Evaluating a Real-time Invehicle Driver Monitoring and Auditory Feedback Device for Improving Fleet Driver Performance
Sydney, Australia, November 11, 2009
Nadine Levick MD, MPH, Research Director

In this week’s consumer news...

Visual, Auditory and Haptic Feedback

To mention a few...
- Auditory Feedback
  - Roadsafety
  - Tii
- Visual Dash Alerts
  - Greenroad
- A recorder
  - Carchip

Availability of after market consumer ‘e-safety’ technologies is accelerating rapidly – but – how can the consumer decide which aftermarket device is effective and suited to their needs
- Marketing appears to be driving safety decisions in this arena – rather than reliable scientific data

Lexicon....
- Vehicle e-safety systems
- Intelligent Speed Adaptation - ISA
- Advanced Driver Assistance Technologies
- Invehicle Telematics
- Adaptive Integrated Driver-vehicle Interface – AIDE
- Invehicle data recording - IVDR
- ........ ??

Alerts and warnings
- Visual - What color means what?
  - On the dash?
  - Heads up display?
- Auditory - What tone means what for which device or which safety or behavior alert?
  - Tones, beeps, growls?
- Haptic
  - Steering wheel?
  - Seat?

Are these valuable aftermarket safety tools?
and
Are we about to enter an impending minefield of confusion.....?
Real-time feedback means...
• Milliseconds
  - How many?
• Seconds
  - How many?
• That day
• That week...

So...
• Evaluating a Real-time In-vehicle After market Driver Monitoring and Auditory Feedback ‘E-safety’ Device for Improving Fleet Driver Performance
• In the setting of a special fleet – ambulance vehicles in the USA

To quote Steve “Sid” Caesar – Director IHS ES
“We want everyone to get home safely each day”

Emergency Medical Services (EMS)
An important and unique transport system
• Public safety, public health and emergency service
• Is there to save lives

Uniquely suited to fleet ‘telematics’ evaluation
• High volume of risky driving practices
• High crash and injury rate
• Large cohort of high risk drivers – young males
• System is protocol driven
• Strict performance monitoring from a clinical perspective is an accepted norm
• Benchmarking is in response times...

USA EMS transport safety data estimates
• ~ 50,000 vehicles
• ~ 9,000 crashes a year
• ~ One fatality each week
  – ~ 2/3 pedestrians or occupants of other car
• ~10 serious injuries each day
• Cost estimates > $500 million annually

Ambulance transport a serious USA transport safety problem...
• the most lethal vehicle on the road both per mile travelled and per vehicle
• is exempt from federal fleet safety oversight
• 2/3 fatalities not in the ambulance
• Exempt from most FMVSS standards
  AND.....
• Is THE VEHICLE THAT COMES TO RESCUE YOU ON THE HIGHWAY!!

Some odd USA facts
• 97% of ambulance transports are routine
• <3% are critical or life threatening
• Ambulances are generally not built by the automotive industry
• No ESC, or ISA or....
• The most lethal commercial vehicle on the road

Very Important Principle
Ambulance transport safety is part of a SYSTEM, the overall balance of risk involves the safety of all occupants and the public
Firstly!
- An accident?
- or
- a predictable and preventable event

Last month... October 22, 2009
Provider and Patient Killed

April 30, 2009 - Tennessee

Primum Non Nocere...??

National Academies TRB
Ambulance Transport Safety Summit
October 29, 2009

Driver behavior monitoring and feedback device

What about changing driver behavior in the real world??

April 30, 2009 - Tennessee
Objective

- To evaluate and compare outcomes of the use of a real-time driver monitoring and feedback device for improving driver safety performance in two ambulance transport settings

The conceptual approach to this end user market - The "Feedback Box" - A transportation safety monitoring and feedback device

“This technology is conceptually like a vehicle safety pulse oximeter – that with auditory feedback - can save your life, your coworkers life, your patients life, and others on the road.”

