EMS Transport: Where is the State of the Art and Where Should It Be?

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Science behind Policy

“For successful technology, reality must take precedence over public relations, for Nature cannot be fooled.”
Richard P. Feynman 1988

Outline

I. Review of data on ambulance crashes and safety standards and guidelines that exist for the ground EMS
II. Identification of ground EMS transport safety issues, hazards and areas of risk to patients, providers and public
III. Highlight unacceptable mythology and challenges to advancing EMS transport safety
IV. Profile innovation, new safety technologies and strategies and knowledge transfer to enhance safety and reduce risks of ground EMS and patient transport

In a nutshell

Comprehensive perspective on:
- system wide data
- the challenges
- the cutting edge
- the gaps in knowledge and application of transportation systems safety in the big picture of Emergency Medical Services transportation

Interactive handout
http://www.objectivesafety.net

Emergency Medical Service Transport

- 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?

Recent adverse EMS transport outcomes

- Ambulances are generally not built by the automotive industry
- Intelligent Transportation Systems (ITS), transportation safety engineering and transport systems engineering are 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

Some odd facts

- Ambulances are generally not built by the automotive industry
- Intelligent Transportation Systems (ITS), transportation safety engineering and transport systems engineering are 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
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......

A tragic emergency health care intervention outcome

It does happen....

New York.....

Major deal....

This month....

Last month ......

“Ambulance transport has a death toll....”

Carl Craigle EMT-P, Chief Platte Valley Ambulance

...May 25th 2007?
EMS Transport Safety is complex and multidisciplinary.

An interhospital transport? “Do no harm…”?

An ambulance involved in a crash; patient pronounced dead at scene.

EMS Safety
- Risk Management
- Public Safety
- EMS Policy
- EMS
- Ergonomic Research
- Biomechanical
- Automotive Safety
- Driver Training
- Fleet Safety Program
- Communications Technology
- EMS Research
- Repatriation and Transfer

Firstly!

- An accident?
- or a predictable and preventable event

An ambulance is not an ED / ICU on wheels.

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

August 16th...

August 22, 2005...

Deadly Ambulance Accident

An accident involving an ambulance and a patient being transported from a hospital.

An ambulance involved in a crash; patient pronounced dead at scene.

An ambulance involved in a crash; patient pronounced dead at scene.

An ambulance involved in a crash; patient pronounced dead at scene.

An ambulance involved in a crash; patient pronounced dead at scene.
Transport oversight?

- In contrast to the bus and truck industries, which have:
  - comprehensive safety oversight
  - transportation safety interventions
  - transportation safety data captured via the Federal Motor Carrier Safety Administration (FMCSA)

- EMS has been focused more as an acute health care delivery and emergency medical service and largely outside of much of the other transportation oversight infrastructure that exists.

Knowledge Transfer?

- Active Projects (as of 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

What are the solutions?

- Practice Policy?
- Training?
- Transportation Systems Engineering?
- Automotive Engineering?
- Education of other road users???

Unique workplace

- In vehicles
- At roadside and other emergency scenes

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%, < 1/3 emergent)
- Cost - ~$8 Billion annually
- Safety Oversight - ? Disparate

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

The National Transportation Safety Board (NTSB)

A Simple Question....

- 1960 to 2007
  - A passenger vehicle - sure
  - A laundry or mail truck??
UPS and Laundry trucks have very similar design and even more stringent safety requirements to EMS vehicles BUT very different cargo......

People are passengers and NOT packages or parcels

The first and only published scientific text on ambulance crashes (1995) ... and by an optometrist

The first and only technical symposium 2001

Key Issues
- Mythology
  - That Emergency Medical Service personnel are safe
- Injury Hazards
  - Illness
  - 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
    - Emergency Vehicles
    - \textit{Emergency Vehicles} – design data are scant
  - Automotive Safety
    - \textit{Emergency Vehicles} – “exempt” from automotive research

Challenges to Optimizing EMS Transport Safety
- Disparate and fragmented safety infrastructure
- Lack of a centralized EMS Safety oversight or data
- A large number of small groups of end users, with a mix of volunteers and professionals
- Ambulances are hybrid non-standard vehicles, a truck chassis and an after market box or a modified van
- EMS vehicle safety is not integrated as a part of the transport safety industry
- Rear compartment exempt from FMVSS
- Complex automotive safety area bridging acute clinical care, public health, public safety and automotive safety
- Very recent history as a research issue
- Limited fiscal support for cross disciplinary EMS transport safety research

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

'Workplace' Hazards
It does happen....

But what about head protection?

Attitudes to Head Protection in EMS

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

New EMS helmet prototypes for 2006-2007

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???

EMS Best Practice, Sept 2006

Goals

- Standards for safety
- Policy based on Science
- Databases to demonstrate outcome
This is not acceptable

In the USA*
- ~ 5,000 crashes a year
- ~ One fatality each week
- ~ 2/3 pedestrians or occupants of other car
- Approximately 4 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 and Fire Vehicles

Minimum Annual Fatalities
1995 - 2005

Ambulance Safety Research: A New Field

EMS Provider Fatalities

- 12.7 fatalities/100,000 EMS workers
- Greater than 2x the national average (5.0 fatalities/100,000)
- Similar to Police (14.2/100,000) and Fire Fighters (16.5/100,000)

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

So does it make sense?

