The Ride of Your Life:
Ambulance Transport Safety – The State of the Art

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- Recipient, International Society of Automotive Engineers, Women’s Leadership Award for EMS Safety

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

What are the transport safety issues that pertain to this important public service and public safety industry?
What do we know of the risks and hazards and how can we measure these?
How can the safety of this transport system be optimized?

The EMS Safety Foundation
www.EMSSafetyFoundation.org
brings this presentation to you

What we shall cover…
- Multimedia overview of safety statistics, demonstration of crash testing, and a review of what is on the horizon in ambulance safety development.
- An outline of strategies and new safety technologies to enhance occupant safety, highlight of important predictable and preventable occupant risks, and expose mythologies regarding safety practices and devices.

Things can go wrong – but when there are sound safety policies and technologies in place, and the system is well prepared, you can minimize harm

There are more safety standards for moving cattle than for moving patients

Your Interactive Handout awaits you online at…
- www.objectivesafety.net

This WILL be FAST!! No need to take any notes – all text slides will be awaiting you in your online Handout
2009 TRB Summit

- Brought together a spectrum of diverse expertise and representation:
  - Government agencies
    - National Highway Traffic Safety Administration (NHTSA)
    - Department of Transportation ITS (DOT)
    - National Transportation Safety Board (NTSB)
    - Federal Highways Administration (FHWA)
    - Federal Motor Carrier Safety Administration (FMCSA)
    - Bureau of Labor and Statistics (BLS),
    - Department of Homeland Security (DHS)
  - Teams
  - EMS State Directors
  - EMS Services
  - private and municipal from across North America
  - Fire/EMS
  - Volunteer EMS
  - EMS Physicians
  - Industry partners
    - EMS Equipment
    - Vendors/OEM and aftermarket
  - Academics
  - Technical experts
    - Automotive safety engineering
    - Occupant protection
    - Ergonomics and human factors.

The www.GlobalEMSForum.org
your public access gratis resource

The most valuable part of the EMS system is….

You…

- The least protected part of the system
- The part of the system with the least focus on safety and policy standards
- Minimal investment on your safety R&D

Yet…

- Tragedy you don’t want to be involved in
Dan E. Berry, P.ENG. (1948 - 1998)

- Dan Berry graduated in mechanical engineering from Queen's University, Ontario in 1972, embarking on a career in mining, transportation and EMS.
- In 1980, Dan joined the Emergency Health Services Branch of the Ontario Ministry of Health.
- In 1991, Dan initiated a series of projects to evaluate the handling, stability and crashworthiness of Ontario's ambulances as they relate to the safety and comfort of patients and paramedic crews.
- Frontal and lateral crash testing of van and modular ambulances was completed at Transport Canada facilities in Blainville, Quebec.
- Further safety improvements as the result of analysis of the extensive accident database and industry initiatives, principles of user survey feedback and research of industry initiatives.
- The ambulances now in operation in Ontario are a confirmation of the professionalism and innovative skills of Dan Berry.

Real world answers to real world questions -

- What features will enhance safety of my new vehicle purchase?
- What color scheme do I want on my vehicle to make it safest?
- Do I need a helmet, and if so which one?
- What policies offer the safest system?
- How do I get my team to address safety issues?
- What data should I collect when something goes wrong, and how to analyze it?

Some questions for you all:

- Have you ever been in a EMS crash?
- How many times?
  - 1
  - 2
  - More?
- Have you ever been hurt in an EMS crash?
- Do you know any one who has ever been hurt in an EMS crash?
- Do you know of anyone who has been killed in an EMS crash?

Firstly!

An accident?

or

a predictable and preventable event

A tragic emergency health care intervention outcome

It does happen….

A devastating tragedy…

- An ETT down the wrong hole may kill your patient and be a terrible burden for the pts family and for the medic involved
- BUT an EMS crash can kill all involved AND wipe out an EMS systems response capacity…….

Ambulance Transport Safety

- Emergency care, public health, public safety, and patient transportation.
- Important Principle: Ambulance transport safety is part of a system, the overall balance of risk involves the safety of all occupants and the public.
- All get home safely

In a nutshell

- Am here to try to save you
  - Lives
  - Time
  - Money
Safety oversight of what and by whom

- Vehicle Safety
- Vehicle Design
- Transportation systems safety
- Safety Equipment Design
- Vehicle and Safety Equipment Testing and Standard development
- Safety policies

October 2008 JEMS Article “Rig Safety – 911”

Is there an acceptable rate of morbidity and mortality for pre-hospital transport systems??

