EMLIRC CLINCON 2006
presents 2006 Clinical Conference on Prehospital Emergency Care

The Richard Slevinski Keynote Presentation
ClinCon, Orlando, Florida 2006

# *Emergency Vehicle Safety: Your Life Depends On It*

Nadine Levick, MD MPH
www.ObjectiveSafety.net

## 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
  - 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

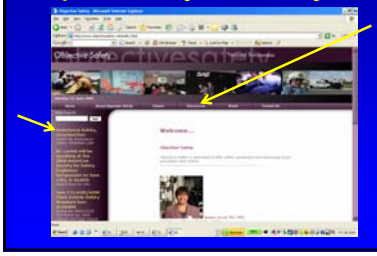
## Safety oversight of what and by …. whom

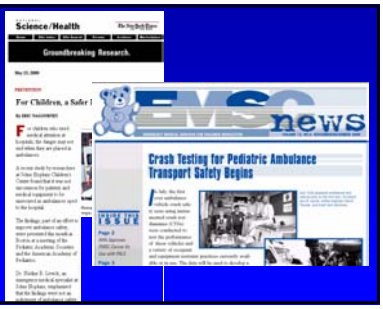
- Vehicle Safety
- Vehicle Design
- Safety Equipment Design
- Vehicle and Safety Equipment Testing and Standard development
- Safety policies

## 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

## http://www.objectivesafety.net




Science/Health

Groundbreaking Research

For Children, a Safer

EMS news

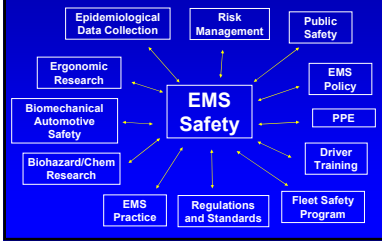
Crash Testing for Pediatric Ambulance Transport Safety Begins

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

TIME & PLACE

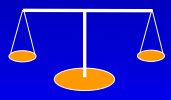
## EMS Safety IS Complex AND Multidisciplinary




## 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
  - 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

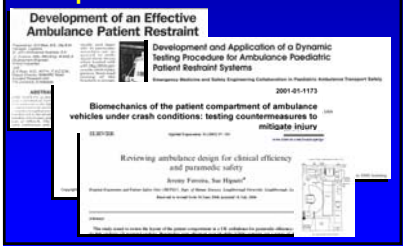
## This is about you and your safety

- What safety practices do you use??
  - Seat belts ?
  - EVOC training ?
  - Equipment lock down ?
  - Helmets ?
  - "Black Box" technology ?
  - Tiered dispatch ?

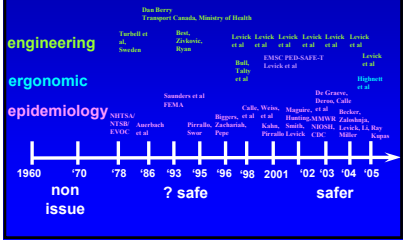
## Some simple and available solutions out there now

- Intersection Policy
- PPE
- Black boxes

## We should use the best safety practices demonstrated




## Ambulance Safety Research: A New Field



## 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*

## So does it make sense ?

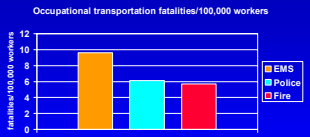
- Gloves and universal precautions?...
  … good biohazard protection BUT aren't going to give much protection in a ambulance crash

## Predictable risks

- More often at intersections, & with another vehicle ($p < 0.001$)*
- 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, Pirralo RG, Kuhn EM. Prehosp Emerg Care 2001 Jul-Sep;5(3):261-9*
***Becker, Zakotnja, 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*

## A word about occupational transportation fatalities..




- WE HAVE A BIG PROBLEM HERE

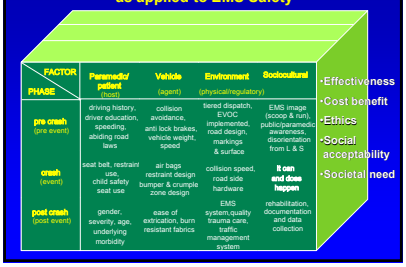
** Maguire, Hunting, Smith & Levick, Occupational Fatalities in Emergency Medical Services: A Hidden Crisis, Annals of Emergency Medicine, Dec 2002*

## 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, Prehospital and Emergency Care Oct/Dec 2005*

## Haddon/Baker/Runyan Phase-Factor Matrix as applied to EMS Safety*




## Goals

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

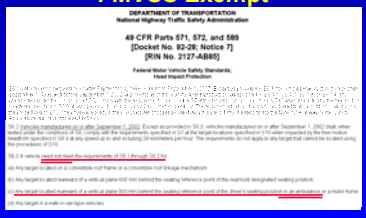
## General Concerns

- 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



DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration

49 CFR Parts 571, 572, and 589
[Docket No. 92-28; Notice 7]
[RIN No. 2127-AB85]

Federal Motor Vehicle Safety Standards;
Head Impact Protection

## 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)

**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…..

## This is happening out there NOW….

Is a license enough for ambulance drivers?

