Using CIREN Data to Assess the Performance of the Second Generation of Air Bags

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Presentation Outline

• Description of the WLIRC Database

• Performance of 1\textsuperscript{st} and 2\textsuperscript{nd} Generation Driver Air Bags

• Performance of 1\textsuperscript{st} and 2\textsuperscript{nd} Generation Passenger Air Bags

• Illustrative Cases
## Adult Trauma Criteria

<table>
<thead>
<tr>
<th>Category 1 (ANY 1 Meets TTC)</th>
<th>Category 2 (ANY 2 Meets TTC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGE</strong></td>
<td>55 years old</td>
</tr>
<tr>
<td><strong>AIRWAY</strong></td>
<td>Respiratory rate 30</td>
</tr>
<tr>
<td><strong>CONSCIOUSNESS</strong></td>
<td>BMR 5</td>
</tr>
<tr>
<td>Assisted / Intubated</td>
<td></td>
</tr>
<tr>
<td>Alter mental status</td>
<td></td>
</tr>
<tr>
<td>GCS ≤ 12</td>
<td>Heart rate 120 bpm</td>
</tr>
<tr>
<td>HR &gt; 120 bpm &lt; 90 mmHg.</td>
<td>Long bone fracture</td>
</tr>
<tr>
<td>2 + long bone fractures</td>
<td>Major degloving injury</td>
</tr>
<tr>
<td>2(^{nd}) or 3(^{rd})° burns to 15% TBSA</td>
<td>Avulsion &gt; 5 inches</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MECHANISM OF INJURY</strong></td>
<td></td>
</tr>
<tr>
<td>Amputation</td>
<td>GSW</td>
</tr>
<tr>
<td></td>
<td>Ejection</td>
</tr>
<tr>
<td></td>
<td>Steering wheel deformity</td>
</tr>
<tr>
<td><strong>OTHER</strong></td>
<td></td>
</tr>
<tr>
<td>High index of suspicion</td>
<td></td>
</tr>
</tbody>
</table>
Crash Injury Research and Engineering Network

- Miami
- San Diego
- Seattle
- Ann Arbor
- Baltimore
- Wash. DC
- Birmingham
- Newark
- Fairfax
- Milwaukee
The WLIRC CIREN Center

- Has Been Collecting Data since 1992
- Collects a Near Census of Occupants with Air Bag Deployment in the South Florida Region who Meet the Trauma Criteria
- By 1995 Provided Data on:
  - Child Fatalities with deploying passenger air bags
  - Fatal neck injuries to small close-in drivers
- Provides Early Data on the Performance of New Safety Features
Comparison of NASS and CIREN Data
Distribution NASS Occupants, in Frontal Crashes by Delta-V

Delta V, mph

0-5  5-10  10-15  15-20  20-25  25-30  30-35  35-40  40+

Percentage

Based on Weighted NASS Data

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Average Weight Factors in NASS vs Delta-V

The diagram shows the average weight factors in NASS compared to Delta-V. The bars represent different delta-V MPH ranges, with the highest weight factors noted in the 0-5 and 5-10 MPH ranges. The text highlights that high weight factors correspond to sparse sample sizes.
NASS Distribution of MAIS Injured

- Failures
  - MAIS 3+: 2%
  - MAIS 1-2: 48%
  - MAIS 0: 50%

- Successes

Injury Rate = \( \frac{\text{MAIS 3+}}{\text{ALL}} \)
NASS vs Trauma Center
Distribution of MAIS Injured

Tow-away (NASS)  Trauma Center Injured

- Fatals
- MAIS 3+
- MAIS 1-2
- MAIS 0

1% 2% 47% 25%
50% 50% 25%
Typical Trauma Center Distribution of MAIS Injured

Fatality Rate = Fatalities/All
Disclaimer

• Statements in the following slides are made relative to WLIRC data only.
• The data is a near census of people in crashes in South Florida who meet trauma criteria; people thought to have life threatening injuries + fatalities.
• Ratios are not statistically significant but are generally consistent with observations from in depth studies.
• Database is not representative of the population of all tow-away crashes in the US.
WLIRC Data on 1\textsuperscript{st} and 2\textsuperscript{nd} Generation Driver Air Bags
Assumptions for Old and New Air Bags

• Old Air Bags (1\textsuperscript{st} Generation) are in all pre MY 1998 vehicles
• New Air Bags (2\textsuperscript{nd} & 3\textsuperscript{rd} Generation) in are all in MY 1998 and later vehicles
• Most of the “New” Air Bags are Sled Certified Air Bags
Driver Air Bag Performance – WLIRC Data

