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

Injuries

- Severe: 2%
- Minor: 48%
- Uninjured: 50%

Percent of Population in Crashes

Tow-away
NASS - A Sample of Tow-Aways
CIREN - A Census of Injury Crashes

Injuries
- Severe
- Minor
- Uninjured

Percent of Population in Crashes

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Tow-away</th>
<th>WLRIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
<td>2%</td>
<td>85%</td>
</tr>
<tr>
<td>Minor</td>
<td>48%</td>
<td>15%</td>
</tr>
<tr>
<td>Uninjured</td>
<td>50%</td>
<td></td>
</tr>
</tbody>
</table>
# Crash Comparison - NASS vs. WLIRC

<table>
<thead>
<tr>
<th>CRASH COMPARISON</th>
<th>NASS 85</th>
<th>NASS/CDS</th>
<th>WLIRC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collision Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle-to-vehicle</td>
<td>72%</td>
<td>75%</td>
<td>78%</td>
</tr>
<tr>
<td>Fixed object</td>
<td>28%</td>
<td>25%</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Occupant Exposure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Side</td>
<td>67%</td>
<td>66%</td>
<td>70%</td>
</tr>
<tr>
<td>Far Side</td>
<td>33%</td>
<td>34%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Impact Location</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pax Compartment</td>
<td>90%</td>
<td>94%</td>
<td>94%</td>
</tr>
<tr>
<td>Other</td>
<td>10%</td>
<td>6%</td>
<td>6%</td>
</tr>
</tbody>
</table>
## Crash Comparison - NASS vs. WLIRC

<table>
<thead>
<tr>
<th>Crush, in</th>
<th>NASS</th>
<th>WLIRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12</td>
<td>15%</td>
<td>9%</td>
</tr>
<tr>
<td>13-24</td>
<td>71%</td>
<td>59%</td>
</tr>
<tr>
<td>24+</td>
<td>14%</td>
<td>33%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Striking Vehicle</th>
<th>NASS</th>
<th>WLIRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>49%</td>
<td>52%</td>
</tr>
<tr>
<td>LTV</td>
<td>37%</td>
<td>46%</td>
</tr>
<tr>
<td>Heavy Truck</td>
<td>13%</td>
<td>2%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
<td>0%</td>
</tr>
</tbody>
</table>
# Crash Comparison: NASS vs. WLIRC

## Injured Body Region

<table>
<thead>
<tr>
<th>Body Region</th>
<th>NASS</th>
<th>WLIRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/Face</td>
<td>24%</td>
<td>20%</td>
</tr>
<tr>
<td>Chest</td>
<td>44%</td>
<td>48%</td>
</tr>
<tr>
<td>Abdomen</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Pelvic/LX</td>
<td>14%</td>
<td>7%</td>
</tr>
<tr>
<td>Spine/Neck</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Other</td>
<td>9%</td>
<td>2%</td>
</tr>
</tbody>
</table>
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
LEHMANN 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
LEHMANN 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

<table>
<thead>
<tr>
<th>INJURY</th>
<th>All AIS 3+</th>
<th>Most Serious AIS 4+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta</td>
<td>8.20%</td>
<td>21.20%</td>
</tr>
<tr>
<td>Brain</td>
<td>12.90%</td>
<td>21.20%</td>
</tr>
<tr>
<td>Heart</td>
<td>3.50%</td>
<td>18.20%</td>
</tr>
<tr>
<td>Rib</td>
<td>15.90%</td>
<td>18.20%</td>
</tr>
<tr>
<td>Spleen</td>
<td>6.50%</td>
<td>12.10%</td>
</tr>
<tr>
<td>Lung</td>
<td>12.90%</td>
<td>3.00%</td>
</tr>
<tr>
<td>Liver</td>
<td>5.90%</td>
<td>3.00%</td>
</tr>
<tr>
<td>Spine</td>
<td>2.90%</td>
<td>2.90%</td>
</tr>
</tbody>
</table>
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
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- Association of International Automobile Manufacturers
- CIREN Centers
QUESTIONS