CI REN
Improved Injury Causation Coding Methods;
An Initial Review

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ORIGINAL CRASH DATA

- **Environment**
  - Roadway, weather, traffic control devices and so on...

- **Vehicle**
  - Make, model, year, weight, crush measures, AB location and deployment, intrusion measures, tire tread depth, number of engine cylinders, tire pressure and so on...

- **Occupant**
  - Gender, race, age, HT, WT, vitals, GCS, hospital days, blood given, seat position, posture, belt status, mortality, admit and dc times, ABG, AIS injury code(s), injury aspects, source of injury - and that’s about it.
Data Out of Balance
“Broad Brush” conclusions to causation

- Multi event crash
  - All injury assigned to RANK 1 event
- No ID on injury from injury
  - Some injuries are a result of another injury (double dip)
- Intrusion not related
  - Factor or Critical to causation (component level)
- Contributing factors relationship
  - Osteoporosis, obesity, seat belt interaction…
  - Often documented and discussed – not linked
- Single component source
  - Are all injuries caused by single source contact
Data Issue

Uniformly capture the multidisciplinary CIREN discussion that occurs on every significant injury in every case.

- Medical
- Engineering
- Crash Investigation

Apply peer reviewed research
Need

- Design a method by which causation evidence and factors are uniformly related to an applicable injury.
Bio-Tab Injury Causation Coding

Serious Injury

Physical Evidence

Source of Energy

Involved Physical Component(s) (IPC)

Identify BR Injured Versus BR Contacted

Caused by Other Injury?

Contributing Factor(s)

Mechanisms (Regional+Organ) Researched Based
Innovation and Improvement

- Complete medical documentation access and appropriate interpretation
  - Injury pattern and kinematic comparisons
    - Fracture patterns, soft tissue contacts, injury location
  - “Damage pattern” for the occupant matched to the damage pattern on the vehicle
  - Radiology access (image and report) and expert interpretation
  - Comorbidities accurately associated to causation
    - Direct relationship per injury
    - Not per occupant
  - Injury relationship to impact biomechanical research
Innovation and Improvement

Bio-Tab Body Regions
- Head
- Face
- Neck
- Shoulder
- Arm
- Elbow
- Forearm
- Wrist Hand
- Thorax
- Abdomen
- Cervical spine
- Thoracic spine
- Lumbar spine
- Pelvis
- Hip
- Thigh
- Knee
- Leg
- Ankle
- Foot

Why?
- Define as Joints and Segments
- Ability to determine and code load paths
Innovation and Improvement

- Directly relate injury mechanism(s) to established peer-reviewed literature.
  - Approved mechanical/biomechanical
  - Approved medical
- Match life to lab
Balanced Data
Old versus New

AIS 6502343
Cervical spine vertebral body fracture (C4)
- Source of Energy – Crash (event specific)
- IPC – Belt restraint
- Load path – Thorax / Thoracic spine / Cervical spine
- Contributing factor – Comorbidity of ankylosing spondylitis
- Regional mechanism – Flexion and compression
- Evidence – Loaded belt, chest/abd belt contusion, anterior column compression fx w/post ligament disruption

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Increase Confidence with Evidence

- 81 yr old driver (belted/5’10”)
- 03 Ford Focus (frontal w/jumped curb)
- AIS3 C-spine fx (C4-C7, T5)
- DV=14 kph / 8.7 mph

- Belt loading w/ flexion?
  - Not supported

- Head contact= compression w/ extension of the C-spine
  - Scalp contact (under hair)
  - Posterior spine fxs
  - Confidence - Improved
Current Bio-Tab Population

Cases coded = 1,160

Crash Mode

- Frontal: 57%
- Side: 35%
- Roll: 6%
- Rear: 1%
- Undercarriage: 1%

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Current Bio-Tab Population

Cases coded = 1,160
Population Age

Cases by Age (N=1,160)

