Ambulance Safety – The State of the Art

Nadine Levick, MD MPH

SEMAC, EMS Week, Albany, NY 23 May 2006

Key Issues

- Mythology
  - Are Emergency Medical Service personnel safe?
- Injury Hazards
  - 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 is in a vehicle – exposure data are scant
  - Automotive Safety
    - a vehicle is the workplace – 'exempt' from automotive research and regulation

In a nutshell

- No accepted safety standards for -
  - EMS fleet management or safety practice
  - Ambulance vehicle rear compartment design and performance
  - provider occupational injury protective equipment
- Yet convincing data for injury risk and hazard
- Need for patient, provider and public safety focus

 EMS Safety IS Complex AND Multidisciplinary

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

This is not acceptable

- ~ 5,000 crashes a year
- ~ One fatality each week
- ~ 20 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

Predictable risks

- More than 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 22.2 vs restrained)
- ~95% of fatally injured EMS rear occupants unrestrained
- > 74% of EMT occupational fatalities are MVC related
- Serious head injury to ~95% of fatal occupant injured
- 70% of fatal crashes EMS crashes during Emergency Use
- More likely to crash at an intersection with traffic lights (31% vs 16% p<0.001) & more people & injuries/crash than similar sized vehicles

*FARS/BTS 2004-5
**Becker, Zaloshnja, Levick, Li, Miller, Acc Anal Prev 2003
#NIOSH, 2003
##Ray AM, Kupas DF, Prehosp Emerg Care 2005 Dec; 9:412-415
##NHTSA, 49 CFR Parts 571, 572 & 589 Docket no. 92-28; notice 7
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)

Greater than 2 X the national average
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


A word about occupational transportation fatalities...

WE HAVE A BIG PROBLEM HERE

A word about occupational transportation fatalities...

We have a big problem here

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
- 5.6 x that of health services personnel
- 7 x the national average

* Maguire, Hunting, Guidotti & Smith, Occupational Injuries among Emergency Medical Services Personnel, Prehospital and Emergency Care Oct/Dec 2005

Background: Problems

- No reporting system or database specifically for identifying ambulance crash related 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 exceed 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
Pennsylvania Code

We should use the best safety practices demonstrated

Balance of concerns and risk during transport

“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 22%, 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)
40 mph
Stopped at 176 feet

Perception + Reaction time Vehicle Braking  time (wet)
40 mph
Stopped at 220 feet

* Stopping distance:
Perception time + Reaction time + Vehicle braking time (varies with age, skill, agility, alertness + vehicle type, tire pressure, road etc)

What do we know now??

Intersection crashes are the most lethal

There are documented hazards, some of 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??

Increasing interest in safety
Upcoming Initiatives/Events

- June – Halifax Emergency Medical Service Chiefs of Canada
- June – Seattle, American Society of Safety Engineers (ASSE) 2006 Conference and Exposition
- Jan – DC TRB
- May – DC MMTS
- September – SAE TopTec

Protective devices/concepts

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

To prevent a crash
- Driver feedback
- Driver monitoring
- Driver training
- Vehicle technologies
- Tiered dispatch
- Appropriate policies

But what about head protection?

- 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

Intelligent Transport Safety Systems

Providers often in vulnerable positions during transport.
- Bench seat
- Captain's chair
- Standing or kneeling

The 'workplace' IS a vehicle

Preliminary Study: Attitudes to Head Protection in EMS

Survey on Head Protection in Healthcare Settings: n = 32

Would You Consider Wearing a Helmet?

- Yes: 16%
- No: 84%

Would you consider wearing a helmet?

- Yes: 82%
- No: 18%

n = 32
Real world
- We do know from large samples that the most common reason for medics to get up is to get to the radio.
- We do know that CPR enroute to the hospital is a very rare event – too small in frequency to even evaluate using national data bases, and often with non survival outcome when it does occur.

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.

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

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 jury is out on
- Opticon
- Simulators

Technical Research
- Based on reliable and real world field data
- Cost effective and practical
- Involve low cost development – University engineering and transportation research centers

Active Projects
(all due late 2006)
- 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
Concern

- What is currently occurring as routine practice in EMS is ignoring that science, and worse there are initiatives that are automotive safety in their entirety that are occurring outside of that industry and those principles.

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

- EMS Industry
  - Occ. Health, Automotive, Technical, Clinical & Fiscal
  - Practice Policy, Risk Management and Fleet Safety

- Academia
  - Independent and collaborative
  - R & D and evaluation of all of the above

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:
  Incident rate = Number of incidents / Number of vehicles

- Injury incident rate based on vehicle mileage:
  Injury incident rate = Number of incidents with injury / Vehicle mileage

- Incident rates based on service activity:
  Incidents per 10,000 transports = Number of incidents / Number of transports

- Vehicle injury rates based on work hours:
  Vehicle incidents per 200,000 hours = Number of incidents / Number of hours worked

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

USA EMS Risk/Hazards

- Predictable risks
- Serious occupational hazard
- Predictable fatal injuries

Safe Practices for Fleet Motor Vehicle Operations

Full Vehicle Crash Tests - 2000

Test 1 - Right side impact

Test 2 - Frontal
USA design initiatives

New Australian vehicles

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

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

Current fleet
- Secure all equipment
- Secure occupants
- Don’t drive through red lights
- Use properly implemented “Black Boxes”
- Monitor crash events with common denominators (i.e. per 100,000 miles and per trip)
- Have a written and implemented ‘safety program’

Current and Future Research
- Epidemiology
- Ergonomic hazards
- Bio/Chem/Radiation hazard
- PPE & Head protection
- Transport
  - Vehicle/Occupant automotive testing
  - Vehicle design innovation
  - Driver behavior (Real time and Simulated)
  - Intelligent Transportation Systems
- Operations tracking
- Data systems/reporting systems
- Enhanced Practice policies

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

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

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

Thank you! Any Questions??
http://www.objectivesafety.net