

# AORTIC INJURIES IN NEAR-SIDE VEHICLE TO VEHICLE COLLISIONS

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# OBJECTIVES

- Identify:
  - Injury Patterns in Near Side Crashes
  - Potential Predictive Crash Configurations

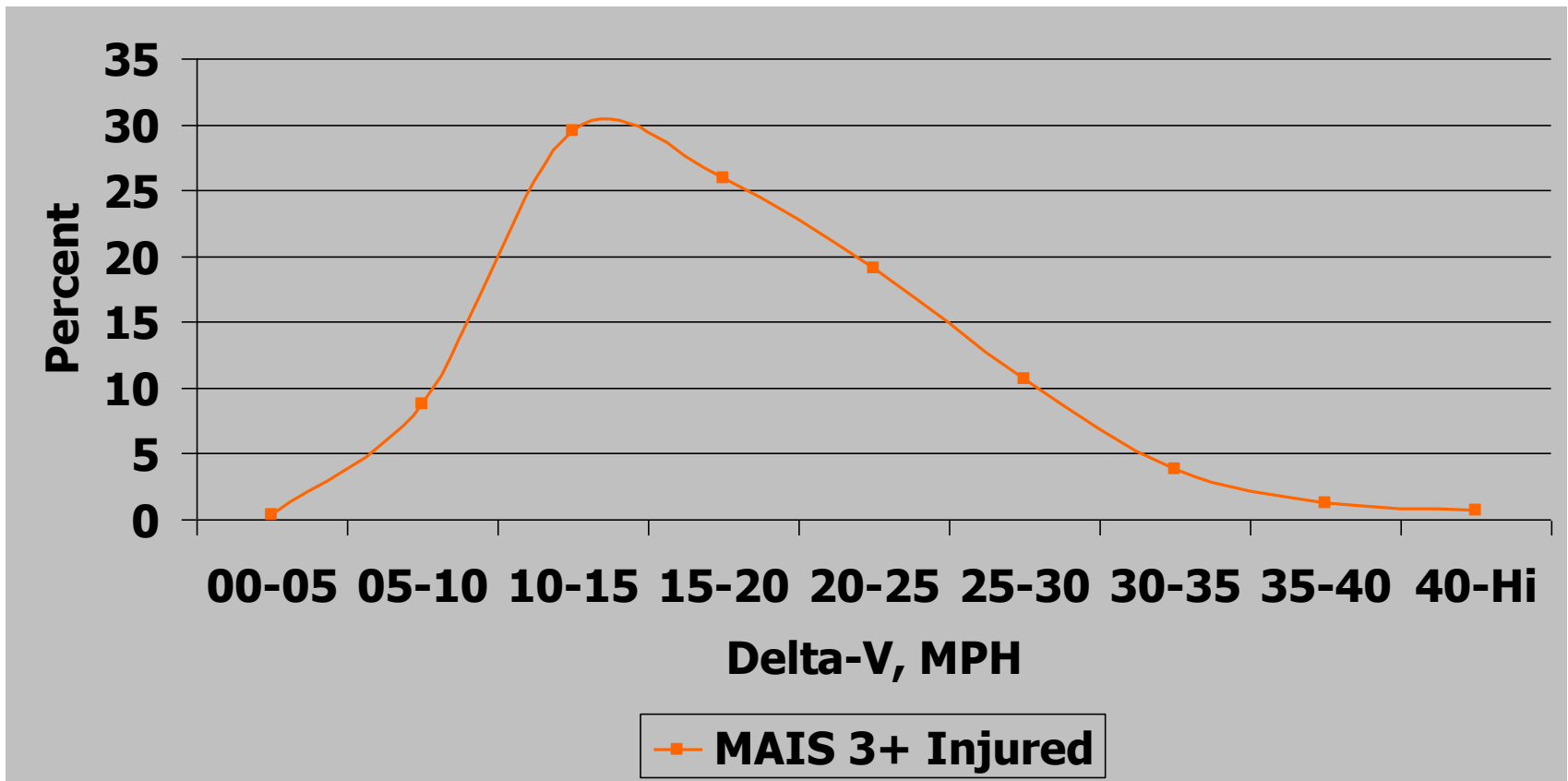
# DATA SOURCES

- The National Automotive Sampling System/Crashworthiness Database (NASS/CDS), 1988 to 1996
- The William Lehman Injury Research Center Database (WLIRC), 1995 to 1998

# Overview of Side Crashes -NASS/CDS 1988-97

- 925,000 Tow-away Side Crashes Annually
- 36,000 MAIS 3+ Injured or Killed
- 11,230 Fatally Injured