Extent of EMT training questioned by widower

By DAVID DOEGE

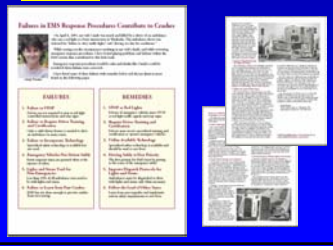
Cindy Theune

Quotable

"It's no different than someone who delivers pizzas."

–Gregg Theune, crash victim's husband, on training

## Gregg Theunes Appeal to his Senator, December 29, 2005

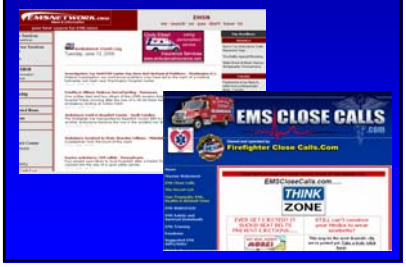


Failure in EMS Response Procedure Contributes to Crashes

FAILURES

REMEDIES

## Increasing awareness …

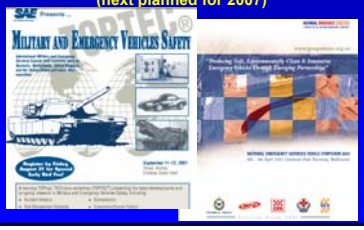



## Crash Prevention

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

## 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

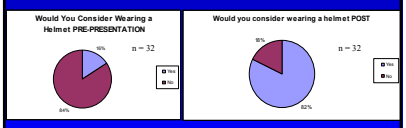

View of Ambulance interior from Rear

## 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




## 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

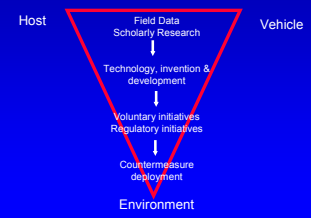
**To prevent a crash**

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

**In the event of a crash**

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

## Automotive Injury Triangle and Safety Development



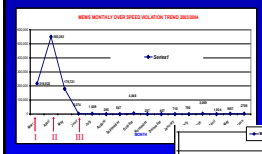

## The "Black Box"

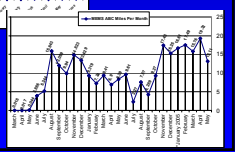
**Driver behavior monitoring and feedback device**

## 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

## Monitoring and feedback devices

- Implementation well received by the providers.
- 20% cost saving in vehicle maintenance within 6 months.
- No increase in response times
- Fewer crashes and less severe crashes
- Sustained improvement in safety proxies, with no inservice or retraining after the initial introduction period.

## Dynamic Safety Testing

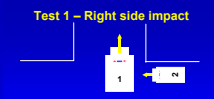
- requires sophisticated, expensive equipment
- measurably demonstrates forces generated during collision
- accepted international standard for vehicle restraint systems

## If we know this – and its published….

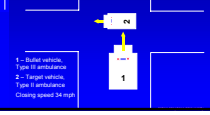

## Why do we do this?

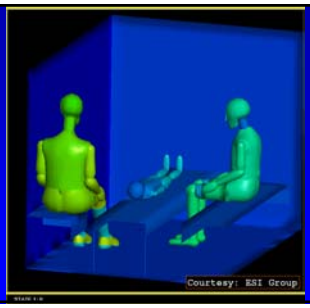
## Full Vehicle Crash Tests - 2000

Test 1 – Right side impact




Test 2- Frontal

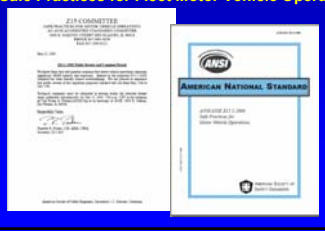



## Air EMS is a role model for safety initiatives and focus

## 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

## 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


## Acknowledgements

- EMSC funding –Targeted Issues Grant, PED-SAFE-T
- The late Capt. Garry Criddle – ExNHTSA/EMSC
- George Gillespie & Michael Schultze – US Military NAWC
- Joe McIntire & Joe Liscina - USAARL
- Veridian/Calspan/CenTIR
- Ambulance Association of America
- The USA EMS community
- Bill Murphy - Ontario Ministry of Health
- Muttiah Jeyendra - Standards Australia
- Research assistants – Allison Better, Tony Tsai, Philip Lee, Puneet Gupta and Leo McFarland.