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EMS Vehicle Safety:  
Where is the State-of-the-Art?

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Safety IS Complex and Multidisciplinary

Key Issues

- Mythology
  - That Emergency Service Responders are safe
- Injury Hazards
  - Violence
  - Chemical/Toxicology
  - Physical/Mechanical Issues – THE BIG PROBLEM
- Motor Vehicle Crashes are the highest cause of death at work – first responders have > 2X that rate
- An R & D and Regulatory Gap
  - Occupancy Health and Safety
- The workplace is in a vehicle – exempt from automotive research

Then, The Opportunity

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

This morning’s Scope

- Key Issues
  - Health and Safety Data
  - Optimal use of very scarce resource
- Guidelines – standards
- Transport safety management
  - Detailed procedure
  - Transport incident form
  - Fixed emergency vehicle – safety features
- Future
  - R & D
  - New model vehicles
  - New technologies
  - New practices
  - New regulations

So.. What is the problem and how has it been studied

- Published epidemiology research
  - Retrospective real data
  - Multidisciplinary real-world sled and crash testing and simulation
  - Convincing clear evidence of hazard and risk
  - Consensus with and substantiates findings in epidemiology studies
  - 1986 – 2004: All 10 papers have similar conclusions

Background: Problems

- Predictable risks
  - Work sites at intersections, and with another vehicle (p<0.001)
  - Risk of PPE and infrastructure abuses to the rear (OR 2.2, 95% CI) and to improperly restrained occupants (OR 2.5 vs restrained)
- EMS is "the largest and most dangerous non-transport industry" 
  - EMR has >20 the mean national occupational fatality rate
  - 10% of all occupational injuries for EMS are MVC related
  - Serious head injury involved 44% of fatal EMS occupant injuries
  - Vehicle rear passenger compartment > 60cm behind driver - exempt from FMVSS

Ideally Who, What and Where?

- Occupational Health and Safety
  - Epidemiology, Bio/Chem Hazards and Ergonomics
  - Regulation and Research
- Automotive Safety
  - Epidemiology, Engineering and Impact Biomechanics
  - Regulation and Research
- First Responder Industry
  - Occ. Health, Automotive, Technical, Clinical & Fiscal data
- Practice-Policy, Risk Management and Fleet Safety
- Academia
  - Independent and collaborative
  - R & D and evaluation of all of the above

Challenges to Optimizing USA 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 vehicle
- Rear compartment exempt from FMVSS
- EMS Vehicle Safety: A large number of small groups of end users, with a mix of volunteers and professionals
- EMS has > 2X the mean national occupational fatality rate
- 82% of fatally injured EMS rear occupants were unrestrained
- Most serious and fatal injuries occurred in the rear (OR 2.7 vs front)
- More often at intersections, and with another vehicle (p < 0.001)
- Serious head injury involved >65% of fatal EMS occupant injuries

R & D and Regulatory Gap

- An R & D and Regulatory Gap
  - Occupational Health and Safety
- The workplace is in a vehicle – exempt from automotive research
- Ambulance Transport Safety Management
  - Detailed procedure
  - Transport incident form
  - Fixed emergency vehicle – safety features
- Future
  - R & D
  - New model vehicles
  - New technologies
  - New practices
  - New regulations

EMS Safety

- Epidemiological Data Collection
- Risk Management
- EMS Practice
- EMS Policy
- Published epidemiology research
- Convincing clear evidence of risk
- Retrospective real data
- ‘Exempt’ from automotive research
- FMVSS
- Epidemiology, Engineering and Impact Biomechanics
- Regulation and Research

Biomechanical

Biomechanical

Biohazard

Biomechanical

Biohazard

Biohazard

Biohazard

Biohazard

Biohazard
We should use the best safety practices demonstrated.

UK Ergonomic Paper 2005

Background: Biomechanics

- Vehicles are hazardous
- Vehicles have poor crashworthiness
- Vehicle interiors are hazardous
- There exist simple solutions to substantially optimize the safety of this environment

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 current vehicle design features are beneficial, such as automotive grade padding in head strike areas, seats that can slide toward the patient
- Head protection??

Balance of concerns and risk during transport

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

EMS is emerging in the vehicle safety arena

- First and only presentation of ambulance safety research at ESV Congress was 2001
- SAE TopTec on Military and Emergency Vehicles, USA, September 2001
- Emergency Vehicle Symposium, Australia, Melbourne, May 2003
- Thomco EMS Safety Symposium, Chicago, June 2003
- Sporadic Ambulance safety research presented at peer reviewed AAAM, IITMA, SAEM, Safe America, World Injury, Asia Pacific Injury Conferences 1999-2005

Arizona, September 11th 2001

Melbourne April 8th 2003
Protective devices

In the event of a crash
- Seat belts
- Equipment lock downs
- Padding
- Head protection