# Severe Injuries in Vehicle-to-Vehicle Side Crashes

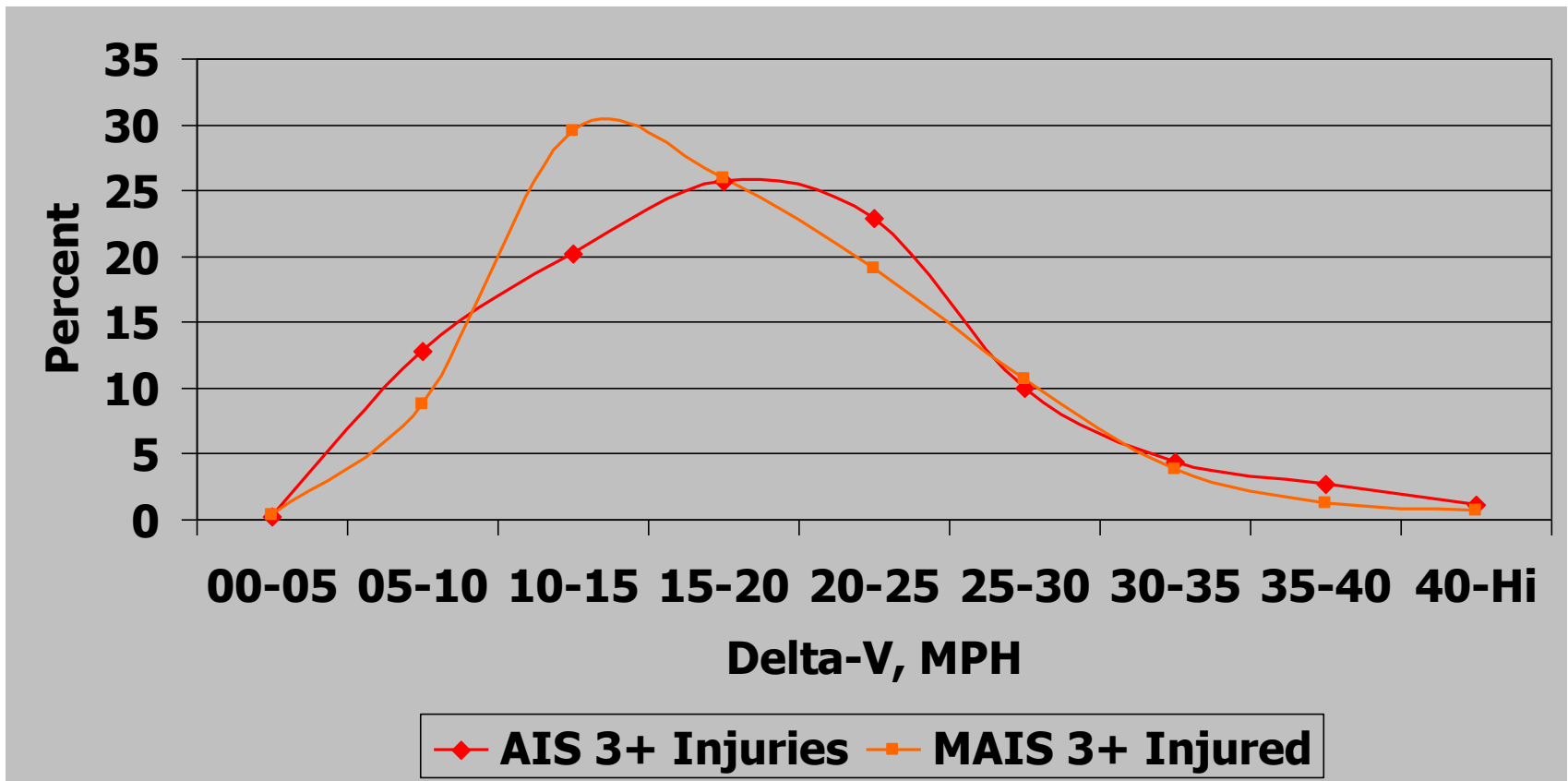


NASS/CDS 1988-96

# Overview of Side Crashes -NASS/CDS 1988-97

- On Average, 2 AIS 3+ Injuries per MAIS 3+ Injured Occupant

# Severe Injuries in Vehicle-to-Vehicle Side Crashes



NASS/CDS 1988-96

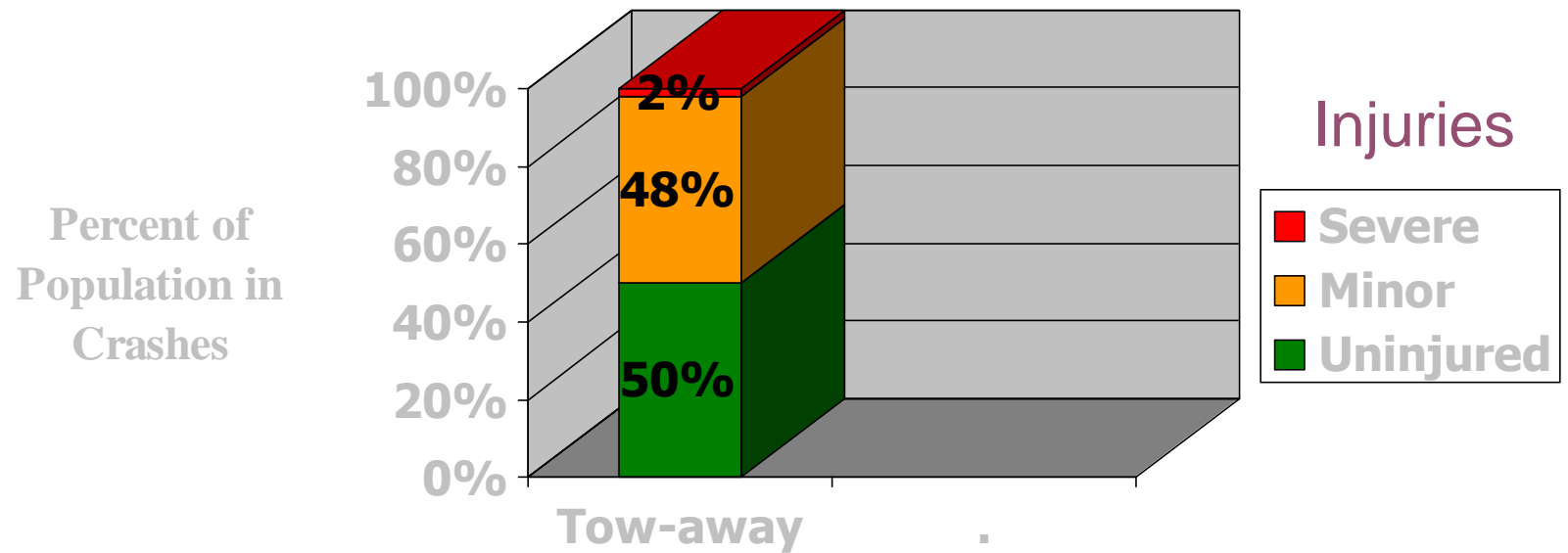
# TRAUMA CRITERIA FOR WLIRC CASES

- Systolic BP < 90 (Shock)
- Respiratory Rate < 10 Per Minute or > 29 Per Minute
- Glasgow Coma Scale < 12
- Penetrating Injury to Head, Neck, Chest, Abdomen or Groin
