SEMAC, EMS Week, Albany, NY
23 May 2006

Ambulance Safety – The State of the Art

Nadine Levick, MD MPH

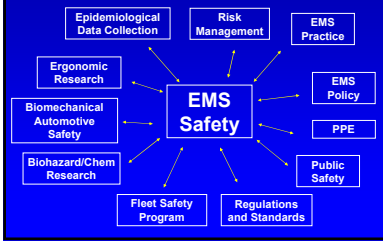
Key Issues

- Mythology
  - That Emergency Medical Service personnel are safe
- Injury Hazards
  - Biohazard
  - 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 work place – '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

Safety oversight of what and by …. whom

- Vehicle Safety
- Vehicle Design
- Safety Equipment Design
- Vehicle and Safety Equipment Testing and Standard development
- Safety policies

This is not acceptable

- ~ 5,000 crashes a year
- ~ One fatality each week
  - ~ 2/3 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

*FARS/BTS 2004-5

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***
- Serious head injury in >65% of fatal occupant injuries#
- 70% 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##

*Kahn CA, Pirrallo RG, Kuhn EM. Prehosp Emerg Care 2001 Jul-Sep;5(3):261-9
**Becker, Zaloshnja, Levick, Li, Miller. Acc Anal Prev 2003
***Maguire, Hunting, Smith, Levick, Annals Emerg Med Dec 2002
#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)

** Maguire, Hunting, Smith & Levick, Occupational Fatalities in Emergency Medical Services: A Hidden Crisis, Annals of Emergency Medicine, Dec 2002*

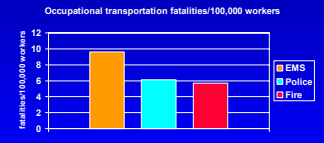
and what is killing EMS ?

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

** Maguire, Hunting, Smith & Levick, Occupational Fatalities in Emergency Medical Services: A Hidden Crisis, Annals of Emergency Medicine, Dec 2002*

A word about occupational transportation fatalities..



- WE HAVE A BIG PROBLEM HERE

** Maguire, Hunting, Smith & Levick, Occupational Fatalities in Emergency Medical Services: A Hidden Crisis, Annals of Emergency Medicine, Dec 2002*

EMS Injuries*

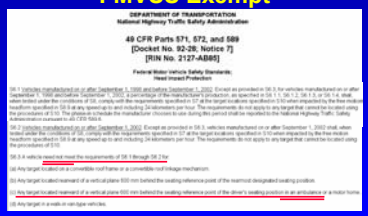
- Higher than the injury rate for any private industry published by DOL
- 34.6 injuries/100 fulltime workers per year
- 1.5 x that of fire fighters
- 5.8 x that of health services personnel
- 7 x the national average

** Maguire, Hunting, Guidotti & Smith, Occupational Injuries among Emergency Medical Services Personnel, Prehospitial 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



DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration

49 CFR Parts 571, 572, and 589
[Docket No. 93-28; Notice 7]
[RIN No. 2127-AB85]

Federal Motor Vehicle Safety Standards;
Head Impact Protection

S6.1 Vehicles manufactured on or after September 1, 1998 and before September 1, 2002. Except as provided in S6.3, for vehicles manufactured on or after September 1, 1998 and before September 1, 2002, a percentage of the manufacturer's production, as specified in S6.1.1, S6.1.2, S6.1.3, or S6.1.4, shall, when tested under the conditions of S8, comply with the requirements specified in S7 at the target locations specified in S10 when impacted by the free motion headform specified in S8.8 at any speed up to and including 24 kilometers per hour. The requirements do not apply to any target that cannot be located using the procedures of S10. The phase-in schedule the manufacturer chooses to use during this period shall be reported to the National Highway Traffic Safety Administration pursuant to 49 CFR 584.6.

S6.2 Vehicles manufactured on or after September 1, 2002. Except as provided in S6.3, vehicles manufactured on or after September 1, 2002 shall, when tested under the conditions of S8, comply with the requirements specified in S7 at the target locations specified in S10 when impacted by the free motion headform specified in S8.8 at any speed up to and including 24 kilometers per hour. The requirements do not apply to any target that cannot be located using the procedures of S10.

S6.3 A vehicle need not meet the requirements of S6.1 through S6.2 for:

(a) Any target located on a convertible roof frame or a convertible roof linkage mechanism.

(b) Any target located rearward of a vertical plane 600 mm behind the seating reference point of the rearmost designated seating position.