USA EMS data

In the USA:
- ~ 50,000 vehicles
- ~ 5,000 crashes a year
- One fatality each week
  - 2&3 pedestrians or occupants of other car
  - Approximately 2 child fatalities per year
- ~10 serious injuries each day
- Cost estimates > $500 million annually
- USA crash fatality rate/capita 35x higher than in Australia

USA EMS data

Is it your service’s tragic year?

- ~ 50 fatalities a year
- 15,000 EMS services
- Each year one in 300 services experiences a fatality

Creating a Safety Culture

within a company must start with upper management’s commitment to safety

- Awareness
- Training
- Incentive

Safety - Why now?

- Operating optimally in a transportation environment that is largely devoid of specific safety standards for the hazards and risks present
- Bridge the gap between what technical information exists and what is accessible and applied to EMS

the EMS transport process

- Communications/dispach
- Patient
- Restrainting device/seat
- Transporating device/gurney
- Paramedics/transport nurses, doctors & family
- Patient monitoring equipment
- Clinical care & interventions
- Protective equipment
- The vehicle
- The driver/driving skill
- Other road users
- The road

The Emergency Department (ED)
An ambulance is not an ED/ICU on wheels

What is a survivable impact?
E = ½ mv²  v² = 2as

~ 30 mph - survivable
~ 60 mph – not survivable

What is a survivable impact?

A survivable impact??

Thursday July 5th 2007…… Paramedic Allan Parson’s killed

Five Killed in Crash of Ambulance and Semi

2 weeks later… Friday July 20th 2007 The worst ambulance crash in USA history
June 17th, 2008
a paramedic and a patient killed

In this vehicle…

January 10, 2008

County News
AMBULANCE ROLLS, INJURING 4

Jan 28th, 2008

1 dead, others injured in Sussex crash involving ambulance

April 20, 2008 ??

This is not a crashworthy environment
October 31, 2008 - Kentucky

April 30, 2009 - Tennessee

August 2009 – Impaired…

October 22, 2009, TN

Patient and Provider killed, Attendant Critical

An interhospital transport
“Do no harm…”?

EMS Safety
  ▶ ‘patient safety’
  ▶ AND also
  ▶ ‘provider’ and ‘public safety’

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
Technical Safety Science should drive policy

Ambulance Safety Research: A New Field

We should use the best safety practices demonstrated in engineering

...in automotive safety engineering

2 most recent publications

October SAE – October 2009

and in ergonomics

Range of reach... This is a well defined technical science

Ambulance Safety Research: A New Field

Funding??
This IS a Transportation and Automotive Safety issue

Benefit of Safety

Any cost of addressing these issues is dwarfed in contrast to the huge burden of not doing so - in financial costs let alone the personal, societal, ethical and litigation costs.

Some odd facts

- Ambulances are generally not built by the automotive industry
- Intelligent Transportation Systems (ITS), transportation safety engineering is not generally integrated into EMS systems
- Although all EMS systems have medical direction and oversight, it is rare for there to be transportation expertise oversight

Unique workplace

- In vehicles
- At roadside and other emergency scenes

The ‘workplace’ IS a vehicle

- EMT’s often in vulnerable positions during transport.
  - Bench seat
  - Captain’s chair
  - Standing or kneeling

The ‘workplace’ is also a crash scene

Absence of standards and oversight

- Challenges in identifying best practice
- Myriad of unregulated commercial products
- No safety performance standards
- Absent national safety oversight

What we need to consider, where is the ‘bang for buck’ in ambulance transport safety:
C45 - A criminal offence to not act in a way that protects the worker


Canada - Corporate Manslaughter
Corporate Homicide Act: 8th April, 2008

1960 to 2009
A passenger vehicle - sure

A 'laundry or mail truck' - ??

A passenger vehicle – yes!

> “Ambulance transport has a death toll…..”
Carl Craigle EMT-P, Chief Platte Valley Ambulance

Ambulance/Daily News
Paramedic injured in crash is recovering

But what about head protection?

New EMS helmet prototypes for 2008-2009

It does happen....
So for EMS personnel...

- What’s going to kill you?
- What’s going to injure you?

**Ground Transport Safety IS Complex AND Multidisciplinary**

- Epidemiological Data Collection
- Ergonomic Research
- Biomechanical Automotive Safety
- Biohazard/Chem Research
- Communications technology
- Safety Technology
- Regulations and Standards
- Foot Safety Program

**Goals**

- Standards for safety
- Policy based on Science
- Databases to demonstrate outcome

**Ambulance Vehicle Standards??**

- KKK?
- AMD?
- FMVSS?
- CVSS?
- NFPA?
- SAE?