- Paramedic Judgment --- High Index of Suspicion of Injury



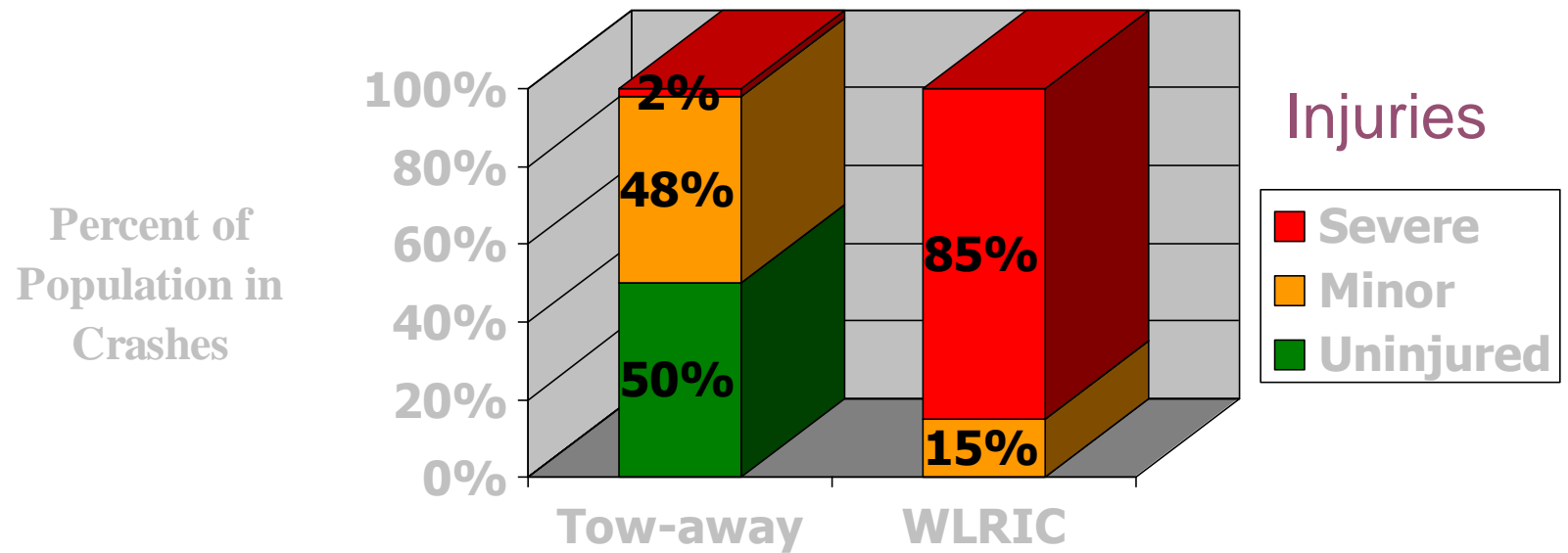
# Comparison of NASS/CDS and WLRIC Databases

# NASS - A Sample of Tow-Aways



# NASS - A Sample of Tow-Aways

## CIREN - A Census of Injury Crashes



# Crash Comparison - NASS vs. WLIRC

<b>CRASH COMPARISON</b>	<b>NASS 85</b>	<b>NASS/CDS</b>	<b>WLIRC</b>
<b>Collision Type</b>			
Vehicle-to-vehicle	72%	75%	78%
Fixed object	28%	25%	22%
<b>Occupant Exposure</b>			
Near Side	67%	66%	70%
Far Side	33%	34%	30%
<b>Impact Location</b>			
Pax Compartment	90%	94%	94%
Other	10%	6%	6%

