“Emergency Vehicle Safety: Who’s Safe in Your Rig?”
What you need to know about Ambulance transport safety

Nadine Levick, MD MPH
CEO, Research Director
EMS Safety Foundation
Objective Safety LLC

Ohio Critical Care Transport Symposium, Vision Zero
Akron, Ohio March 23-24, 2007

A tragic emergency health care intervention outcome

This week...

This week too ...

EMS Safety Crisis

“Chinese” word for ‘crisis’ (危機) is made up of the words ‘danger’ (危) and ‘opportunity’ (機)

Firstly, the DANGER...

- EMS has a transportation safety record worse than any other vehicle on the road per mile traveled
- The state of EMS transport safety research is an EMBARRASSMENT
- Lags at least 30 years behind general automotive safety research NOT EVEN ON THE PLAYING FIELD of state of the art automotive safety research
- ‘Reinventing the wheel’ – should be avoided at all costs

Then, The OPPORTUNITY

- This is vehicles and transportation, and this is vehicles and transportation safety
- Vehicle and transportation safety technology and infrastructure exists
- Ditto drivers, and driver safety technology
- Collaboration, and the multidisciplinary model
- Optimal use of very scarce resource

Outline

I. Review of data on ambulance crashes and ground transport safety
II. Review of safety standards and guidelines that exist for the ground EMS and patient transport environment and update of latest safety developments
III. Identification of ground transport safety issues, hazards and areas of risk patients and EMS providers and profile new safety technologies.
IV. Strategies to enhance safety and reduce risks of injury during ground EMS and patient transport
This month in Graz, Austria

Buffalo, USA

Some recent adverse outcomes

Fatalities and funerals

Last week…. 

http://www.objectivesafety.net

A few weeks ago in New York

Major deal….
Last month... 

"Do no harm..."?

August 16th...

August 22, 2005....

Firstly!

An accident ?

or a predictable and preventable event

An ‘Accident’....?

So....

EMS Best Practice, Sept 2006
Best Practice...? The technology described in your junk mail is far more advanced than that used in EMS

Ambulance Safety Research: A New Field

We should use the best safety practices demonstrated in engineering

and in ergonomics

Predictable risks

Risk Exposure Rates

and what is killing EMS?

EMS personnel fatalities

EMS Injuries

Higher than the injury rate for any private industry published by DOL

A word about occupational transportation fatalities

EMS personnel fatalities

EMS Injuries

More often at intersections, & with another vehicle (p < 0.001)*
Most serious & fatal injuries occurred in rear (OR 2.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)**
42% of fatally injured EMS rear occupants unrestrained***
74% of EMS occupational fatalities are MVC related****
82% of fatally injured EMS rear occupants unrestrained**
> 74% of EMT occupational fatalities are MVC related***
Serious head injury in >65% of fatal occupant injuries#
70% of fatal crashes EMS crashes during Emergency Use##

More likely to crash at an intersection with traffic lights (37% vs 18% p=0.001) & more people & injuries/crash than similar sized vehicles##

Development and application of a dynamic safety-framework for ambulance transport patients, systems & environment

Crashes per 100 million miles

Type of vehicle

Automobile
Light Truck
Large Truck
Motorcycle
Urban Ambulance (Biggers et al. 1994)

90
80
70
60
50
40
30
20
10
0

0
500
1000
1500
2000
2500
3000
3500

FARS 2003 DATA & Biggers et al 1994

Higher than the injury rate for any private industry published by DOL

1.5 x that of fire fighters
5.8 x that of health services personnel
7 x the national average

and what is killing EMS?

 EMS personnel fatalities

- 74% transportation related
  - 1/5 of ground transport fatalities were struck by moving vehicles
  - 11% were cardiovascular
  - 9% were homicide
  - 4% needle sticks, electrocution, drowning and other


EMS personnel fatalities

- 74% transportation related
  - 1/5 of ground transport fatalities were struck by moving vehicles
  - 11% were cardiovascular
  - 9% were homicide
  - 4% needle sticks, electrocution, drowning and other


EMS Injuries

- Higher than the injury rate for any private industry published by DOL
- 34.6 injuries/100 fulltime workers per year
- 1.5 x that of fire fighters
- 5.8 x that of health services personnel
- 7 x the national average

