New initiatives in EMS
Transport Safety:
Where is the state of the art?

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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

Objectives
1. Educate on the risks to patients, transport and emergency medical service providers and the public from ambulance crashes.
2. Explore factors related to ambulance crashes and identify potential mechanisms of injury to patients and transport providers
3. Explain new transport safety technologies and innovations, and describe the new concepts that are underdevelopment.
4. Instruct providers on strategies for enhancing transport safety and reducing risk of injury to patients and providers during transport

Some recent adverse outcomes

[Images of adverse outcomes]

http://www.objectivesafety.net

[Images of news articles and websites]
Last month

An interhospital transport? “Do no harm….”?

Firstly!

An accident?

or a predictable and preventable event

So....

On their way TO the hospital

With a patient who was not in cardiac arrest or in a life threatening situation

All 5 in the ambulance critically injured

EMS Best Practice, Sept 2006

We should use the best safety practices demonstrated in engineering

and in ergonomics

Ambulance Safety Research: A New Field

We should use the best safety practices demonstrated in engineering

Development of an Effective Ambulance Patient Transfer System

and in ergonomics

Ergonomics as the human factor: Ergonomic evaluation of ambulance design

Transportation of seated patients under crash conditions: Writing conditions for patient safety

Non-profitable impact of the patient movement on ambulance vehicles under crash conditions: Writing conditions for patient safety
Predictable risks
- 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)
- 82% of fatally injured EMS rear occupants unrestrained
- >74% of EMT occupational fatalities are MVC related
- 76% 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

Risk Exposure Rates

<table>
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<tr>
<th>Risk Category</th>
<th>Crashes per 100 million miles</th>
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<tr>
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<td>Light Truck</td>
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<tr>
<td>Motorcycle</td>
<td>450</td>
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<tr>
<td>Urban Ambulance</td>
<td>340</td>
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</table>

Findings:
- 405 386 212
- 849
- 3,200

So does it make sense?
- Gloves and universal precautions? ...
  - good biohazard protection BUT
  - aren’t going to give much protection
  - in an ambulance crash

A word about occupational transportation fatalities

<table>
<thead>
<tr>
<th>Transportation Fatality/100,000 workers</th>
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<tr>
<td>Elephant</td>
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<td>Tractor</td>
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<td>Motorcycle</td>
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<tr>
<td>Stretcher</td>
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<tr>
<td>Bench seat</td>
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<tr>
<td>Captain's chair</td>
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<tr>
<td>Standing or kneeling</td>
</tr>
</tbody>
</table>

USA EMS
- EMS Systems - >15,000
- Personnel - ~1 million
  - (~30% FT professional & ~70% volunteer)
- Vehicles - ~50,000
  - (Type I, Type II, Type III, Freightliners, ?motorcycles)
- Transports - ~50 million
  - (to Emergency Depts ~ 50%, < 1/3 emergent)
- Cost - ~$8 Billion annually
- Safety Oversight - ? Disparate

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

and what is killing EMS?
- 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

the EMS transport process
- communications/dispatch
- the patient
- restraining device/seat
- transporting 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

EMS Transport Safety IS Complex AND Multidisciplinary
- Epidemiologic Data Collection
- Ergonomic Research
- Biomechanical and Automotive Safety
- Patient Monitoring Technology
- EMS Practice
- Regulations and Standards
- Fleet Safety Program

This is not acceptable
in the USA*
- ~5,000 crashes a year
- ~ One fatality each week
  - ~233 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

Occupational Health and Safety.....?
- This IS an Automotive Safety issue

Paramedic charged in crash that killed 2
[Source: AP / Nov 21, 2005]

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*FARS/BTS 2004-5

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[Source: AP / Nov 21, 2005]
Key Issues

- Mythology
  - That Emergency Medical Service personnel are safe
- Injury Hazards
  - Violence
  - 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 in a vehicle - exposure data are scant
  - Automotive Safety
    - a vehicle is the workplace - ‘exempt’ from automotive research and regulation

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....

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

Factor

Phase
pre crash
pre event
in vehicle
vehicle (host)
vehicle (agent)
environment
social cultural
pre crash
pre event
in vehicle
vehicle (host)
vehicle (agent)
environment
social cultural
post crash
post event
in vehicle
vehicle (host)
vehicle (agent)
environment
social cultural

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!!

EMS Transport General Concerns

- 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

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

“Are our policies killing people?”

- 1991-2000, 202,969 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)


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 (dry)

Dry
Stopped at 176 feet

Wet
Stopped at 220 feet

* Stopping distance: Perception time + Reaction time + Vehicle braking time (varies with age, skill, agility, driver's type, tire pressures, road etc)

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??

No need to reinvent the wheel...

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???
Global EMS Vehicle Safety Standards v Specifications and Guidelines
- EMS Safety and Performance Standards
  - Australia & New Zealand 4535
  - Common European Community (CEN) 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
  - ASTM, CAAS and CAMTS

Australia & New Zealand Ambulance restraint standard AS/NZS 4535:1999
- “Restraint systems shall apply to all equipment and people carried in an ambulance….”
- Dynamic Testing - 50th & 95th percentile manikins
- 24G in Forward and Rearward
- 10G in Transverse

- European Committee for Standardization Medical vehicles and their equipment - Road Ambulances
- “Without exception, all persons, medical devices, equipment, and objects normally carried on the road ambulance shall be maintained to prevent them from becoming a projectile when subject to a force…”
- 50th percentile manikins - 10 G in Forward, Rearward, Transverse, & Vertical directions
- Certified by Notified Body and Ambulance Mfg.

USA ambulance purchase specifications GSA:KKK-A-1822E, 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

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
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

Intelligent Transport Safety Systems

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

The “Black Box”

- Driver behavior monitoring and feedback device

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

Demonstrated Effectiveness

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

Active Projects

- 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

MEMS MONTHLY OVER SPEED VIOLATION TREND 2003/2004

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*January 2005
Dynamic Safety Testing

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

Full Vehicle Crash Tests

Test 1 – Right side impact

Test 2 – Frontal

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

USA design initiatives

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

UK Ambulance vehicles

Clear safety message

Sweden initiatives

Norway initiatives

Other successful models

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

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
- Enhanced cross disciplinary collaboration in development of safety initiatives now exist
- 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