<table>
<thead>
<tr>
<th>Age</th>
<th># Cases</th>
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<tr>
<td>0-3</td>
<td>[Bar]</td>
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<td>4-8</td>
<td>[Bar]</td>
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<td>13-20</td>
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<tr>
<td>21-30</td>
<td>[Bar]</td>
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<tr>
<td>31-40</td>
<td>[Bar]</td>
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<tr>
<td>41-50</td>
<td>[Bar]</td>
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<tr>
<td>51-60</td>
<td>[Bar]</td>
</tr>
<tr>
<td>61+</td>
<td>[Bar]</td>
</tr>
</tbody>
</table>
Multi-Contact Causation Example

- 2003 Dodge Caravan (frontal)
- Open Rt. tibial shaft fx
- Rt. knee contact to KB
- Rt. foot contact to TP/Pedal
- Intrusion (as well)
Multi-Source Data

6% of all AIS3+ injury w/ two “critical” IPCs

Critical IPCs - AIS3+ Injury (3,070)

Body Region

% Critical per BR

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Critical Intrusion Example

- 2007 Toyota Yaris (frontal)
- 25 yr old male driver (belted)
- 5’ 10”
- Open Lt. tempo-parietal skull fx
- A-pillar intruded 23 cms

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Critical Intrusion Data

9% of all AIS2+ injury had “critical” intrusion

Critical Intrusion AIS2+ Injury (N=4,455)
# Contributing Factors (Top 5 of AIS 3+)

<table>
<thead>
<tr>
<th>BR</th>
<th>1*</th>
<th>2*</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thorax (N=718)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intrusion 26%</td>
<td>Other (specify) 17%</td>
<td>Unbelted Case Occupant 15%</td>
<td>Elderly – General 11%</td>
<td>Comorbidity – pick 10%</td>
</tr>
<tr>
<td>Head/Face (N=591)</td>
<td>Intrusion 27%</td>
<td>Other (specify) 15%</td>
<td>Unbelted Case Occupant 10%</td>
<td>High DV 9%</td>
<td>Posture 7%</td>
</tr>
<tr>
<td>Pelvis (N=305)</td>
<td>Intrusion 43%</td>
<td>Other (specify) 18%</td>
<td>Comorbidity – pick 14%</td>
<td>Unbelted Case Occupant 11%</td>
<td>Elderly – General 7%</td>
</tr>
<tr>
<td>Abdomen (N=228)</td>
<td>Intrusion 22%</td>
<td>Other (specify) 17%</td>
<td>Unbelted Case Occupant 15%</td>
<td>High DV 10%</td>
<td>Posture 9%</td>
</tr>
<tr>
<td>C-spine (N=228)</td>
<td>Intrusion 26%</td>
<td>Other (specify) 22%</td>
<td>Unbelted Case Occupant 14%</td>
<td>Elderly – General 13%</td>
<td>Comorbidity – pick 13%</td>
</tr>
</tbody>
</table>
Bio-Tab Data Contributing Factors

Bio-Tab Top 5 Contributing Factors For Injury Severity
(% of all AIS 3+ injury per crash mode)
Data 2005-2008

Intrusion
Unbelted
Elderly
Comorbidity
Other (specify)
Tall

% of AIS 3+
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00

Frontal
Side
Roll
Conclusions - Structure

- Each significant injury sustained by an occupant can have factors and evidence coded and related individually.
- Full access to the medical record and applicable experts is required.
- Improved understanding of occupant and vehicle interaction results.
Conclusions - Data

- Nearly 1,200 cases coded
- Over 3,000 AIS3+ injuries coded
- Critical IPC’s are isolated to knee/lower leg injury
- Critical intrusion observed in majority of BR’s (low %)
- Intrusion and Belt status universal contributing factors to severity
- Review of CF “Other (specify)” required
- No research cited can be an indicator of limit biomechanical research knowledge
- **Reduce** assumption, case loss and imputation in later research

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Thank You