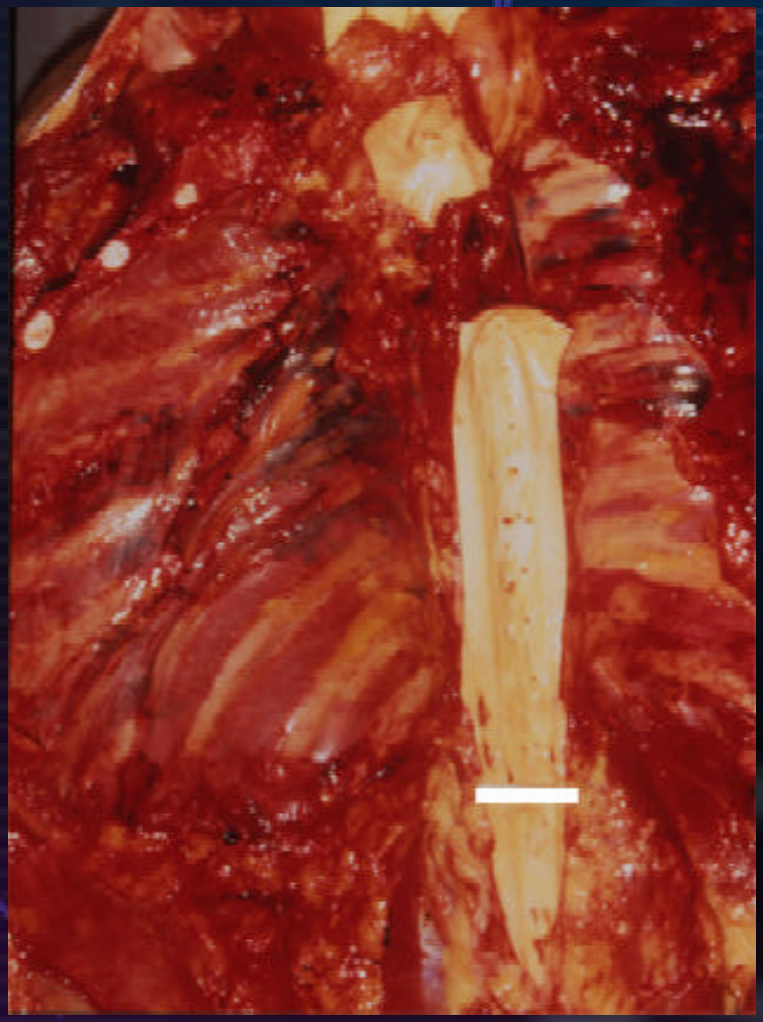
POV 1

POV #1:
’96 Ford
Police Cruiser
Max Crush:
6.5”
DV:
11.8 mph

Aortic Injury

Injuries:

- AIS 5 aorta
- AIS 5 heart
- AIS 5 rib fx



Interior View

Left Side Structure:

- AIS 5 aorta
- AIS 5 heart
- AIS 5 rib fx

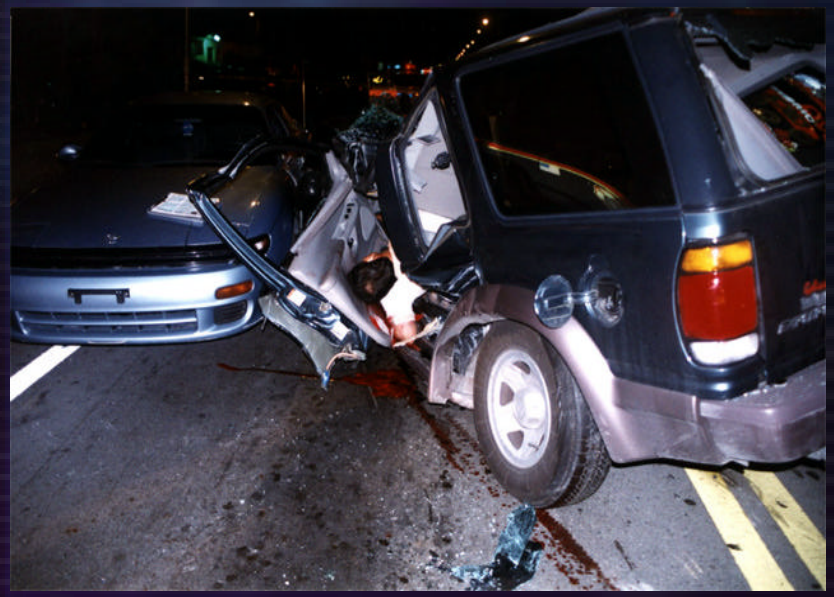
Roof Structure:

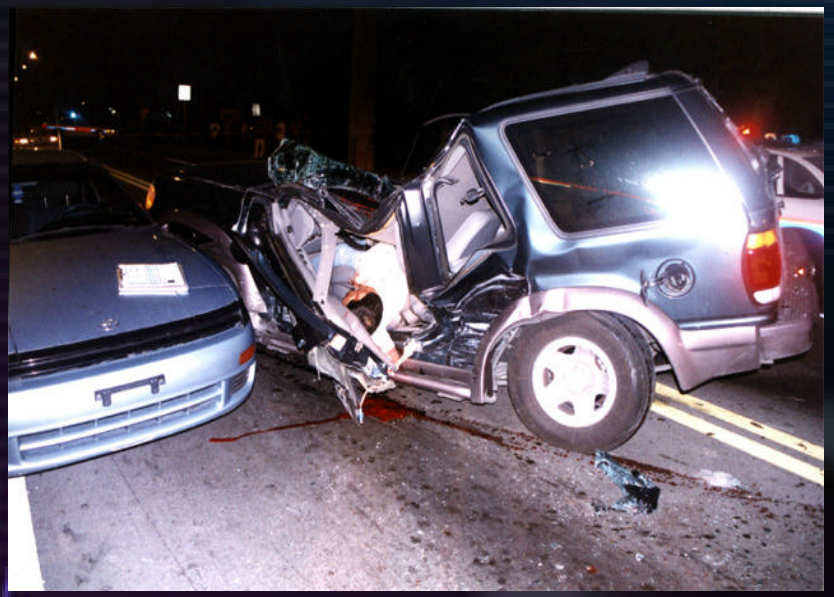
- AIS 4 Skull fx

14 mph Fatality

Struck Pole

14 mph Fatality





Case Highlights

- Male Driver - Unbelted
- Fatal Chest/Abdominal Injuries
- Brain Injuries
- Multiple Impacts - (Side Crash Followed by 1 Quarter-turn Rollover Followed by Frontal Crash)
- Side Crash Most Harmful
- Complex Vehicle Post Crash Motion

Conclusions

- For Belted Occupants:
  - The Overall Injury Risks of SUVs in Rollovers are no Higher Than for Cars in Planar Crashes
  - SUVs Have Lower Overall Injury and Fatality Risk
- For Unbelted Occupants:
  - SUVs Do Not Have a Lower Overall Injury & Fatality Risk - Due to Rollovers

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Injury Patterns in Rollovers
Belted Occupants; NASS/CDS

All Vehicle Classes

Injuring Contact	Body Region	% Harm
Roof/Upper Interior	Head/Neck/Spine	27.6
Exterior	All	9.9
Lower Side Interior	Chest/Abdomen	7.6
Loose Objects	All	5.4
Interior	Upper Extremity	5.0
Seatbelts	Chest/Abdomen	3.2
Noncontact	Head/Neck	2.2
A & B-Pillars	Head	2.1
All Other		37.0

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From SAE 98-2296

Overall Injury Patterns SUVs

- Post Crash Motion More Complex
- Multiple Impact/Crash Modes More Common
- More Frequent Rollovers
- Expect More Complex Injuries - Particularly from Unrestrained Population

Safety Challenges - SUVs

- Increased Belt Use - Particularly in Rollovers
- Advanced Safety Features for Rollovers
- Advanced Safety Features for Multiple Impacts

Case
Air Bag Neck Injury
Belted Infant
13 mph Frontal Crash

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Scene

Case Vehicle:

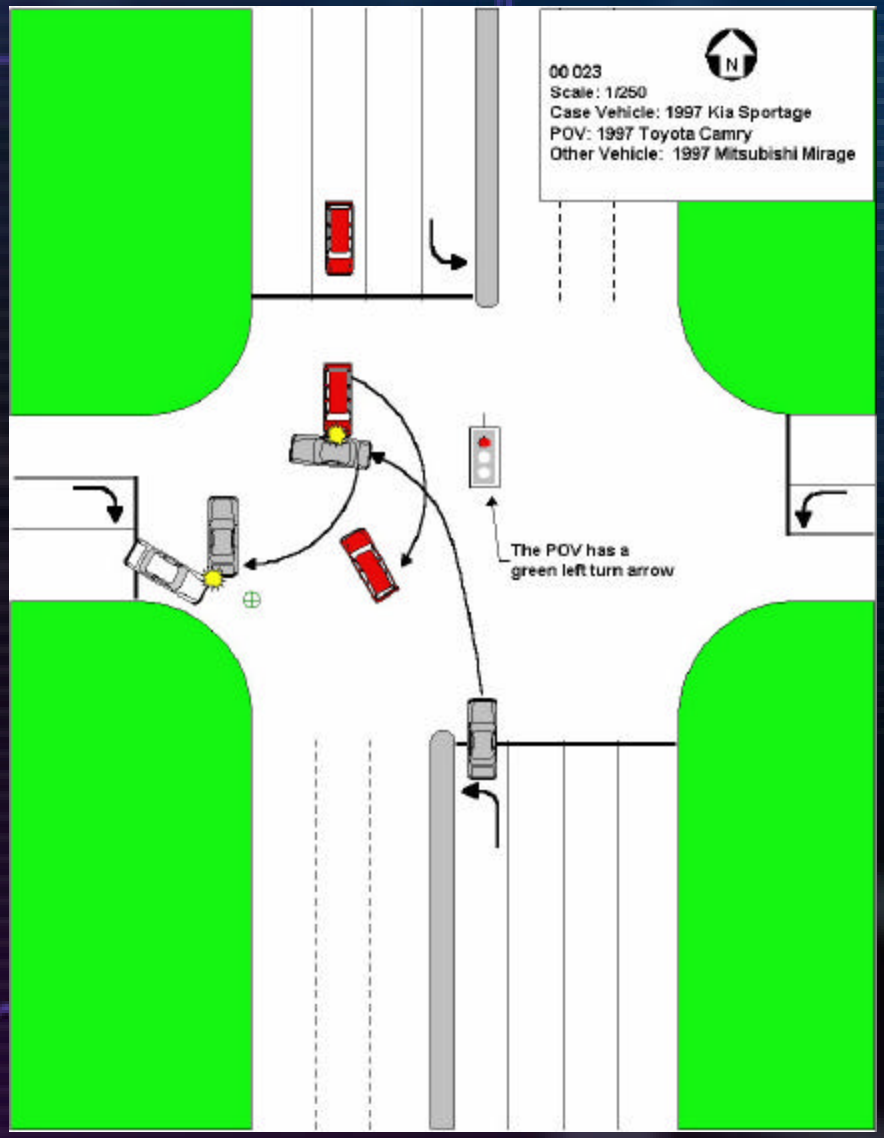
’97 Kia Sportage

POV:

’97 Toyota Camry

PDOF: 11 o’clock

DV: 13 mph



’97 Kia Sportage

RF Passenger, 3 y/o female,
46.5”, 44 lbs
L & S belt
Airbag deployed
11 o’clock
Max crush: 12”
Injuries:
AIS 3 Neck fx

13 mph Survivor

Max Crush:

12”

DeltaV:

13 mph

Neck Distraction

Injuries:

AIS 3 Neck fx

Trauma Criteria:

LOC and

Age<15

Interior View

Passenger Air Bag

AIS 3 Neck fx

AIS 1 Abrasions

Case Highlights

- 3 Year Old Child Occupant - Belted
- Low Severity Crash with Braking
- Neck Injury
- 1997 Air Bag