## Crash Comparison - NASS vs. WLIRC

<b>Crush, in</b>	<b>NASS</b>	<b>WLIRC</b>
0-12	15%	9%
13-24	71%	59%
24+	14%	33%
<b>Striking Vehicle</b>	<b>NASS</b>	<b>WLIRC</b>
Car	49%	52%
LTV	37%	46%
Heavy Truck	13%	2%
Other	1%	0%

# Crash Comparison NASS vs. WLIRC

## Injured Body Region

<b>Body Region</b>	<b>NASS</b>	<b>WLIRC</b>
Head/Face	24%	20%
Chest	44%	48%
Abdomen	5%	20%
Pelvic/LX	14%	7%
Spine/Neck	4%	4%
Other	9%	2%

# Observations - NASS vs. WLRIC

- Similar
  - Vehicle-to-Vehicle vs. Fixed Object
  - Near-side vs. Far-side
  - Occupant Compartment Impact vs. Other
- Differences; WLRIC Has More -
  - Severe Crashes
  - LTV's as Striking Vehicles
  - Chest/Abdominal Injuries

# WLIRC SIDE IMPACT DATABASE

- 51 Vehicle-to-Vehicle Near Side Occupants
- 47 With Occupant Compartment Damage
- 46 of 47 With AIS 3+ Injuries



## LEHMAN CENTER VEHICLE-VEHICLE NEAR-SIDE IMPACT DATABASE

- 46 Cases with AIS 3+ Injuries
- 26 Fatalities
- Survivors Averaged 2.1 AIS 3+ Injuries
- Fatalities Averaged 5.0 AIS 3+ Injuries

# COMPARISON OF CRASHES



Survivor



**Fatality**

# LEHMAN CENTER VEHICLE-VEHICLE NEAR-SIDE IMPACT DATABASE

- Highest Crash Severity Survivor -  
31 mph Lateral Delta V; 33" Crush
- 23 of the 26 Fatalities Were in Less Severe Crashes

VEHICLE-TO-VEHICLE  
NEAR-SIDE CRASHES  
WITH  
OCCUPANT COMPARTMENT  
DAMAGE

## INJURIES - WLIRC SIDE IMPACTS

INJURY	All AIS 3+	Most Serious AIS 4+
Aorta	8.20%	21.20%
Brain	12.90%	21.20%
Heart	3.50%	18.20%
Rib	15.90%	18.20%
Spleen	6.50%	12.10%
Lung	12.90%	3.00%
Liver	5.90%	3.00%
Spine	2.90%	2.90%

# Overview of Injury Patterns

- Brain
  - - Contact with POV - 35.5%
  - - Contacts with Pillars - 25%
  - - Contacts with Side Interior - 25%
- Heart
  - - High Severity Crashes
- Aorta
  - - Complex Crashes; Damage to 2/3 of Vehicle

# Characteristics of Aortic Injuries in Vehicle-to-vehicle Near-side Crashes

# CHARACTERISTICS OF AORTIC INJURIES

- **NASS:**

- 40% of AIS 6 Injuries in Side Impacts

- **WLIRC**

- Present in 46% of Fatally Injured
  - 12 Cases With Aortic Injury; 11 Fatal
  - 3 Cases Not Triaged to Trauma Center



# WLIRC CHARACTERISTICS OF AORTIC INJURIES

- 50% Older Than 60
- 50% Had Far Side Occupant
- Predominately Oblique Impacts
- Average Crush - 22"
- 100% Had Damage to Front 2/3 of Vehicle

# CRASHES WITH SIDE DAMAGE TO FRONT 2/3



In NASS:

- 30% of Crashes
- 38% of AIS 3+ Injuries

# CRASHES WITH SIDE DAMAGE TO FRONT 2/3



In WLIRC:

100% of Crashes with Aortic  
Injury

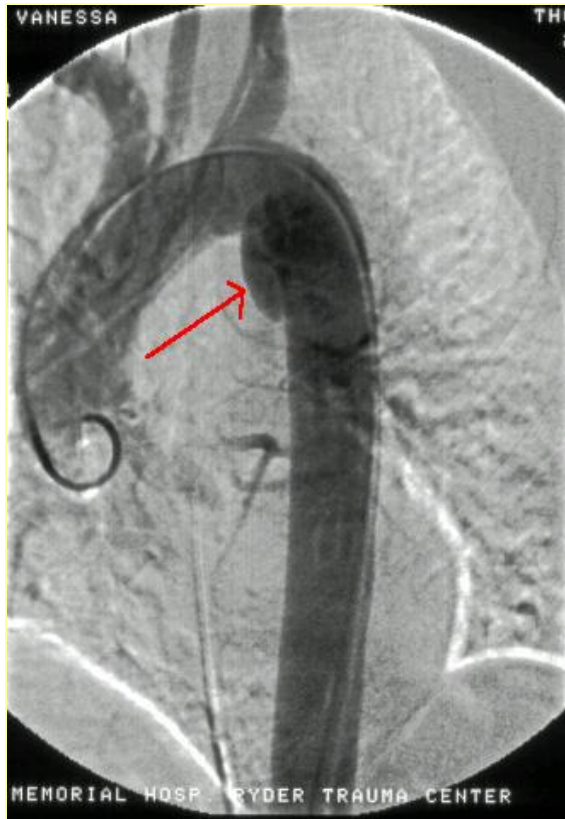
N =12

# CRASHES WITH SIDE DAMAGE TO FRONT 2/3



- N=12
- 8 with Crash Lowest Severity to Follow

# Aortic Case Reviews



# SUMMARY OF 8 AORTIC INJURY CASES



# Case 97-003S

## 19 MPH CRASH - NON FATAL

- Driver 49 Y/O Female
- 67" Tall; 240 Lbs.
- 10 O'clock
- 20" Max Crush
- Injuries:
  - AIS-5 Aorta
  - AIS-4 Rib
- Alert on Scene