USA EMS
- EMS Systems - >15,000
- Personnel - ~1 million
  (~30% F/T professional & 70% volunteer)
- Vehicles - ~50,000
  (Type I, Type II, Type III, Freightliners, ?motorcycles)
- Transports - ~50 million
  (to Emergency Depots - 50%, < 15 emergent)
- Cost - ~$8 Billion annually
- Safety Oversight - ? Disparate

Safety oversight of what and by .... whom
- Vehicle Safety
- Vehicle Design
- Safety Equipment Design
- Vehicle and Safety Equipment Testing and Standard development
- Safety policies

USA EMS
- EMS Systems - >15,000
- Personnel - ~1 million
  (~30% F/T professional & 70% volunteer)
- Vehicles - ~50,000
  (Type I, Type II, Type III, Freightliners, ?motorcycles)
- Transports - ~50 million
  (to Emergency Depots - 50%, < 15 emergent)
- Cost - ~$8 Billion annually
- Safety Oversight - ? Disparate

Safety oversight of what and by .... whom
- Vehicle Safety
- Vehicle Design
- Safety Equipment Design
- Vehicle and Safety Equipment Testing and Standard development
- Safety policies

A Simple Question....

The NTSB

FMCSA's Objectives
- Produce Safer Drivers:
- Improve Safety of Commercial Motor Vehicles:
- Produce Safer Carriers:
- Advance Safety Through Information-Based Initiatives:
- Improve Security Through Safety Initiatives:
- Enable and Motivate Internal Excellence:

- EMERGENCY MEDICAL SERVICES DISPATCH SERVICES
- EMERGENCY MEDICAL SERVICES PARTNERSHIPS
- PRE-HOSPITAL TRAINING PROGRAMS
- ROAD CONDITION AND INCIDENT RESPONSE

EMERGENCY MEDICAL SERVICES DISPATCH SERVICES
- Increase the participation and role of Regional EMS Councils in local and regional highway traffic safety boards and/or organizations

EMERGENCY MEDICAL SERVICES PARTNERSHIPS
- Increase the participation and role of Regional EMS Councils in local and regional highway traffic safety boards and/or organizations

PRE-HOSPITAL TRAINING PROGRAMS
- Increase education and involvement of EMS providers in principles of appropriate traffic safety techniques
- Develop and implement ambulance traffic safety protocols at state, regional and service level
- Study the performance of ambulance traffic safety protocols to identify those that may contribute to injury resulting from the impact of ambulance crashes
- Identify methods to provide incentives for adoption by EMS services of protocols that enhance traffic safety
- Partner with organizations that provide public driver awareness and education campaigns to improve driver awareness of driver responsibility and appropriate response to approaching emergency vehicles

ROAD CONDITION AND INCIDENT RESPONSE
- Provide a placeholder for regional and/or county EMS representatives in municipal DOT emergency management plan development and implementation


EMS RESPONDER CRASH PREVENTION
- Undertake a systematic review of other state actions and protocols on responder crash prevention to determine best practices and provide funds to EMS providers in the use of these protocols and develop their use by EMS providers in the use of these protocols
d- Increase education and involvement of EMS providers in principles of appropriate traffic safety techniques
- Develop and implement ambulance traffic safety protocols at state, regional and service level
- Study the performance of ambulance traffic safety protocols to identify those that may contribute to injury resulting from the impact of ambulance crashes
- Identify methods to provide incentives for adoption by EMS services of protocols that enhance traffic safety
- Partner with organizations that provide public driver awareness and education campaigns to improve driver awareness of driver responsibility and appropriate response to approaching emergency vehicles

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
- communications/dispatch
- the patient
- restraining device/seat
- transporting device/vehicle
- patient monitoring equipment
- clinical care & interventions
- protective equipment
- the vehicle
- the driver/driving skill
- other road users
- the road

EMS Transport Safety IS Complex AND Multidisciplinary

- Epidemiological Data Collection
- Ergonomic Research
- Biocomposite Automotive Safety
- Biomedical/Chemical Research
- Communications Technology

The EMS transport process

- EMS Safety
- Risk Management
- Public Safety
- EMS Policy
- PPE
- Driver Training
- Fleet Safety Program

This is not acceptable
- In the USA:
  - ~ 5,000 crashes a year
  - ~10 serious injuries each day
  - ~2/3 pedestrians or occupants of other car
  - ~100 serious injuries per year
  - Cost estimates > $500 million annually
  - USA crash fatality rate/capita 35x higher than in Australia

Occupational Health and Safety.....?

- This IS an Automotive Safety issue
Is it your services tragic year?