- Gloves and universal precautions?...
  ... good biohazard protection BUT aren’t going to give much protection in a ambulance crash

Occupational Health and Safety.....?

- This IS an Automotive Safety issue

Occupational transportation fatalities...

Predictable risks

- Fatal crashes more often at intersections, & with another vehicle (p < 0.001)
- 70% of fatal crashes EMS crashes during Emergency Use
- Most serious & fatal injuries occurred to rear (OR 3.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)
- 82% of fatally injured EMS rear occupants unrestrained
- 84% of fatal occupant fatalities are MVC-related
- 70% of fatal crashesEMS during Emergency Use
- Most serious & fatal injuries occurred in rear (OR 2.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)
- 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
- More likely to crash at an intersection with traffic signals (31% vs 16%; p<0.001) & more people & injuries/crash than similar sized vehicles

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

Global EMS Standards

- Australia & New Zealand ASA 4535
- Common European Community EN1789
- 'USA KKK & NTEA – AMD'
  [Aviation - FAA/CAA/JAA]
- CAMTS
- CAAS
- International Joint Commission on Medical Transport
- ANSI/ASSE Z15

USA ambulance purchase specifications
GSA:KAA-182Z, 2002

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

Some KKK spec info

- Text detail:
  - 151 lines of text, 2 tables and a diagram, over 5 pages
  - preparation of painting, color and markings
  - 167 lines of text, 1 table, over 3 pages
  - protection of patients and crew
  - 31 lines of text
- USA Ambulances: FMVSS Exempt

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- [Aviation - FAA/CAA/JAA]
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FMVSS exempt……

ASTM F 1086 - 94

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

Z15 Incident Rates
- Incident rate based on number of vehicles operated:
  \[ \text{Incident rate} = \frac{\text{Number of incidents}}{\text{Number of vehicles}} \times 100 \]
- Incident rate based on vehicle mileage:
  \[ \text{Incident rate} = \frac{\text{Number of incidents}}{\text{Vehicle mileage}} \times 1,000,000 \]
- Injury incident rate based on vehicle mileage:
  \[ \text{Injury incident rate} = \frac{\text{Number of incidents with injury}}{\text{Vehicle mileage}} \times 1,000,000 \]
- Incident rates based on service activity:
  \[ \text{Injuries per 10,000 transports} = \frac{\text{Number of incidents}}{\text{Number of transports}} \times 10,000 \]
- Vehicle injury rates based on work hours:
  \[ \text{Vehicle incidents per 200,000 hours} = \frac{\text{Number of incidents}}{\text{Number of hours worked}} \times 200,000 \]

Legal Perspectives on Z.15

EMS Transport Safety
- ‘patient safety’
- AND also
- ‘provider’ and ‘public safety’

NAEMT July 2006 Position Statement
Innovation

What's new
- New automotive safety technologies
  - Crashworthiness
  - EVS
  - ITS
  - Monitoring and feedback enhancements
- New expertise
  - TRB
  - ASSE
  - SAE
  - UTRC
  - Ergonomics
  - Industrial Design

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

Why do we do this?
Patients must be in the over the shoulder harness, medics restrained in seat belts, equipment secured

Full Vehicle Crash Tests
Test 1 - Right side impact
Test 2 - Frontal

High speed crash, rolled and the occupants (patient and medics) had only minor scratches
Major events for innovation sharing — but regional and often language isolation

Vehicle Occupant Safety design

2007 European design

Safety technology is a key focus

Ergonomic design

Ergonomic layout and equipment

Driver behavior monitoring and feedback device

Levick NR, Swanson J, Proceedings - 49th Annual Conf. of the Assoc. for the Advancement of Automotive Med, September 2005

AMBEX-999 Research Forum 2006 – Research most likely to change practice award

Demonstrated Effectiveness

A key to safe ambulance transport

Automotive Injury Triangle

and Safety Development
Protective devices/concepts

To prevent a crash:
- Driver feedback
- Driver monitoring
- Driver testing
- Vehicle Intelligent Transportation System (ITS) technologies
- Timed dispatch
- Appropriate policies

In the event of a crash:
- Vehicle crashworthiness
- Seatbelt systems
- Equipment lock downs
- Padding
- Head protection

Intelligent Transport Safety Systems

Vehicle visibility and conspicuity

Protective Equipment

Integration and Collaboration


Tips for Emergency Vehicle Operations

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

No need to reinvent the wheel...

USFA Emergency Vehicle Safety Initiative
March 2007 - FHWA

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

Vehicle design and safety
- The principles of automotive safety involve a complex science, engineering technical skill, expertise, training and knowledge
- “Give the engineers a working list of our needs and let them tell us how it should be built to accomplish those tasks.”

The squad bench??

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???

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
http://www.EveryoneGoesHome.com
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.

Future

- Meaningful Goals
- New policies
- New practices
- New standards
- New vehicles
- New technologies

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

Conclusion

- EMS transport has serious hazards and safety issues.
- Major advances in EMS safety research, infrastructure and practice over the past 5 years.
- Development of substantive EMS safety standards is a necessity and a reality.
- Multidisciplinary safety issue that EMS cannot solve internally.
- 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, transportation and occupational safety.

And....

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