Purpose of ‘Monitoring and Feedback box’ Program

- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

How the Device Works

- Computerized monitoring device installed on each vehicle to measure parameters
- Each driver has individual key ‘fob’
- Data collected every second – including: vehicle speed and performance, driver behaviors and emergency mode
- Immediate auditory feedback of warning ‘growls’, and penalty tones to driver
- Can also alert management via cellular network
- Data downloaded automatically every day

Key fob for driver specific activation of the system

Video Demonstration

- Log on procedure
- Hard cornering
  - Freeway entrance ramp – tighten turn radius
- Over-speed
  - Shortened warning period to high overspeed
  - Low overspeed during deceleration

Over speed - accelerating

- Listen for growl – 15 sec warning begins
- Growl frequency increases near end of warning
- Tone on – penalty points awarded
- Slow down – tone stops
- Accelerate again - growl on – slow down – growl stops - no points

Methods

- Implementation of an aftermarket onboard real-time driver monitoring and auditory feedback device in the setting of two ambulance services
- Sites compared for fleet use and environment
- Data collected for driver performance, vehicle parameters and safety behaviours during the three phased period.
- System performance comparisons conducted
The implementation sites

<table>
<thead>
<tr>
<th>Site A</th>
<th>Site B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Served</td>
<td>500,000 people in Little Rock area, Arkansas</td>
</tr>
<tr>
<td>Serves</td>
<td>The Lehigh Valley area, Pennsylvania</td>
</tr>
<tr>
<td>Ambulance Units Deployed</td>
<td>29 units daily</td>
</tr>
<tr>
<td>Ambulance Calls</td>
<td>58,000 calls per year</td>
</tr>
<tr>
<td>Service Area</td>
<td>2,400 square mile</td>
</tr>
<tr>
<td>Operational Employees</td>
<td>195 full time / 75 part time uniformed employees</td>
</tr>
<tr>
<td>Ambulance Miles Travelled</td>
<td>1.9 million miles annually</td>
</tr>
<tr>
<td>Mean response time</td>
<td>6 minutes</td>
</tr>
</tbody>
</table>

Implementation Phases

- **Phase I:** Blind data - no tones, no ID capture
- **Phase II:** Warning and penalty tones only
- **Phase III:** Fully operational

Implementation Phase Duration

<table>
<thead>
<tr>
<th>Site</th>
<th>Phase</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A</td>
<td>Phase II: Warning and penalty tones only</td>
<td>4/2003</td>
<td>6/2003</td>
</tr>
<tr>
<td>Site B</td>
<td>Phase II: Warning and penalty tones only</td>
<td>5/2005</td>
<td>7/2006</td>
</tr>
</tbody>
</table>

Parameters Monitored

- Vehicle Speed (against user set limits – both hot and cold)
- Hard acceleration/braking
- Cornering velocity and G-forces
- Use of Emergency Lights and Sirens
- Parking brake
- Back up spotter
- Vehicle Speed (against user set limits – both hot and cold)

Performance incentives

- Both services incentivized good performance
  - Free lunch
  - Team competition
  - Bonus
  - Schedule benefits
- Both services highlighted perfect drivers not the goal

Onboard Computer Device Settings used in this study

<table>
<thead>
<tr>
<th>Site</th>
<th>Setting</th>
<th>Site A</th>
<th>Site B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Speed (LEFCOUNT)</td>
<td>70 - 80 mph</td>
<td>70 - 80 mph</td>
<td></td>
</tr>
<tr>
<td>High Speed (HSCOUNT)</td>
<td>80 - 90 mph</td>
<td>90 - 100 mph</td>
<td></td>
</tr>
<tr>
<td>Cornering Low Over Force (LFCOUNT)</td>
<td>25%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>Cornering High Over Force (HFCOUNT)</td>
<td>35%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Reverse Count (RVCOUNT)</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Seat Belt Distance (SBCOUNT)</td>
<td>0.2 mile</td>
<td>0.1 mile</td>
<td></td>
</tr>
</tbody>
</table>