(c) Any target located rearward of a vertical plane 600 mm behind the seating reference point of the driver's seating position in an ambulance or a motor home.

(d) Any target in a walk-in van-type vehicles.

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

Pennsylvania Code

Commonwealth of Pennsylvania

Pennsylvania Code

Title 28, Health and Safety

Chapters 1001 – 1015

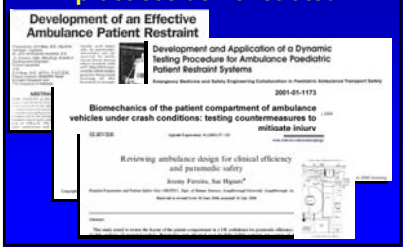
PART VII. EMERGENCY MEDICAL SERVICES

Chapter

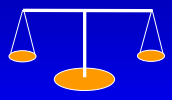
1001. ADMINISTRATION OF THE EMS SYSTEM
1003. PERSONNEL
1005. LICENSING OF BLS AND ALS GROUND AMBULANCE SERVICES
1007. LICENSING OF AIR AMBULANCE SERVICES - RESERVED
1009. MOBILE COMMUNICATIONS FACILITIES
1011. APPROVAL OF EMS OPERATIONS TRAINING INSTITUTES
1013. SPECIALTY CENTERS
1015. QUICK RESPONSE SERVICE RECOGNITION PROGRAM

(a) *Accident, injury and fatality reporting.* An ambulance service shall report to the appropriate regional EMS council, in a form or manner prescribed by the Department, an ambulance vehicle accident that is reportable under 75 Pa.C.S., and an accident or injury to an individual that occurs in the line of duty of the ambulance service that results in a fatality, or medical treatment at a facility. The report shall be made within 24 hours after the accident or injury. The report of a fatality shall be made within 8 hours after the fatality.

We should use the best safety practices demonstrated



Balance of concerns and risk during transport



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

"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)

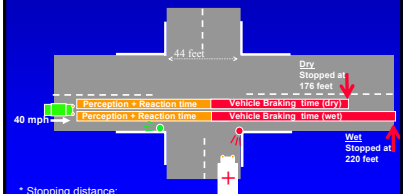
**Comparison of Crashes Involving Ambulances with those of similar sized vehicles – Adam Ray, Douglas Kupas, PEC Dec 2005;9:412-415*

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, alertness + vehicle type, tire pressure, road etc)

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??

Daily American Republic

Ambulance driver in fatal crash is charged

KENNETT, Mo. (AP) -- An ambulance driver from the Missouri Bootheel was charged Friday with two counts of involuntary manslaughter for an accident that killed a patient in the ambulance and the driver of the other vehicle.

The accident happened Sunday on Missouri 164 near Kennett in Dunklin County.

Patrick White, 23, of Poplar Bluff, was driving an ambulance for Poplar Bluff Regional Medical Center. The Missouri State Highway Patrol said White failed to stop at a stop sign and struck a 1992 Buick driven by Dorothy Worrell, 64, of Hornersville.

The ambulance's siren and emergency lights were not on, the patrol report said.

Worrell and a patient in the ambulance, William Braden, 66, of Wappapello, were killed.

White suffered minor injuries. His co-worker in the ambulance, James Simpson, 43, of Pocahontas, Ark., was taken to a hospital in Memphis, Tenn., with serious injuries.

Bond for White was set at $10,000.

Increasing interest in safety

Upcoming Initiatives/Events

- June – Halifax Emergency Medical Service Chiefs of Canada
  - *Ambulance Safety Planning*
- June – Seattle - American Society of Safety Engineers (ASSE) 2006 Conference and Exposition
  - *Hazard Analysis and Vehicle Safety Issues for Emergency Medical Service Vehicles: Where is the State of the Art?'*
- June – UK 2999 EMS Research Forum, AMBEX 2006
  - *Panel on 'EMS Safety Issues'*
- Jan - DC TRB
- May - DC MMTS
- September - SAE TopTec

Protective devices/concepts

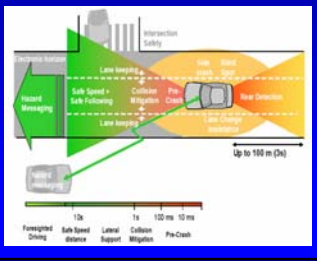
In the event of a crash

- Vehicle crashworthiness
- Seat/seat belt systems
- Equipment lock downs
- Padding
- Head protection