- Frontal Crashes with No Rollover
- WLIRC Cases + All Fatal Cases
- Trauma Center Patients + Fatals = Census of Severely Injured in South Florida

- 161 Drivers with Old Air Bags; 48% Belted
- 66 Drivers with New Air Bags; 38% Belted
1st Generation Driver Air Bags

9 Fatalities at Delta-V > 20 mph

- Characteristics of Fatalities:
- 4 Short Statured – 5’4” or less
  - Head/neck injuries
- 4 Elderly – 65 or older
  - Chest Organ Injuries
- 1 at 20 mph due to incompatibility/intrusion

Issue:
Air Bags too aggressive close-up and too stiff for elderly

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Driver Air Bag Deployment in WLIRC Database by Delta-V

Number of Drivers at WLIRC – All Data
- Old Air Bags – 161
- New Air Bags – 66

Crash distribution generally similar
Driver Air Bag Deployment in WLIRC Database by Delta-V

Fatality Rate of Drivers at WLIRC

Delta-V, mph.

Distribution of Drivers at WLIRC

Delta-V, mph.

Much Lower Rate of Fatalities in Low Severity Crashes

Old Air Bag Deployment in WLIRC Database by Delta-V

Distribution of Drivers at WLIRC

Delta-V, mph.

Much Lower Rate of Fatalities in Low Severity Crashes

Old Air Bag
New Air Bag

0 - 20 21 - 25 26 - 30 31+

Look further at this

Old Air Bags
New Air Bags

0 - 20 21 - 25 26 - 30 31+

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Driver Air Bag Deployment in WLIRC Database by Delta-V

Number of Drivers at WLIRC - Unbelted
- Old Air Bags - 83
- New Air Bags - 41

New Air Bags in lower severity crashes
Driver Air Bag Fatality Rate in WLIRC Database by Delta-V

Number of Drivers at WLIRC - Unbelted
- Old Air Bags - 83
- New Air Bags - 41

New Air Bags Have:
- Lower % Fatalities in Low Severity Crashes
- Higher % Fatalities in High Severity Crashes
Driver Air Bag Deployment in WLIRC Database by Delta-V

Number of Drivers at WLIRC - Bleted
- Old Air Bags - 78
- New Air Bags - 25

Higher % of New Air Bags in 26-30 mph crashes

<table>
<thead>
<tr>
<th>Delta-V, mph</th>
<th>Old Air Bags</th>
<th>New Air Bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26-30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31+</td>
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</tbody>
</table>
Driver Air Bag Fatality Rate in WLIRC Database by Delta-V

Number of Drivers at WLIRC & CIREN -
Belted
Old Air Bags - 78
New Air Bags - 25
New Air Bags Have Lower % of Fatalities in all Crashes

Fatality Rate of Belted Drivers at WLRC

- Fatality Rate
- Delta-V, mph.
- Old Air Bag
- New Air Bag

0 0.25 0.5
0-20 21-25 26-30 31+

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Belted Driver Air Bag Risks in CIREN Database by Delta-V

Number of Drivers at CIREN - Belted
- Old Air Bags - 141
- New Air Bags - 78

New Air Bags Performing Well for Belted Drivers

Fatality Risk of Belted Driver in CIREN

<table>
<thead>
<tr>
<th>Delta-V, mph</th>
<th>Fatality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>0.25</td>
</tr>
<tr>
<td>21-30</td>
<td>0.00</td>
</tr>
<tr>
<td>31-40</td>
<td>0.50</td>
</tr>
</tbody>
</table>

- Old Air Bag
- New Air Bag
Belted Driver Air Bag Risks in WLIRC & CIREN

Fatality Rate of Belted Drivers at WLIRC

Fatality Risk of Belted Driver in CIREN

Old Air Bag  New Air Bag

Fatality Rate

Delta-V, mph.

Old Air Bag  New Air Bag

Fatality Rate

Delta-V, mph.
New Driver Air Bags - Observations

- No Elderly Fatalities below 30 mph Delta-V
- No Short Statured fatalities below 30 mph Delta-V
- New Driver Air Bags appear to be working well for belted drivers at all crash severities and for unbelted drivers in crashes less than 25 Mph
- Watch the unbelted fatality rate at 25+ mph

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Selected Cases from WLIRC Data
Case Subject

- 18 Year old male - Driver
- 66", 125 lbs
- Unrestrained
- Front & passenger air bags deployed
- Single occupant

High suspicion of injury

9 days in hospital
Scene

Crash occurred: 06:30 am
Trauma arrival: 06:54 am
Via-rescue vehicle

-High suspicion of injury
Case Vehicle

- 2003 Honda Element
- Max crush: 43"
- PDOF: 12 O’clock
- DeltaV: 44mph
Injuries