**What KKK-A-1822F, AMD and FMVSS state and don’t state...**

**USA KKK ambulance purchase specifications**

**GSA:KKK-A-1822F, Aug 2007**

- Specifications for the purchase of a Star of Life Ambulance
- Static Pull test
- 2200 Lbs. static stretcher test in longitudinal, lateral & vertical
- No dynamic test for vehicle, occupants or equipment
- No automotive test manikin
- Voluntary

**USA Ambulance Manufacturing Division (AMD) Ambulance Standards – August 2007**

- No dynamic or impact test
- No automotive test manikin
- Mandates NO 'crumple zone'
- No impact tested anchorages for occupant restraint or equipment
- Internal, not independent

**2009 USA ambulance ‘safety testing’ ?? Not consistent with accepted automotive safety practice...**

- [Website](http://www.ntea.com/WorkArea/downloadasset.aspx?id=1352)
- [Website](http://www.ntea.com/WorkArea/showcontent.aspx?id=1350)

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**USA KKK ambulance purchase specifications**

**GSA:KKK-A-1822F, Aug 2007**

**Ambulance Vehicle Standards??**

- KKK?
- AMD?
- FMVSS?
- CVSS?
- NFPA?
- SAE?
USA Ambulances: FMVSS Exemption

EMS Best Practice, Sept 2006

Patients must be in the over the shoulder harness, medics restrained in seat belts, equipment secured

What are the solutions?
- Training?
- Practice Policy?
- Transportation Systems Engineering?
- Automotive Engineering?
- Education of other road users???

Balance of concerns and risk during transport
- Response and transport time
- Clinical care provision
- Occupant safety/protection
- Public Safety

Safety Management
- A Safety Culture
- Protective Policies
- Protective Devices
  - To prevent a crash
  - In the event of a crash
- Continuous Education and Evaluation

And very Predictable...
- Intersections are lethal environments

So... The real world for an EMS vehicle approaching a red light
- You think they heard you....
- You know they must have seen you..
- And maybe they did
- ...... But...
- There is NO way humanly possible that they could stop.....

The real world
Intersection passenger car stopping distance*
at 40 mph dry and wet

* Stopping distance: Perception time + Reaction time + Vehicle braking time (varies with age, skill, agility, alertness + vehicle type, the pressure, road etc)
Testing the real world

The Crash Event - Crash Testing

- An introduction
- What one needs to know
- What do the tests really mean
- And, what tests are meaningful

Intrusion vs Deceleration

- Intrusion
  - vehicle to vehicle or vehicle to fixed narrow object
- Deceleration
  - sudden stop – ie. sled test

Intrusion

Deceleration

Dynamic Safety Testing

- requires sophisticated, expensive equipment
- measurably demonstrates forces generated during collision
- accepted international standard for vehicle restraint systems

Dynamic Sled Testing of Ambulance Pediatric Restraints

If we know this – and its published....

Why do we do this?

Pre crash sled test configuration
(view of squad bench)

Uninstrumented
unrestrained SID

Uninstrumented
restrained CTD

"man saver" device

Post impact (from rear door)

Test 1 – Right side impact

What is actually happening
during an ambulance crash

Johns Hopkins University

1 – Target vehicle,
Type I ambulance

2 – Bullet vehicle,
Type II ambulance

Closing speed 44 mph
And this all takes place in 60 millisecs – the blink of an eye

‘Safety’ approaches being driven by manufacturers claims and sales rather than by science and data

A few key words about restraint systems...
PPE from the stationary environment can be highly hazardous in the automotive setting.


Side facing 4-point harnesses demonstrated to be lethal, even at slow ground vehicle speeds.


Side facing 4-point harnesses demonstrated to be lethal, even at slow ground vehicle speeds.

USA 2004, NIOSH Head strike zone hazards

Being seated IN an automotive seat is what will protect you

- Anything that allows or encourages you to get up out of your seat will also encourage you to be injured or killed – it is potentially lethal to be out of your seat in any fashion
- 4 or 5 point harnesses for side-facing occupants are potentially lethal – and is in NO WAY SUPPORTED BY ANY DATA OR AUTOMOTIVE SAFETY EXPERTISE

Rash of “Safety Concept” vehicles…..