Implementation Specifics

- No inservice training during Phase II & III
- No time out in drivers Ed classes
- Extended Phase II period in Site B to capture low frequency driver mix
- Speed tolerances and seat belt tolerances were more stringent at Site B
  - Speed warning period is 30% shorter
  - Seat Belt warning distance is 50% shorter

Site A | Site B
---|---
MEMS Safety | CETRONIA AMBULANCE CORPS
EMS Safety | EMS Safety
Site A: Overspeed violations

MEMS - Overspeed Violations per Month

<table>
<thead>
<tr>
<th>Month</th>
<th>Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-03</td>
<td>550,353</td>
</tr>
<tr>
<td>May-03</td>
<td>400,000</td>
</tr>
<tr>
<td>Jul-03</td>
<td>500,000</td>
</tr>
<tr>
<td>Sep-03</td>
<td>600,000</td>
</tr>
</tbody>
</table>

Site A: Seatbelt violations

MEMS - Seatbelt Violations per Month

<table>
<thead>
<tr>
<th>Month</th>
<th>Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-03</td>
<td>13,884</td>
</tr>
<tr>
<td>May-03</td>
<td>8,000</td>
</tr>
<tr>
<td>Jul-03</td>
<td>10,000</td>
</tr>
<tr>
<td>Sep-03</td>
<td>12,000</td>
</tr>
</tbody>
</table>

Site A: Overforce violations

MEMS - Force Count Violations per Month

<table>
<thead>
<tr>
<th>Month</th>
<th>Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-03</td>
<td>24,601</td>
</tr>
<tr>
<td>May-03</td>
<td>20,000</td>
</tr>
<tr>
<td>Jul-03</td>
<td>25,000</td>
</tr>
<tr>
<td>Sep-03</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Site A: Driver Performance

MEMS - Percent of Drivers Below Standard

<table>
<thead>
<tr>
<th>Zone</th>
<th>Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zones</td>
<td>Percent</td>
</tr>
<tr>
<td>1</td>
<td>46%</td>
</tr>
<tr>
<td>2</td>
<td>28%</td>
</tr>
<tr>
<td>3</td>
<td>39%</td>
</tr>
<tr>
<td>4</td>
<td>33%</td>
</tr>
<tr>
<td>5</td>
<td>35%</td>
</tr>
<tr>
<td>6</td>
<td>29%</td>
</tr>
<tr>
<td>7</td>
<td>25%</td>
</tr>
<tr>
<td>8</td>
<td>41%</td>
</tr>
<tr>
<td>9</td>
<td>30%</td>
</tr>
<tr>
<td>10</td>
<td>35%</td>
</tr>
<tr>
<td>11</td>
<td>40%</td>
</tr>
<tr>
<td>12</td>
<td>45%</td>
</tr>
</tbody>
</table>

Site B: Overall Results

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>193,210</td>
<td>89,259</td>
<td>2.16</td>
<td>12,936</td>
<td>14.94</td>
<td>37</td>
<td>0.19</td>
<td>552</td>
<td>0.003</td>
<td>15,697</td>
<td>12.31</td>
<td>40,893</td>
<td>4.72</td>
</tr>
<tr>
<td>Phase II</td>
<td>682,320</td>
<td>100,195</td>
<td>0.5</td>
<td>14,448</td>
<td>0.02</td>
<td>347</td>
<td>0.19</td>
<td>1,210</td>
<td>0.002</td>
<td>69,779</td>
<td>0.10</td>
<td>45,366</td>
<td>0.07</td>
</tr>
<tr>
<td>Phase III</td>
<td>75,957</td>
<td>96</td>
<td>0.001</td>
<td>2</td>
<td>0.00003</td>
<td>64</td>
<td>0.09</td>
<td>7,100</td>
<td>0.09</td>
<td>7,100</td>
<td>0.09</td>
<td>90</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Response times

- Site A
  - Call volume increased 20%, vehicle and personnel resources remained constant
  - Response time remained at 6 minutes
- Site B
  - Stable call volume and resources
  - Response times- 11:14/10:36/10:46 minutes

Crash Rates

- Site A
  - No serious/injury crashes during study period
  - One unavoidable crash due to a bridge obstruction
- Site B
  - 19 vehicle incidents in Phase I
  - 11 vehicle incidents in Phase II
  - None in Phase III

when a crash happens…. (Site A)

Unit 302 Crash data
**Direct Benefit**
- 20% cost saving in vehicle maintenance within 6 months.
- No increase in response times
- Fewer crashes and less severe crashes
- Sustained improvement in safety proxies, with no inservice or retraining after the initial introduction period.

