Outline

- Look at the data on EMS transport safety
- Demonstrate what happens during an ambulance crash
- Review of national guidelines and standards
- Address what needs to be done to enhance safety in EMS transport

Key Issues

- Mythology
  - 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
    - workplace in a vehicle – exposure data are scant
  - Automotive Safety
    - a vehicle is the workplace – 'exempt' from automotive research and regulation
- 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 Depts ~ 50%, < 1/3 emergent)
- Cost - ~$5 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

the EMS 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 driving/driver skill
- other road users
- the road

http://www.objectivesafety.net
EMS Safety IS Complex AND Multidisciplinary

EMS Safety
- Risk Management
- EMS Policy
- Public Safety
- Regulations and Standards
- Fleet Safety Programs
- Ergonomic Research
- Automotive Safety
- Epidemiological Data Collection

Approach to hazard analysis and optimizing safety
- Unique nature of EMS, it bridges:
  - Public health
  - Public safety
  - Emergency medical care
  - Automotive and transportation safety
  - System safety engineering
  - Occupational health and safety
  - Risk management, liability
- It is paramount that the safety of this system be addressed with a comprehensive multidisciplinary approach.

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

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?

Some simple and available solutions out there now
- Intersection Policy
- PPE
- Black boxes

We should use the best safety practices demonstrated

Ambulance Safety Research: A New Field
- Ergonomic
- Epidemiology
- Engineering
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**EMS Provider Fatalities**

- 12.7 fatalities/100,000 EMS workers
- Greater than 2 X 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

**Predictable risks**

- More often at intersections, & with another vehicle (p < 0.001)
- More 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
- 76% of fatal crashes EMS crashes during Emergency Use
- Serious head injury in >65% of fatal occupant injuries
- > 74% of EMT occupational fatalities are MVC related
- 82% of fatally injured EMS rear occupants unrestrained

**A word about occupational transportation fatalities**

**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


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**Haddon/Baker/Runyan Phase-Factor Matrix**

**Goals**

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

**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

What do ambulance crashes really cost?

- Loss of life and injury
- Negative impact on EMS system
- Collisions are the largest liability cost and exceeds malpractice or negligence
- Besides the direct financial costs of replacing a damaged ambulance and equipment, there are additional hidden costs incurred:
  - investigating the ambulance collision
  - litigation/settlement/lawsuit
  - medical/disability costs of injured EMTs
  - hiring of new employees to replace injured personnel
  - retraining and psychological counseling of personnel involved and others
  - increased insurance rates

"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)

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....

This is happening out there NOW....

Gregg Theunes Appeal to his Senator, December 29, 2005

Increasing awareness ...

- EVOC
- Tiered Dispatch
- The "Black Box"
- Intelligent vehicle design
- Appropriate policy

Crash Prevention
Only two technical symposia
2001 and 2003
(next planned for 2007)

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...

A number of potential interventions to enhance safety have been identified:
- Safety Policy
- Safety performance standards
- Vehicle crashworthiness
- Vehicle interior ergonomics
- Personal Protective Equipment design
- Driver training and simulation
- Safety and risk awareness modification
- Risk behavior modification
- Intelligent Transportation Systems (ITS)

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

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

Preliminary Study: Attitudes to Head Protection in EMS

<table>
<thead>
<tr>
<th>View of Ambulance interior from Rear</th>
<th>Would you consider wearing a helmet PRE- PRESENT A T ION</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 32</td>
<td>Yes: 16%  No: 84%</td>
</tr>
<tr>
<td>Would you consider wearing a helmet POST</td>
<td>Yes: 82%  No: 18%</td>
</tr>
<tr>
<td>n = 32</td>
<td></td>
</tr>
</tbody>
</table>

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???

Protective devices/concepts

- To prevent a crash
  - Driver feedback
  - Driver monitoring
  - Driver training
  - Vehicle ITS technologies
  - Tuned dynamics
  - Appropriate policies

- In the event of a crash
  - Vehicle crashworthiness
  - Seatbelt belt systems
  - Emergency brake systems
  - Padding
  - Head protection

Automotive Injury Triangle and Safety Development

<table>
<thead>
<tr>
<th>Host</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
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</table>

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

<table>
<thead>
<tr>
<th>Monitoring and feedback devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation well received by the providers.</td>
</tr>
<tr>
<td>20% cost saving in vehicle maintenance within 6 months.</td>
</tr>
<tr>
<td>No increase in response times</td>
</tr>
<tr>
<td>Fewer crashes and less severe crashes</td>
</tr>
<tr>
<td>Sustained improvement in safety proxies, with no inservice or retraining after the initial introduction period.</td>
</tr>
</tbody>
</table>

Dynamic Safety Testing

- requires sophisticated, expensive equipment
- measurably demonstrates forces generated during collision
- accepted international standard for vehicle restraint systems
If we know this – and its published....

Why do we do this?

Full Vehicle Crash Tests - 2000

Test 1 - Right side impact

Test 2 - Frontal

Air EMS is a role model for safety initiatives and focus


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

Johns Hopkins University Test 1 – Right side impact

1 – Target vehicle, Type I ambulance

2 – Bullet vehicle, Type II ambulance

Closing speed 44 mph

Johns Hopkins University Test 2 – Frontal

1 – Bullet vehicle, Type III ambulance

2 – Target vehicle, Type II ambulance

Closing speed 34 mph


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:
  \[ \text{Incidents per 10,000 transports} = \frac{\text{Number of incidents}}{10,000} \]

- Vehicle injury rates based on work hours:
  \[ \text{Vehicle incidents per 200,000 hours} = \frac{\text{Number of incidents}}{200,000} \]

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 Enhancements Being Implemented

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

Future

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

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

- 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

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