**CV - 1987 Buick Park Avenue**  
**POV-1992 Lincoln Continental**

# Case 96-008S

## 14 MPH CRASH - FATALITY

- Driver, 62 Y/O Male
- 68" Tall; 174 Lbs
- 10 O'clock
- 13" Max Crush
- Injuries:
  - AIS-6 Aorta
  - AIS-5 Rib/Lung
  - AIS-4 Lower X
- Alert on Scene



**CV - 1990 Lexus 250**  
**POV- 1983 Cutlass**



# Case 97-029S

## 23 MPH CRASH - FATALITY

- Driver, 77 Y/O Female
- 65" Tall; 193 Lbs
- 10 O'clock
- 15.5" Max Crush
- Injuries:
  - AIS-6 Aorta
  - AIS-5 Rib/Lung
  - AIS-4 Pelvis/Skull
- Alert on Scene



**CV- 1987 Buick Century**  
**POV-1985 Ford Van**

# Case 97-032S

## 18 MPH CRASH - FATALITY

- Front Passenger
- 74 Y/O Female
- 60" Tall; 187 Lbs
- 2 O'clock
- 14.25" Max Crush
- Injuries:
  - AIS-5 Aorta/Rib
  - AIS-4 Liver/Lung



**CV - 1989 Toyota Celica GT**  
**POV- 1992 Cavalier**

# CASE 97-024S

## 21 MPH CRASH - FATALITY

- Driver
- 27 Y/O Male
- 69" Tall; 164 Lbs
- 11 O'clock
- 19" Max Crush
- Injuries:  
AIS-6 Aorta



**CV - 1985 Nissan Sentra**  
**POV- 1987 Dodge Caravan**

# CASE 97-005S

## 28 MPH CRASH - FATALITY

- Driver
- 57 Y/O Female
- 63" Tall; 166 Lbs
- 8 O'clock
- 24" Max Crush
- Injuries:
  - AIS 6-Aorta
  - AIS 5-Rib/Chest
  - AIS 4-Heart



**CV - 1995 Ford Contour**  
**POV- 1979 Cadillac Coupe**  
**DeVille**



# CASE 96-004S

## 34 MPH CRASH - FATALITY

- Driver
- 51 Y/O Male
- 67" Tall; 145 Lbs
- 9 O'clock
- 23.5" Max Crush
- Injuries:
  - AIS-6 Brain
  - AIS-5 Aorta
  - AIS-4 Skull



**CV -1988 Honda Prelude**  
**POV- 1994 Ford Econoline Van**

# CASE 97-040BL

## 35 MPH CRASH - FATALITY

- Driver
- 77 Y/O Female
- 65" Tall; 127 Lbs
- 10 O'clock
- 18" Max Crush
- Injuries:
  - AIS-6 Heart
  - AIS-5 Spleen
  - AIS-4 Rib/Aorta



**CV - 1993 Toyota Camry**  
**POV- School Bus**

# CRASH CHARACTERISTICS THAT MAY CONTRIBUTE TO AORTIC INJURY

- Near-side Impacts
- Side Damage to Front 2/3 of Struck Vehicle With Door Intrusion at Shoulder Level
- Oblique Crash Direction
- Presence of Far-side Occupants
- Older Occupants