Devoid of substantive automotive safety engineering input or testing

Yes, the ride of your life…. 

- Sure… these vehicles all parade around the EMS and Fire shows
- BUT…
- NOT ONE of these vehicles has been to the automotive safety shows or scrutinized by the automotive safety industry

Systems safety failure AND dangerous

Overwhelming existing evidence these practices are HIGHLY dangerous

NO evidence whatsoever that these practices are NOT dangerous let alone safe

Airbags in the back??
Airbags in the back?? .... Absent adequate crash and injury biomechanics data, or safety testing standards or occupant positioning data.... ARE CONSIDERED HIGHLY HAZARDOUS BY AUTOMOTIVE SAFETY EXPERTS

Increasing awareness ...

What do we know now??
- Intersection crashes are the most lethal
- There are documented hazards, some which can be avoided
- Occupant and equipment restraint with standard belts is effective. (Over the shoulder harnesses for patients should be used, with the gurney in the upright position where medically feasible)
- Some vehicle design features are beneficial - automotive grade padding in head strike areas, seats that can slide toward the patient
- Electronic Driver monitoring/feedback systems appear to be highly effective
- Head protection??

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

Increasing awareness ...

What about changing driver behavior in the real world??

Innovation

Safety concepts out there now
- Driver feedback technologies
- Tiered dispatch
- Enhanced ambulance vehicle design
- Intelligent Transport Technologies - ITS
- New Safety Standards

What about changing driver behavior in the real world??

Purpose of ‘Feedback box’ Program
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

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

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
- Auditory feedback of warning ‘growls’, and penalty tones
- Data downloaded automatically every day
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

Demonstrated Effectiveness

MEMS MONTHLY OVER SPEED VIOLATION TREND 2003/2004

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And when a rare crash happens….

Unit 302 Accident

A key to safe ambulance transport

Monitoring and feedback devices

- Implementation well received by the providers.
- 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??

- Do you want graphic images of the crashes your investment DID NOT HELP YOU AVOID???

- The jury is out on
  - Opticon
  - Simulators

Resource availability and allocation technologies

Safe Practices for Fleet Motor Vehicle Operations
What Z15 encompasses

- Safety Program
- Safety Policy
- Responsibilities and Accountabilities
- Driver Recruitment, Selection and Assessment
- Organizational Safety Rules
- Orientation and Training
- Reporting Rates and Major Incidents to Executives
- Oversight

 Visibility and lighting issues

Hmm...

So why is it...

- That the EMS providers -
  - Wore navy blue – one of the most difficult colors to see at night
  - Had no protective clothing, when other emergency personnel at the scene did
  - Had no head protection, when other emergency personnel at the scene did???

It's not like this outside of the USA

News we don't want to see

Worker visibility Act:
November 24th 2008

Day visibility

Night visibility

Caught On Video: EMT Struck By Car

Day visibility

Night visibility
Here’s the real world at 6 ft...

Policy and practice ignorant of existing technical safety data

This addresses some very real risks, very creatively – and currently ONLY available in London Ontario!

Color-blindness affects 10% of the population

Emergency Vehicles – Viewer Awareness

For a timely, appropriate and safe response

- Location
- Size
- Shape
- Speed
- Intended path
Having access to that technical knowledge supports changes to improve safety practice.

From this….. to this

Another excellent example - From this to … this!

Summit County EMS - Colorado
Old vehicle
New yellow vehicle markings
Staff use lime-green vests & jackets

Muskoka EMS - Canada
Old design
New design

Muskoka EMS - Canada
Old design
New design

August 2009 – Visibility review

Key Findings /Opportunities are basic sound practise

1. First step toward developing informed guidelines
2. A generalised report with an underlying awareness of numerous political & multi-agency sensitivities
3. Embraces operational diversity (Fire, Police, EMS)
4. Recognises US & selected international research
5. Key Findings /Opportunities are basic sound practise
6. BUT...
7. Generalisation can lead to misinterpretation of detail
8. Many photos in the report display real-life examples of poor design & practise

Comments on the Study - John Killeen
Succeeds in focusing the future direction of conspicuity research and practice for all US states and other countries

1. Importance of contour markings – especially the difference between research in USA & Canada + benefits of solid colors

2. Battenburg and chevrons – effectiveness is unproven due to lack of research and possible cross-cultural misinterpretation

3. Need for standardisation of colors for rear chevrons

4. A balanced approach in the use of fluorescent and retro-reflective markings + the possibility of visual overload

But whatever color .... if you run a red light someone will be killed

International approaches

1. The state of the art non-USA vehicles have NO squad bench nor the after market structural vehicle modifications that can potentially decrease crashworthiness integrity that were seen in study vehicles.