To prevent a crash

- Driver feedback
- Driver monitoring
- Driver training
- Vehicle technologies
- Tiered dispatch
- Appropriate policies

Intelligent Transport Safety Systems



The 'workplace' IS a vehicle

- Providers often in vulnerable positions during transport.
  - Bench seat
  - Captains chair
  - Standing or kneeling

View of Ambulance interior from Rear

Rollover Crash Kills Medical Technician

Ambulance Runs Off I-66 and Rolls Over, Injuring Two Employees and a Patient

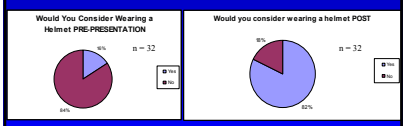
It does happen....

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

Preliminary Study:
Attitudes to Head Protection in EMS



Real world

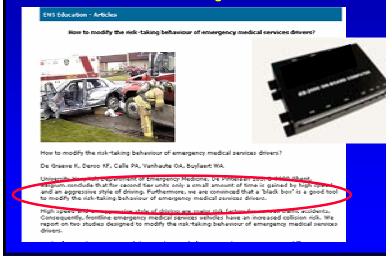
- We do know from large samples that the most common reason for medics to get up is to get to the radio
- We do know that CPR enroute to the hospital is a very rare event – too small in frequency to even evaluate using national data bases, and often with non survival out come when it does occur

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"

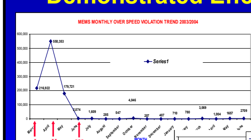
Driver behavior monitoring and feedback device



Purpose of 'Black box' Program

- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

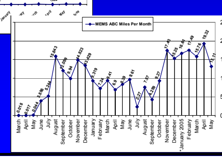
Demonstrated Effectiveness



I – blind data, no growls

II – growls & tones ON unidentified data capture

III – identified data



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

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

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

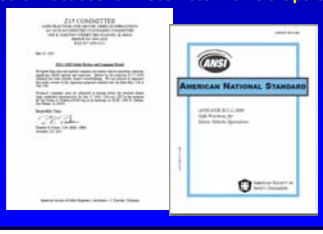
- What is currently occurring as routine practice in EMS is ignoring that science, and worse there are initiatives that are automotive safety in their entirety that are occurring outside of that industry and those principles.

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 data
    - Practice Policy, Risk Management and Fleet Safety
- Academia
  - Independent and collaborative
    - R & D and evaluation of all of the above

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

Z15 Incident Rates

- Incident rate based on number of vehicles operated:
  Incident rate = Number of incidents x 100 / Number of vehicles
- Incident rate based on vehicle mileage:
  Incident rate = Number of incidents x 1,000,000 / Vehicle mileage
- Injury incident rate based on vehicle mileage:
  - Injury incident rates, the most frequently used indicator of incident severity, are useful for tracking events that have the potential to affect financial or operational performance of the operating unit.

  Injury incident rate = Number of incidents with injury x 1,000,000 / Vehicle mileage
- Incident rates based on service activity:
  - Motor vehicle operations that pose injury risks other than those associated with driving should also use the service activity as the basis of a safety performance rate. The number of deliveries, stops, or loads should be considered as appropriate indicators of performance.

  Incidents per 10,000 transports = Number of incidents x 10,000 / Number of transports
- Vehicle injury rates based on work hours:
  Vehicle incidents per 200,000 hours = Number of incidents x 200,000 / 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

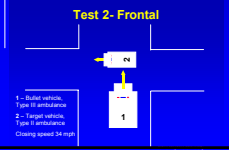
- Predictable risks
- Serious occupational hazard
- Predictable fatal injuries

Full Vehicle Crash Tests - 2000

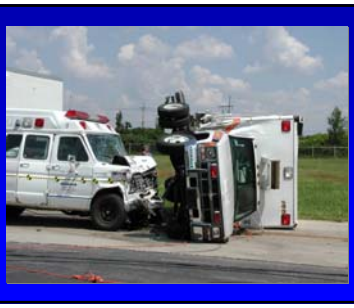
Test 1 – Right side impact

1 – Target vehicle, Type I ambulance
2 – Bullet vehicle, Type II ambulance
Closing speed 44 mph

Test 2- Frontal



1 – Bullet vehicle, Type III ambulance
2 – Target vehicle, Type II ambulance
Closing speed 34 mph



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 (ie. 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