Onboard Monitoring/Naturalistic Driving Crash Analysis

Jeffrey Hickman, Ph.D
Center for Truck and Bus Safety at the Virginia Tech Transportation Institute
Post-Hoc Crash Reconstruction

- Crash database analyses
  - Derived from police accident reports (PARs)
    - GES, FARS, TIFA, BIFA, MCMIS, CDLIS
  - LTCCS & NMVCCS
    - Supplemented information from PARs
    - Vehicle inspection
    - Witness
    - Crash reconstruction
    - 600 variables
Strengths and Weaknesses

- **Strengths**
  - Information about crash risk
  - Important circumstances and scenarios that lead to crashes
  - Crashes
  - Typically skewed towards higher severity crashes

- **Weaknesses**
  - Limited pre-crash information
  - No exposure
  - Prone to error
  - Typically skewed towards higher severity crashes (missing crashes and near-crashes)
Case Study of PAR

- Single vehicle off road crash
  - Left road departure
- 2 lane divided highway (grass)
- 55 mph
- No skid marks, steered left to avoid rear of lead vehicle
- Lead vehicle witness: truck was right behind me then turned toward median
- Driver: in hospital with minor injuries, limited recall of crash (was just driving down the road)
- What is the cause?
What is the cause here?
Naturalistic Driving

- Instrumented vehicles
  - Video, GPS, radar, onboard computer, machine vision, etc.
- Driver behavior in the natural environment
  - Truck drivers
    - Normal revenue-producing deliveries
  - Passenger car drivers
    - Work, store, kids to school
- “with the driver”
Strengths and Weaknesses

- **Strengths**
  - Precise information on driver behavior
  - High ecological validity
  - Crashes, but also near-crashes that wouldn’t be reported
  - Exposure
  - Estimates of crash risk

- **Weaknesses**
  - Can include non-crashes
  - Limited information on non-instrumented vehicle
Onboard Monitoring Systems

- Commercially-available systems already collecting data
  - Lytx, SmartDrive, etc.
- Event based
- 10,000s crashes/year
- Opportunity to mine these data
### FMCSA (2009)

- 13,305 vehicles (trucks and buses)
- 1,085 crashes; 39,036 near-crashes and events
- 211,171 baselines

<table>
<thead>
<tr>
<th>Tertiary Task</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th># of SCEs</th>
<th># of Baselines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Phone</td>
<td>1.14*</td>
<td>1.06 – 1.23</td>
<td>895</td>
<td>4,262</td>
</tr>
<tr>
<td>Dialing a Cell Phone</td>
<td>3.51*</td>
<td>2.89 – 4.27</td>
<td>165</td>
<td>256</td>
</tr>
<tr>
<td>Talk/Listen on a Hands-free Cell Phone</td>
<td>0.65*</td>
<td>0.56 – 0.76</td>
<td>194</td>
<td>1,626</td>
</tr>
<tr>
<td>Talk/Listen on a Hand-held Cell Phone</td>
<td>0.89</td>
<td>0.80 – 1.00</td>
<td>372</td>
<td>2,266</td>
</tr>
<tr>
<td>Reach for Bluetooth Device</td>
<td>3.38*</td>
<td>2.64 – 4.31</td>
<td>104</td>
<td>168</td>
</tr>
<tr>
<td>Reach for Cell Phone</td>
<td>3.74*</td>
<td>2.97 – 4.71</td>
<td>122</td>
<td>178</td>
</tr>
</tbody>
</table>
FMCSA (2015)

- 6,379 vehicles (trucks and buses)
- 1,121 safety-critical events
- 11,562 and 10,597 random and spurious baselines

<table>
<thead>
<tr>
<th>Interval in 0.25 s Segments</th>
<th>Percent of Recording IDs with EOFR (6-s interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>VR SCEs</td>
</tr>
<tr>
<td>0.25</td>
<td>VR Spurious Baselines</td>
</tr>
<tr>
<td>0.5</td>
<td>VR Random Baselines</td>
</tr>
</tbody>
</table>

Trigger Point: 5.75
FMCSA through NSTSCE (2015)

- LTCCS variables captured via OBM
- ~80% of 802 LTCCS variables could be captured
  - More accuracy in pre-, during, and post-crash behavior
- LTCCS had missing data
  - 25% of LTCCS variables missing data
  - Only ~50% of variables had an option for unknown
    - 10% of those coded as unknown
How Would it Work?

- Obtain videos from OBM vendors
- Reduce and analyze videos using LTCCS codebook (or new codebook)
- Obtain similar records as LTCCS (or other records)
  - VIN, VHR, PAR, CDLIS, MCMIS, SAFER
- Similar outputs as LTCCS
- Could also compare video reduction to PARs
- Could also collect baseline to assess risk
Naturalistic Data Collection

- Continuous data collection
- More capabilities and ability to answer additional research questions post-hoc
- Multiple vehicle platforms: light vehicles, trucks, motorcoaches, off-road vehicles, motorcycles, pedalcycles
Sample Topics Studied

- Crash risk
- Distraction
- Fatigue
- HOS
  - Rest breaks
- CMV training
- Newly licensed teen drivers
- Autonomous features
- Training teen and older drivers
- Crash avoidance systems
- Indirect visibility systems
- Rear lighting systems
- Prescription drugs
- Personality
QUESTIONS

jhickman@vti.vt.edu