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

Key Issues

- Mythology
  - The Emergency Medical Service personnel are safe
- Injury Hazards
  - Radiation
  - Chemical/Radiation
  - Physical/Mechanical trauma – THE BIG PROBLEM
- Motor Vehicle Crashes are the highest cause of death at work – EMS has > 2X the mean national rate

An R & D and Regulatory Gap

- Occupational Health and Safety
  - the workplace is in a vehicle – exposure data are scant
- Automotive Safety
  - 'exempt' from automotive research and regulation

What’s missing

1. What data is collected nationally?
   - We have no denominator data
   - We have incomplete numerator data
   - Absent population based national injury data or injury mechanics data
   - Absent structured transportation safety engineering input
   - 1 + 2 + 3 = resultant inability to design and evaluate efficacy of injury interventions
   - What oversight is there?
   - Which organizations would determine policy?

EMS Research/Data Vacuum

- ? total no. of ambulances
- ? total no. of medics
- ? total no. of runs (per age & severity)
- ? total pt. miles (per age & severity)
- ? true crash fatality rate per mile
- ? crash injury rate
- ? adverse events

Haddon/Baker/Runyan Phase-Factor Matrix as applied to EMS Safety

National EMS Information System

“Nation’s Emergency Care System is fragmented, unable to respond to disasters”, says Institute of Medicine, June 14, 2006

Balance of concerns and risk during transport

- Response and transport time
- Clinical care provision
- Occupant safety/protection
- Public Safety
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.

This is about you and your safety

What safety practices do you use??
• Seat belts ?
• EVOC training ?
• Equipment lock down ?
• Helmets ?
• “Black Box” technology ?
• Tiered dispatch ?

NAEMT July 2006 Position statement

Tips for Emergency Vehicle Operations

The truck and bus industry is on the right track.... Where is EMS??

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

Active Projects (all due early 2007)
• Commercial Motor Vehicle Driver Training Curricula and Delivery Methods and Their Effectiveness
• Commercial Motor Vehicle Carrier Safety Management Certification
• The Role of Safety Culture in Preventing Commercial Vehicle Crashes
• The Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers
• Health and Wellness Programs for Commercial Motor Vehicle Drivers

Federal Highway Administration

• Consequences can be predictable & likely preventable
• Costs of these adverse events are high in loss of life, financial burden and negative impact on delivery of EMS care
• Other high speed vehicles (eg. racing cars) have a different safety paradigm
• Design of interventions to mitigate injury is predicated on a valid testing model
• Complex both engineering and public health issues

EMS Transport General Concerns
and who’s life was he racing to save?

NASCAR, Car of tomorrow ready to go
USA Today – March 23rd, 2007

Background: USA Problems
- No reporting system or database specifically for identifying ambulance crash related injury
- No occupational and health safety standards to protect providers from injury
- Rear passenger compartment, > 60cm behind driver - exempt from Federal Motor Vehicle Safety Standards (FMVSS)

USA Ambulances: FMVSS Exempt

Predictable

Very Predictable...
- Intersections are lethal environments

“Are our policies killing people?”
- 1991-2000, 302,969 Emergency vehicles were involved in MVCs - 1,565 involving fatalities*
- In PA 1997-2001, ambulances were more likely than similar sized vehicles to be involved in:
  - 4 way intersection crashes (43% vs 23%, p=0.001)
  - Collisions at traffic signals (37% vs 18%, p=0.001)
  - MVCs with more people injured (76% vs 61%, p=0.001)

*Comparison of crashes involving ambulances with those of similar sized vehicles – Adam Ray, Douglas Kupas, PEC Dec 2005, 9:412-415
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

- Perception + Reaction time + Vehicle Braking time

<table>
<thead>
<tr>
<th>Condition</th>
<th>Vehicle Braking Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Stopped at 176 ft</td>
</tr>
<tr>
<td>Wet</td>
<td>Stopped at 220 ft</td>
</tr>
</tbody>
</table>

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

911 Call to Hospital/ED Definitive Care Time Intervals*

- Emergency Occurs
- 911 contacted
- EMS vehicle dispatched
- EMS arrives on scene
- EMS leaves scene
- EMS arrives at ED
- EMS bay
- Hospital/ED definitive care

*Not drawn to scale

Vehicle related transport time
EMS response to the scene

Some challenges
- No accepted national safety standards for -
  - EMS fleet management or safety practice
  - Ambulance vehicle rear compartment design and performance
  - Provider occupational injury protective equipment
- Yet convincing data for injury risk and hazard
- Need for patient, provider and public safety focus

Increasing awareness ...