- AIS 3 - Liver laceration
- AIS 2 - Spleen laceration
- AIS 3 - Right lung contusion & laceration
- AIS 2 - Right rib FX
- AIS 2 - Right malleolus & fibular FX
Observation

- Young Male, unbelted in 44 mph narrow object crash
- No head injuries
- Survivable AIS 3 chest injuries
- Air bag + steering column absorbed crash energy
40 MPH Fatality

Unrestrained Driver
Barrier Type Crash

FATALITY

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40 MPH Fatality

2000 Toyota Celica
Vehicle-to-Barrier
PDOF: 12 o’clock
Delta V: 39 mph
Max Crush: 31 in.
On Scene Picture

Uneven Ground

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Car to Barrier Crash

30” max vehicle crush

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Vehicle Interior

A-pillar head strike

11” Left Toe Pan Intrusion
3.1” Steering Wheel Deformation

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Vehicle Interior

Driver: Unrestrained 20 year old Female 5’4”, 135 lbs

Fatal Head Injury A-Pillar Contact
Fatal Brain Injuries –
A-pillar Contact

- Brain Injuries –
  - 3- AIS 5
  - 4- AIS 4
  - 1- AIS 3
  - 1- AIS 2
- No other AIS 2+
Injuries
- No Skull Fracture
Observation

- Unrestrained driver 5’4” in 39 mph collision
- May have been out of position due to rough ground
- No severe chest/abdominal injuries
- Catastrophic brain injuries from a-pillar contact
- Crash direction/driver position may have induced a-pillar head impact – head missed air bag
Conclusions- New Driver Air Bags

- New Driver Air Bags Perform Better than Expected
  - Very Low Fatality Rate for Belted (.08 new vs. .26 old)
  - Slightly Lower Fatality Rate for Unbelted
- No Short Person Fatalities Below Delta-V 30 Mph
- No Elderly Fatalities Below Delta-V 30 Mph
- Several Success Stories Above Delta-V 40 Mph
- Head Injuries Observed in Angular Impact (High Severe Crash & Unbelted Occupant)
- Need to Monitor Unbelted at 30+ mph – May Tend to Miss the Air Bag
WLIRC Data on Old and New Passenger Air Bags
Fatalities in 1st Generation Passenger Air Bags

Characteristics of 4 Low Delta-V Fatalities:

- 2 Infants in rear facing child seats
  - Head/neck injuries
- 2 Children under 3 years old – no belts
  - Head/neck injuries
- 1 Unexpected Fatality at moderate severity – Occupant reaching forward at time of crash (Out of Position)
  - Head/neck injuries
Issue: 1st Generation Passenger Air Bags too aggressive close-up
Passenger Air Bag Deployment in WLIRC Database by Delta-V

Number of Passengers at WLIRC

Old Air Bags - 33
New Air Bags - 25

New Air Bags Had Fewer Passengers in Lowest Severity Crashes

Distribution of Passengers at WLIRC

- Delta-V, mph.
- Old Air Bag
- New Air Bag

0-20
21-25
26-30
31+

0.6
0.4
0.2
0

OLD Air Bag
NEW Air Bag
Passenger Air Bag Risks in WLIRC Database by Delta-V

Number of Passengers at WLIRC
- Old Air Bags - 33
- New Air Bags - 25

New Air Bags Have Lower Fatality Rate in Low Severity Crashes; Higher in High Severity Crashes

Fatality Risk of Pass. at WLIRC

<table>
<thead>
<tr>
<th>Delta-V, mph.</th>
<th>0-20</th>
<th>21-25</th>
<th>26-30</th>
<th>31+</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLD Air Bag</td>
<td>0.25</td>
<td>0.25</td>
<td>0.5</td>
<td>0.75</td>
</tr>
<tr>
<td>NEW Air Bag</td>
<td>0.5</td>
<td>0.5</td>
<td>0.75</td>
<td>1</td>
</tr>
</tbody>
</table>
Conclusions: New Passenger Air Bags

- New Passenger Air Bags Perform As Expected In WLIRC Data
- No Child Fatalities, No Close-in Fatalities
- No Elderly Fatalities below 30 mph
- Not Much Difference in Old and New Fatality Rates
- Need to Verify Increased Fatality Rate Above Delta-V 25 mph

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Conclusions – New Air Bags

• In WLIRC data, New Air Bags performed as expected – Less injury in lower severity crashes
• Except for higher fatality rates above 25 mph for unbelted drivers and passengers, findings are consistent with other research by Blue Ribbon Panel
• Limited data – Needs validation from other sources
The End