The EMS Safety Foundation
Intro and Logistics Webinars from December 11th 2007 & Jan 8th 2008
EMS Safety Foundation tab at www.objectivesafety.net

EMS Safety Foundation Delegation bringing Rettmobil to you

Wayne Zygowicz, Advisory Board, Littleton Fire/EMS, Colorado & JEMS

Vehicle Occupant Safety design

European design

Safety technology is a key focus
Safe and Ergonomic design

Ergonomic layout and equipment

Flexibility to manage two patients

High speed crash, rolled and the occupants (patient and medics) had only minor scratches

Outline to cover

- Sprinter Features
- Sprinter Active Safety
- Sprinter Passive Safety
- Sprinter Customer Assurance Program
- Sprinter Engineering Contacts

Accessibility

Unique interior compartment accessibility of any full size van

- 20 inch side step (lowest height in the segment)
- 27 inch load floor (lowest height in the segment)
- 18 3/4 inch rear bumper step pad height

Sprinter Features Summary

Market Exclusives

- Available left side sliding door
- Premium CDI turbo Diesel engine with SCR technology to meet the EPA, CARB 2010 emission standards.
- Best in class cargo capacity
- Best in class wheel-to-wheel turning diameter
- Best in class available payload capability
- Superior safety standard with ABS, ASR, BAS, ESP and 2 point seat belts on all passenger seats
- Most versatile commercial van on the market
If a collision exceeds a preset threshold, the ETDs instantly remove...
Ergonomic layout and equipment

Awkward tasks? Develop solutions!

Operating in an environment where many aspects of safety are still devoid of safety standards – requires technical knowledge and understanding

this vehicle is safety crash tested by automotive experts

Unlike this vehicle

So….

- Which vehicle do you want to be in?
- Which vehicle is the best for efficient, and effective patient care?
- Which vehicle provides optimal risk management?
- What is the optimal fleet mix?

Were we safer in the Cadillac???

Fleet Mix?
“Ripoff and Duplicate”

- Avoid reinventing the wheel at all costs
- Where are the best practices that we need to transfer knowledge from

Transportation Research Board is an excellent resource... we should be using it!!

Tips for Emergency Vehicle Operations

USFA Emergency Vehicle Safety Initiative

Traffic Incident Management Systems (TIMS)

Released April 2008
- FEMA, USFA, IFSTA
- Covers setting up safe roadway incident work areas and using unified command at these incidents

National Academies TRB Ambulance Transport Safety Summit October 29, 2009

Risk/Hazards

- Predictable risks
- Predictable fatal injuries
- Serious occupational hazard
- Public safety hazards

What you can do now

- Have a written and implemented 'safety program'
- Secure all equipment
- Secure occupants with standard belts
- Don’t drive through red lights/stop signs
- Use properly implemented “Feedback Boxes”
What do we know works...

- Vehicle Operations Safety Policies
- Squad bench lap seat belts
- Patient over the shoulder belts
- Securing equipment
- Forward and rear facing seating
- Some electronic technical devices
- Safety awareness
- Cultural change

Important Principles!

1. A culture of safety
2. Drive cautiously
3. Wear your belts & restrain all occupants
4. Secure all equipment
5. Integrate scientific data into your policies and procedures

- Unrestrained occupants and equipment are a potential injury risk to all occupants

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

Small changes can make a BIG DIFFERENCE

- PREPARE – TEACH – REACH – RESPOND
  - Look at your own safety record
  - Teach safety and hazard awareness
  - Reach out with safety information to all your EMS providers
  - Respond with the best safety practices

Predictable Preventable and NO ACCIDENT

Conclusion

- EMS transport has serious hazards and safety issues
- Major advances in EMS safety research, infrastructure and practice over the past 5 years
- New technologies for vehicle design, occupant PPE and equipment restraint and driver performance are now available
- Development of substantive EMS safety standards is a necessity and a reality
- Failure to transfer knowledge from transportation and automotive safety is unacceptable and dangerous
- EMS is still way behind the state of the art in vehicle safety and occupant protection

And....

- It is no longer acceptable for EMS to be functioning outside of automotive safety and PPE safety standards for prevention of and protection of EMS providers and the public from injury and death

Thank you!

Any Questions??

Electronic handout available online
http://www.objectivesafety.net