To prevent a crash
- Driver feedback
- Driver monitoring
- Driver training
- Vehicle technologies

Intelligent Transport Safety Systems

Enhanced Safety of Vehicles (ESV) Conference

ESV – The Definitive Vehicle Safety Forum

Ambulance vehicle safety has only been presented at one ESV meeting, the 17th ESV in 2001

Prevention

Injury and crash prevention is better than cure
Crash Prevention
- EVOC
- Tiered Dispatch
- The “Black Box”

Crash Occupant Protection
- Collision speed
- Direction of impact
- Vehicle stiffness and mass
- Compartment size & projectiles
- Passive protection
- Head protection
- Occupant restraint/belts

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

The ‘workplace’ IS a vehicle
- Providers often in vulnerable positions during transport.
  - Bench seat
  - Captain’s chair
  - Standing or kneeling

Hazards
- It does happen….

But what about head protection?
- Absence of standards or guidelines for occupational head protection for ground EMS
- Exposure to ambulance crash head injury is high
- Dramatic increase in preparedness to wear head protection when hazards explained
- There is no PPE device specifically designed to meet the defined head injury hazards in EMS
- Head protection PPE device should include:
  - Communication capacity
  - Address comfort, visibility and aesthetics
  - Be protective for automotive crash forces

The “Black Box”
**Demonstrated Effectiveness**

- **Series I**
  - I - Blind data, no growls
  - II - Growls & tones ON
  - III - Unidentified data capture
  - IV - Identified data

**Two Important Questions**

- Is it ethical to do any further black box studies?
- Is it ethical NOT to have these devices in all EMS vehicles, given the safety benefit and cost effectiveness?

**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
- Much uncertainty as to what is safe and what is unsafe occupant protection practice
- 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

**Safety for EMS Transport Goals**

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

**Air EMS is a role model for safety initiatives and focus**

**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

**Global EMS Standards**

- Australia & New Zealand 4535
- Common European Community (CEN) EN1789
- USA KKK & NTEA - AMD
- [Aviation - FAA/CAA/JAA]
- CAMTS
- Draft ANSI/ASSE Z15
### 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**

### Safety Process

- Identify hazards
- Raise awareness of safety issues
- Create a safety attitude
- Promote Teamwork
- Provide motivation
- Accomplish established goals

### 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?

### USA EMS Risk/Hazards

- Predictable risks
- Serious occupational hazard
- Predictable fatal injuries

### Peds EMS

- One in ten (or about 6 million) ambulance transports involves a child
- Only ~ 1.8 million are children <5 yrs
- Ambulances ≠ standard passenger vehicles
- Pediatric patients in ambulances ≠ children in passenger cars

### Kids are not little adults

- Behavior
- Communication skills
- Fear
- Development
- Size and shape
- Biomechanics
Multidisciplinary collaboration and the way forward

- Development of interdisciplinary teams
  - Healthcare professionals
  - Safety engineering expertise
  - Regulatory bodies
  - Manufacturers
- Safer practices save lives, time and money

Full Vehicle Crash Tests - 2000

Test 1 - Right side impact

Test 2 - Frontal

Important Questions
1. How best to safety test EMS vehicles
2. What are the optimal safety enhancements for current vehicles
3. What is the ideal vehicle design
Concepts out there now
- Helmets
- Black Boxes
- Tiered dispatch
- Enhanced ambulance vehicle design
- Need for a cross disciplinary ambulance transport safety institute to be established

New Industry Task Force (MMTS)
- Development of an industry based task force –
  - First multidisciplinary symposium held in DC, November 2003
- Concept vehicle on display at EMS Expo 2004 & 2005

USA design initiatives
- USA design initiatives concept vehicles I & II
- Swedish Volvo ambulances
- New Australian vehicles
New UK London Ambulance/neonatal vehicles

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?

A glimpse of the future

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

Safety Enhancements Being Implemented
- EVOC
- Tiered dispatch
- Monitoring & Feedback devices
- Helmets
- Optimized ambulance vehicle design

Extremely Important Principles!
1. A culture of safety
2. Drive cautiously
3. Wear your belts & restrain all occupants (use over the shoulder harnesses for patients)
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

Conclusions
- Focus on safety of ALL aspects of the ambulance environment
- Develop a Safety Culture
- Real dangers exist in some current practices - Unrestrained occupants and equipment are a potential injury risk to all occupants
- Safer patient transport practices exist & should be used
- Prevention is key: teach EVOC
- Safety developments are underway: be ready to integrate them into your practice

Electronic Info for you all:
- www.objectivesafety.net
- Electronic Handout of today’s presentation
- “Ambulance Safety: Where is the State of the Art?” Webinar June 14, 2005
- Recorded online - Free access via the internet
- Comprehensive Reference List on EMS Safety

PREDICTABLE PREVENTABLE and NO ACCIDENT
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