

## Ambulance Safety – The State of the Art



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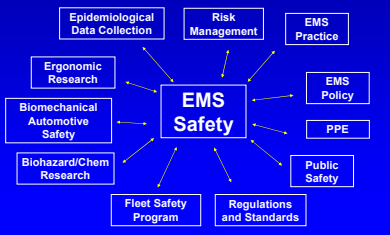
### Key Issues

- ▶ 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

FAO/SITS 2004-6

### Predictable risks

- ▶ More often at intersections, & with another vehicle ( $p < 0.001$ )<sup>\*</sup>
- ▶ Most serious & fatal injuries occurred in rear (OR 2.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)<sup>\*</sup>
- ▶ 82% of fatally injured EMS rear occupants unrestrained<sup>\*\*</sup>
- ▶ > 74% of EMT occupational fatalities are MVC related<sup>\*\*\*</sup>
- ▶ Serious head injury in >65% of fatal occupant injuries<sup>#</sup>
- ▶ 70% of fatal crashes EMS crashes during Emergency Use<sup>#</sup>
- ▶ More likely to crash at an intersection with traffic lights (37% vs 18%  $p=0.001$ ) & more people & injuries/crash than similar sized vehicles<sup>##</sup>

<sup>\*</sup>Klein CA, Pirralo RG, Kuhn EM. *Prehosp Emerg Care* 2001; 6(4):261-9  
<sup>\*\*</sup>Boyer, Zaccaro, Levick, Li, Miller. *Acc Anal Prev* 2003  
<sup>\*\*\*</sup>Maguire, Haining, Smith, Levick, *Prehosp Emerg Med* Dec 2002  
<sup>#</sup>WOSDA, 2003  
<sup>##</sup>Wong, JEM, Rucinski DE. *Prehosp Emerg Care* 2005; Dec; 9(4):412-418  
 #000733A\_49 CFR Parts 571, 572 & 589 Document 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

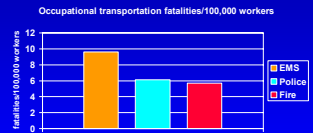
## and what is killing EMS ?

### 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\*

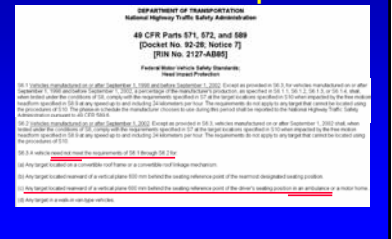
- ▶ Higher than the injury rate for any private industry published by DOL
- ▶ 34.6 injuries/100 fulltime workers per year
- ▶ 1.5 x that of fire fighters
- ▶ 5.8 x that of health services personnel
- ▶ 7 x the national average

\* Maguire, Hunting, Guadotti & 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 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



## 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

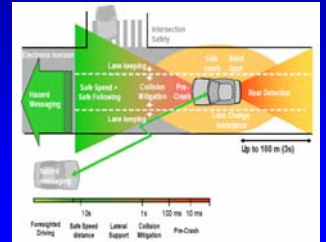
### In the event of a crash

- ▶ 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

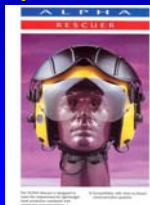


View of Ambulance interior from Rear



It does happen....

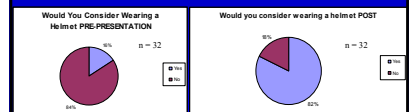
## But what about head protection?



## 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

EMT Education - Article

How to modify the risk-taking behaviour of emergency medical services drivers?



How to modify the risk-taking behaviour of emergency medical services drivers?

Dr. Stephen A. Green, KP, CMAA, PhD, Vanderbilt University

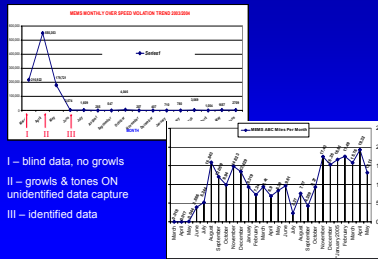
Conducting a randomized controlled trial of an emergency response feedback device to modify the risk-taking behaviour of emergency medical services drivers.

**Abstract** The purpose of this study was to evaluate the effectiveness of a feedback device to modify the risk-taking behaviour of emergency medical services drivers. The device was designed to modify the risk-taking behaviour of emergency medical services drivers.

## 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

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

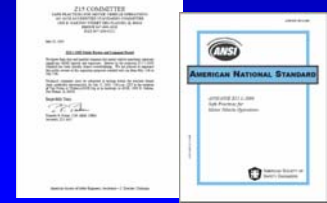
## Concern

- ▶ 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:  

$$\text{Incident rate} = \frac{\text{Number of incidents} \times 100}{\text{Number of vehicles}}$$
- ▶ Incident rate based on vehicle mileage:  

$$\text{Incident rate} = \frac{\text{Number of incidents} \times 1,000,000}{\text{Vehicle mileage}}$$
- ▶ 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.  

$$\text{Injury incident rate} = \frac{\text{Number of incidents with injury} \times 1,000,000}{\text{Vehicle mileage}}$$
- ▶ 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.  

$$\text{Incidents per 10,000 transports} = \frac{\text{Number of incidents} \times 10,000}{\text{Number of transports}}$$
- ▶ Vehicle injury rates based on work hours:  

$$\text{Vehicle incidents per 200,000 hours} = \frac{\text{Number of incidents} \times 200,000}{\text{Number of hours worked}}$$

## 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

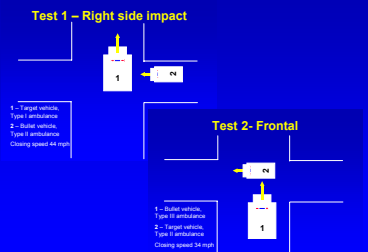
within a company must start with upper management's commitment to safety

- ▶ Awareness
- ▶ Training
- ▶ Incentive

## USA EMS Risk/Hazards

- ▶ Predictable risks
- ▶ Serious occupational hazard
- ▶ Predictable fatal injuries

## Full Vehicle Crash Tests - 2000





**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>