# AORTIC INJURY MECHANISM



# The Crash



# OCCUPANT KINEMATICS



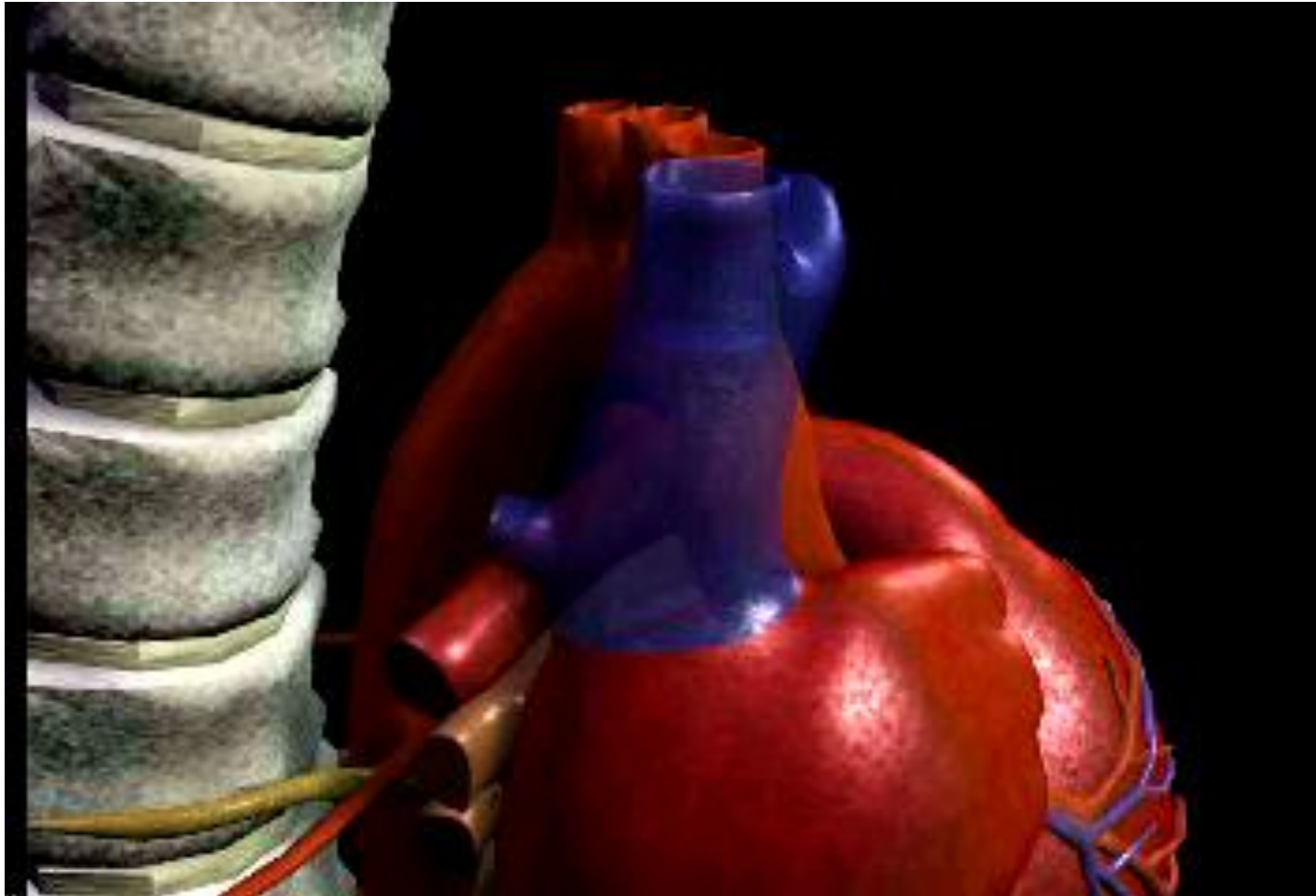
# Occupant Kinematics



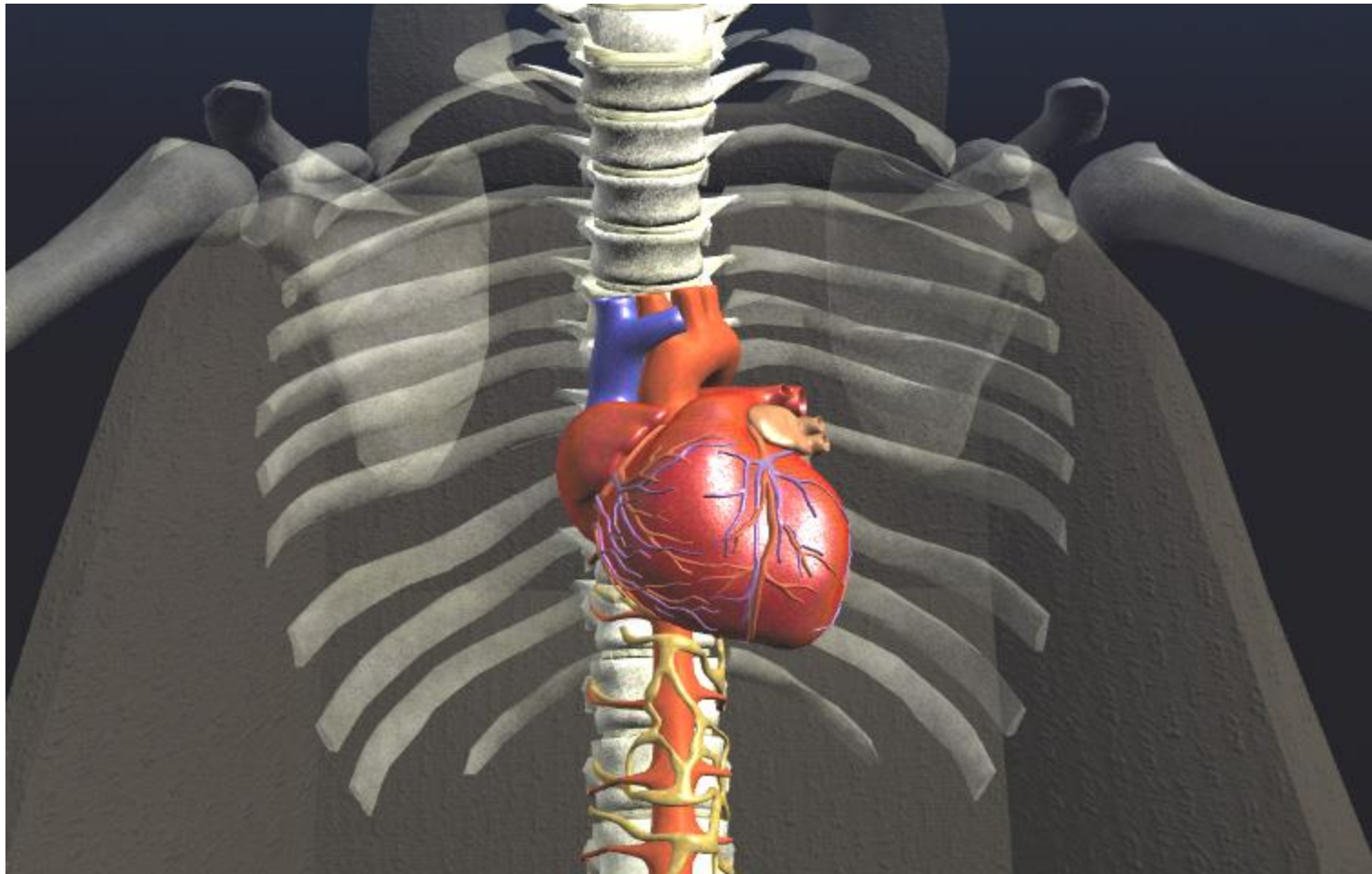
# Anatomical View of Injury



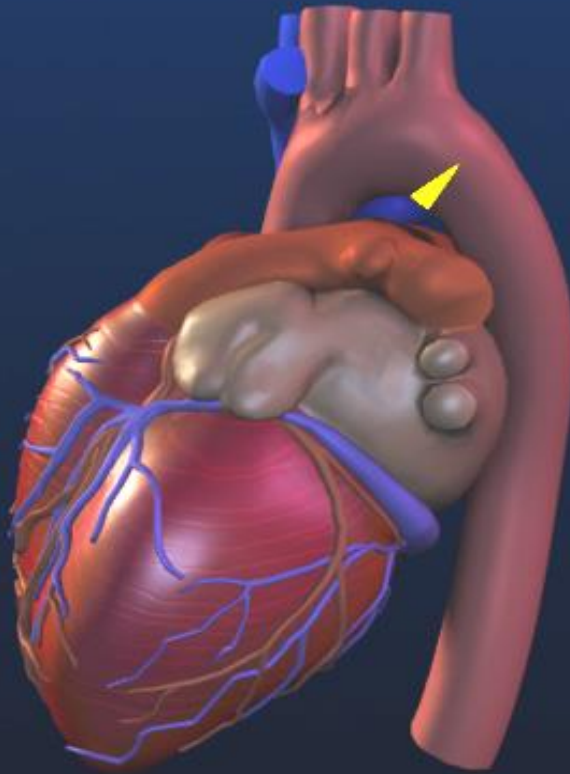
# Internal Organ Motion



# Anterior View of Aortic Attachment

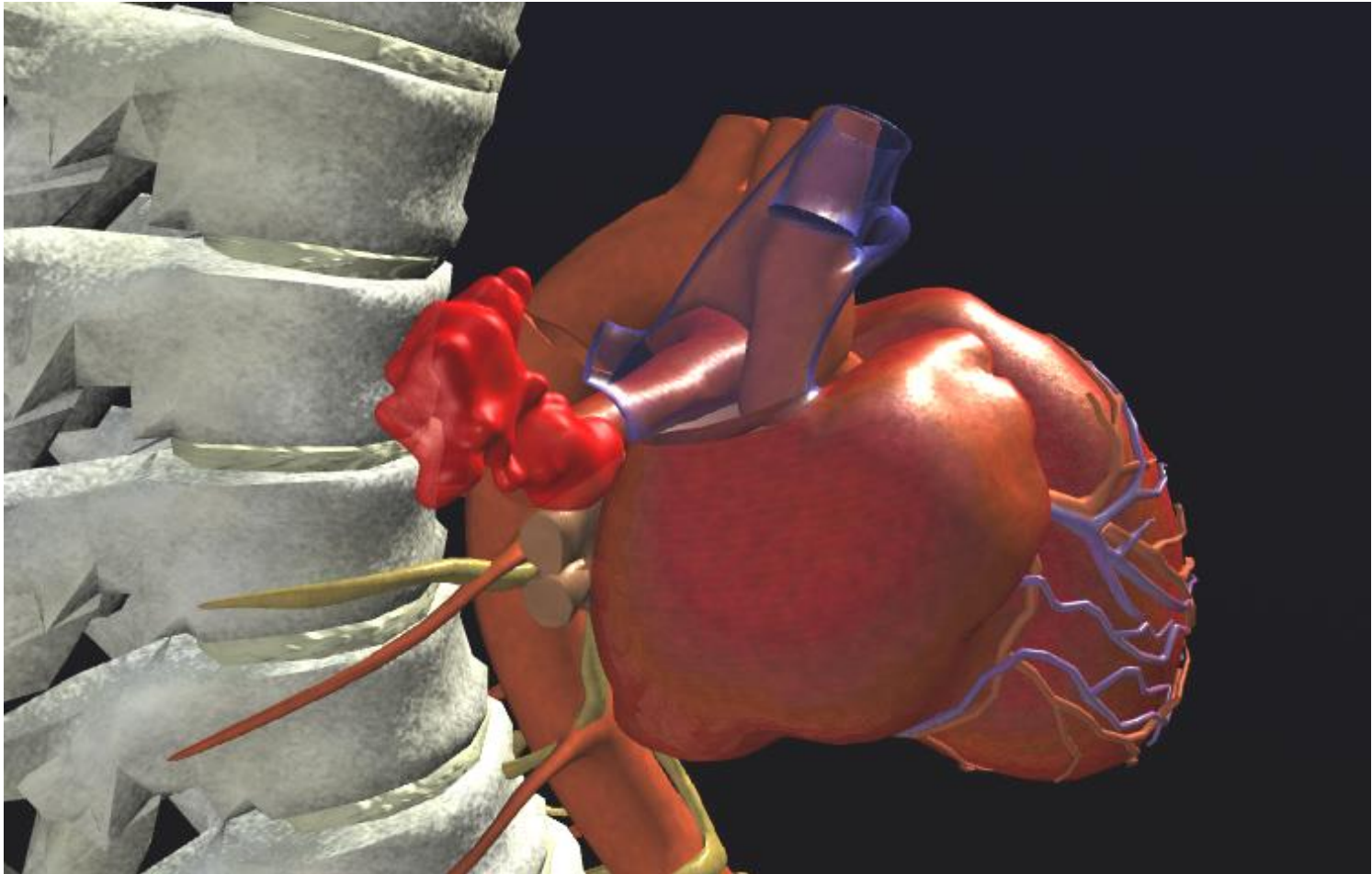


# Laceration Site



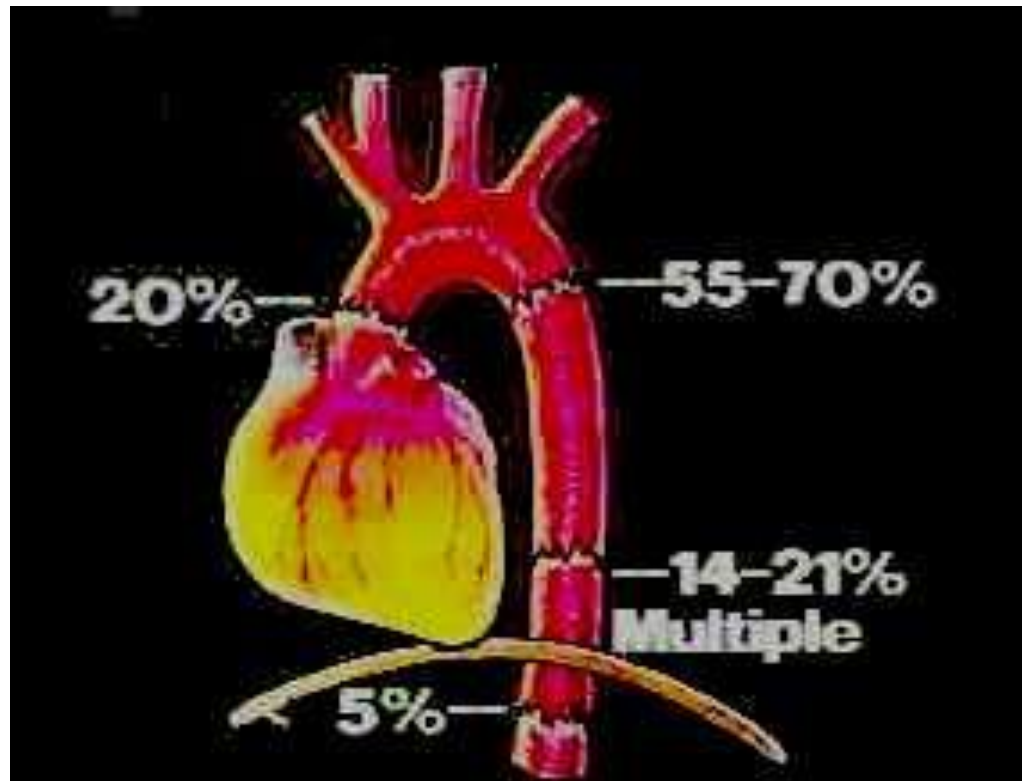


# Aortic Tear





# TEAR SITES



# SUMMARY

- Aortic Injuries- Can Be Occult
- If Alive at Scene, Survivable
- Additional Triage Criteria Needed for Aortic Injuries
- Additional Understanding of Aortic Injury Tolerance Needed

# SUMMARY - AORTIC INJURIES

- Need Not Be Severe Crash
- Consider High Risk for Aortic Injury:
  - Impact to Occupant Side
  - >12 - 15" Crush
  - >8 - 10" Intrusion
  - Loading to Upper Door
  - Oblique Impact

# Summary - Injuries in Near-side Collisions

- Heart Injuries are Primarily in Severe Crashes
- Head Injuries Primarily from POV and/or Upper Interior Structure
- Aortic Injuries in Moderate Severity Crashes with Damage to the Front 2/3 + Other Factors
- Limited Number of Cases -- To be Continued

# ACKNOWLEDGEMENTS

Our Whole Hearted Gratitude for Their Support and Participation:

- DOT/NHTSA**
- Alliance of Automobile Manufacturers**
- Association of International Automobile Manufacturers**
- CIREN Centers**

# QUESTIONS