- 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??

What do we know now??
No need to reinvent the wheel...

'Workplace' Hazards

It does happen....

But what about head protection?

Role of a head protective device

- A simple, immediate and inexpensive adjunct – a protective device -
- To protect occupants from hazardous interiors
- As vehicle crashworthiness design advances
- As driver training advances
- For when equipment becomes unsecured
- As EMS Safety Standards are developed, for both EMS vehicles and EMS occupational safety

Hmm...

So why is it...

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

It isn’t like this outside of the USA
This looks cool AND SAFE!

Global EMS Vehicle Safety Standards v Specifications and Guidelines
- EMS Safety and Performance Standards
  - Australia & New Zealand 4535
  - Common European Community (CEM) EN1789
- Non EMS Specific, USA Standards
  - [Aviation: FAA/CAA/JAA]
  - Z15 – Fleet vehicles safety management
- USA EMS Specification & Guidelines
  - Purchase Specification: KKK & NTEA – AMD
  - Guideline: EMSC Dos and Don’ts
  - ABTM, CAAS and CAMFS

USA ambulance purchase specifications
- Static Pull test
- 2200 Lbs. (8G’s) in Longitudinal and Lateral
- No dynamic test
- No definition to manikin mass
- No restraint for equipment
- Voluntary

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

Legal Perspectives on Z.15

Hot off the press... from the IFAC and USFA

Dynamics of Fleet Safety - NSC

Automotive Injury Triangle and Safety Development

<table>
<thead>
<tr>
<th>Host</th>
<th>Field Data &amp; Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology development</td>
<td>Voluntary initiatives Regulatory initiatives</td>
</tr>
<tr>
<td>Configurations</td>
<td>Environment</td>
</tr>
</tbody>
</table>
Protective devices/concepts
- To prevent a crash
  - Driver feedback
  - Driver monitoring
  - Driver training
  - Vehicle Intelligent Transportation System (ITS) Technologies
  - Tiered dispatch
  - Appropriate policies

In the event of a crash
- Vehicle crashworthiness
- Seat/seat belt systems
- Equipment lock-downs
- Padding
- Head protection

Tiered Dispatch

Intelligent Transport Safety Systems

In the event of a crash
- Vehicle crashworthiness
- Seat/seat belt systems
- Equipment lock-downs
- Padding
- Head protection

Back up Camera..... Shouldn’t all vehicles have one of these?

The “Black 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

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

The “Black Box” –
A transportation safety monitoring and feedback device

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
Demonstrated Effectiveness

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.

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

The jury is out on
- Opticon
- Simulators

Data, but is it generalizable

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

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

Foldable

Full Vehicle Crash Tests
- Test 1 - Right side impact
- Test 2 - Frontal
Automotive Safety PPE
- Automotive restraint in the EMS environment is a specialized form of PPE
- Ergonomic or Occupational Health and Safety expertise is key to workplace safety – but is outside of expertise with a history of automotive crash safety or vehicle/restraint safety testing
- The automotive safety industry is THE industry where the safety of devices that are for the protection of occupants in a moving vehicle, are best evaluated

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 sidefacing occupants are potentially lethal – and is in NO WAY SUPPORTED BY ANY DATA OR AUTOMOTIVE SAFETY EXPERTISE

Were we safer in the Cadillac???

Air EMS is a role model for safety initiatives and focus

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

EMS Risk/Hazards
- Predictable risks
- Predictable fatal injuries
- Serious occupational hazard
- Public safety hazards
Safety Management
- A Safety Culture
- Protective Policies
- Protective Devices
- In the event of a crash
- To prevent a crash
- Continuous Education and Evaluation

Creating a Safety Culture
within a company must start with upper management’s commitment to safety
- Awareness
- Training
- Incentive

An excellent model

Australia, Melbourne

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

NSW, Australian vehicles

Unidentified Firefighter Fatalities in the United States in 2005

Newborn Emergency Transport Service (Victoria)

In the event of a crash...
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?

Safety Enhancements Being Implemented

- EVOC
- Tiered dispatch
- Monitoring & Feedback devices
- Helmets
- Optimized ambulance vehicle design
- New Policies and Standards

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, equipment restraint and driver performance are now available
- Development of substantive EMS safety standards is a necessity and a reality
- Enhanced cross-disciplinary collaboration in development of safety initiatives now exist

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