**Extensive Indirect cost savings**
- Fewer out of service vehicles
- Improved transport times
- Decreased administrative lost in managing unsafe behaviors
- Decreased legal burden
- Automatic system wide data
- Insurance benefits

**Other monitoring devices**
- Primarily to record events during and immediately preceding a crash
- Give no driver crash prevention feedback
- Administratively burdensome
- Intrusive
- Not demonstrated to be as effective in improving vehicle maintenance costs or as effective in modifying driver behavior long term

**You want a system that works!!**
- Does the system really work
- Is it going to be a major burden on your staff to implement
- What are the real costs
- Are you going to have video of your company vehicle on you tube??

**Limitations**
- Need for categorization of ambulance crash severity, and for determining risk exposure rates for each driver.
- Determining a baseline profile of transportation safety challenges, system load and system wide safety hazards for each service is not yet well understood, limiting comprehensive comparative system performance analysis.

**Summary**
- Implementation well received by the providers.
- Both services demonstrated system wide major and sustained improvements in driver behaviour, safety performance and safety proxies over 18-40 months, with a 1,000 fold sustained improvement in distance travelled without breach of safety performance thresholds (speed, torque, seat belt use), a reduction in crash frequency and severity, and improved emergency response times.

**In a nutshell**
- The system works
- Objectively improved performance
- No increase in response times
- At fault accidents reduced
- Accepted into the culture
- However:
  - The system requires monitoring
  - Must be reinforced by management
  - Must be incentives for good performance
  - Must be consequences for poor performance

**Challenges: Its NOT a Black Box**
- ‘Black box’ has transportation wide negative connotations

**SO what is it ??**
- In vehicle telematics….?
- An in vehicle e-safety device….?
What does it really mean?

- Real time
- Feedback
- Alerts
- Warning
- Monitoring
- Penalty

Challenges

- Lexicon
  - Unstable lexicon relating to these devices is hampering dissemination
- How can the consumer make a sensible purchase decision if they don’t know what it is called or how to compare one device to another – and the researchers haven’t even worked it out yet!!

Integration with GIS/GPS

Quandry…?

- Being a silver bullet is clearly not enough…
- Cultural challenges
- Gap between what works and what is what consumers will want and seek
- Applications to special populations as target groups
  - Fleets
  - Recidivist
  - Adolescents

Business Case for Safety

- ROI
- How to make the business case for use of these type of transport/fleet safety interventions
- How to educate the consumer?
  Invehicle video monitoring has been successfully preferentially marketed broadly – absent any compelling or independent data and very high real costs of implementation

Management Incentives?

- Insurance benefits
- Tax incentives
- Grants

Additionally

- Ambulance services are a valuable model for evaluating this type of technology – given the nature of the fleet and its management

And…

- Safety researchers, emergency medical service providers and fleet managers should collaborate and consider use of these devices for both enhancing ambulance driver safety performance, and augmenting system wide ambulance transportation data capture.
Caution…

- Scope for confusion regarding the features and efficacy of these aftermarket devices
- Potential for conflicting types of alerts across platforms – with other aftermarket devices and also OEM features

In conclusion

- A technology based systems safety approach such as invehicle real-time feedback devices has been demonstrated to be highly effective in these settings.
- This high risk fleet setting may be an excellent model for evaluating ‘e-safety’ devices
- Applications for these aftermarket devices should be considered for high risk drivers (ie. adolescents) and other vehicle fleets.

Thank you!
Any Questions??
Electronic handout available online
http://www.objectivesafety.net