Ambulance Transport Safety:
What you need to know

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
UPS, FedEx 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.

http://www.objectivesafety.net
Firstly!
▶ An accident?
▶ or a predictable and preventable event

Outline
1. Review of data on ambulance crashes and ground transport safety
2. Review of safety standards and guidelines that exist for the ground EMS and patient transport environment and update of latest safety developments
3. Identification of ground transport safety issues, hazards and areas of risk patients and EMS providers and profile new safety technologies.
4. Strategies to enhance safety and reduce risks of injury during ground EMS and patient transport.

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Ambulance Safety Research: A New Field

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)
- 92% of fatally injured EMS rear occupants unrestrained
- 70% of fatal crashes EMS crashes during Emergency Use
- 82% of fatally injured EMS rear occupants unrestrained
- > 74% of EMT occupational fatalities are MVC related
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Risk Exposure Rates

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<tr>
<th>Type of Vehicle</th>
<th>Crashes per 100 million miles</th>
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<tr>
<td>Urban Ambulance</td>
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<tr>
<td>Large Truck</td>
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<td>Light Truck</td>
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<td>Motorcycle</td>
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<td>Large Truck</td>
<td>3,990</td>
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USA EMS
- EMS Systems - >15,000
- Personnel - ~1 million
- ~30% F/T professional & 70% volunteer
- Vehicles - ~50,000
- Transports - ~50 million
- 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?
EMS personnel fatalities*
- 74% transportation related
- 11% were cardiovascular
- 9% were homicide
- 4% needle sticks, electrocution, drowning and other

A word about occupational transportation fatalities...

WE HAVE A BIG PROBLEM HERE

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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

EMS Safety
- Epidemiological Data Collection
- Risk Management
- EMS Policy
- EMS Practice
- Regulatory and Standards
- Fruit Safety Program

This is not acceptable
In the USA*
- ~ 5,000 crashes a year
- One fatality each week
  - ~ 23 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

Key Issues
- Mythology
  - The Emergency Medical Service personnel are safe
- Injury Hazards
  - Blunt
  - Chemical/Radiation
- Motor Vehicle Crashes are the highest cause of death at work – EMS has > 2X the mean national rate

OCCUPATIONAL HEALTH AND SAFETY

- This IS an Automotive Safety issue

Occupational Health and Safety…..?

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Paramedic charged in crash that killed 2

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    - the workplace is in a vehicle – exposure data are scant

*FARS/BTS 2004-5

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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*

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<th>Phase Factor Matrix</th>
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<td>Pre Crash</td>
<td>Pre Event</td>
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<td>Driver Education</td>
<td>Speeding</td>
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<td>Abiding Road Laws</td>
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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 (e.g., 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

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, conditions + vehicle type, dry/poor, rain 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...

‘Workplace’ Hazards

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

But what about head protection?

It does happen....
It isn’t like this outside of the USA

eg: Scandinavia Innovation in Vehicles, and Equipment

This looks cool AND SAFE!

Not rocket science...

Global EMS Vehicle Safety Standards
v Specifications and Guidelines

- EMS Safety and Performance Standards
- Australia & New Zealand 4558
- 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

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

American National Standard
ANSI/ASSE Z15.1-2006
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
Automotive Injury Triangle and Safety Development

- Host Vehicle Environment
- Field Data
- Scholarly Research
- Technology, invention & development
- Voluntary initiatives
- Regulatory initiatives
- Countermeasure deployment

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
  - Protective devices/concepts
  - Equipment lock downs
  - Padding
  - Head protection

Intelligent Transport Safety Systems

- Intensive Transport Safety Systems
- Back up Camera….. Shouldn't all vehicles have one of these?
- Purpose of ‘Black box’ Program
  - Enhance Safety
  - Improve Driver Performance
  - Save Maintenance Dollars
  - Aid Accident / Incident Investigation

- 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.

- 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.

- A key to safe ambulance transport
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 Crash Event - Crash Testing

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

Dynamic Safety Testing

- Requires sophisticated, expensive equipment
- Measurably demonstrates forces generated during collision
- Accepted international standard for vehicle restraint systems

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Full Vehicle Crash Tests

1. Right side impact
2. Frontal impact

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

In a collision at 35 mph (60 km/hr), an unrestrained 15 kg child is exposed to the same forces as in falling from a 4th story window:

\[ \text{550 kg/force in 0.03 sec} \]
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

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
- 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