American Ambulance Association
Annual Convention and Trade Show, 2006 Orlando

"Everything you always wanted to know about ambulance transport safety but were afraid to ask!"

Nadine Levick, MD MPH

A tragic emergency health care intervention outcome

It does happen….

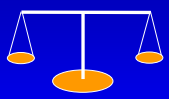
Review of developments addressing the safety, risks and hazards of ambulance transport

- Population based data on ambulance crashes, injuries and mortality
- Ambulance vehicle crashworthiness
- Ergonomics
- Risks and hazards
- Current and new safety intervention technologies
- Safety oversight
- Recently approved fleet safety standards
- New initiatives and guidelines underdevelopment
- Footage of crash scenes and crash tests of ambulances

What's going wrong, Why is it so, and Who's paying for it?????

- Where is the big picture that outlines the problems
- Why are we allowing the same tragic things to happen OVER and OVER again
- Who's pocket is getting hit

Balance of concerns and risk during transport



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

EMS Transport Safety

- 'patient safety'
  AND also
- 'provider' and 'public safety'

Transportation is your biggest black hole

- You are 10 x more likely to be sued for the way your vehicles are operated than you are for medical malpractice
- Vehicle related issues ARE your highest risk management cost

Firstly!

- An accident ?
- or
  a predictable and preventable event

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

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

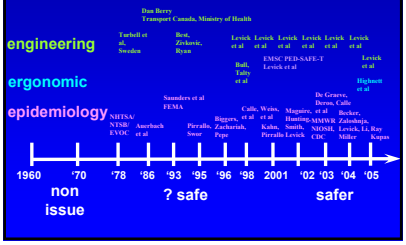
This is not acceptable

In the USA*

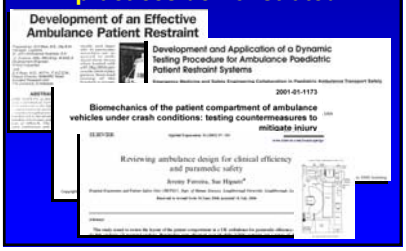
- ~ 5,000 crashes a year
- ~ One fatality each week
  - ~ 2/3 pedestrians or occupants of other car
  - Approximately 4 child fatalities per year
- ~10 serious injuries each day
- Cost estimates > $500 million annually
- USA crash fatality rate/capita 35x higher than in Australia

*FARS/BTS 2004-5

Ambulance Safety Research: A New Field



We should use the best safety practices demonstrated



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*

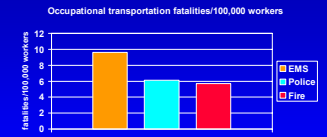
and what is killing EMS ?

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, Prehospital and Emergency Care Oct/Dec 2005*

The NTSB

About the NTSB

History and Mission

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in the other modes of transportation -- railroad, highway, marine and pipeline -- and issuing safety recommendations aimed at preventing future accidents. The Safety Board determines the probable cause of:

- all U.S. civil aviation accidents and certain public-use aircraft accidents;
- selected highway accidents;
- railroad accidents involving passenger trains or any train accident that results in at least one fatality or major property damage;
- major marine accidents and any marine accident involving a public and a nonpublic vessel;
- pipeline accidents involving a fatality or substantial property damage;
- [illegible]; and
- selected transportation accidents that involve purchase of a recurring nature.

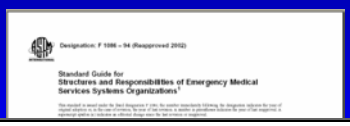
The Board derives its authority from Title 49 of the United States Code, Chapter 11. The rules of the Board are located in Chapter VIII, Title 49 of the Code of Federal Regulations.

The NTSB is responsible for maintaining the government's database of civil aviation accidents and also conducts special studies of transportation safety issues of national significance. The NTSB provides investigators to serve as U.S. Accredited Representatives at

Global EMS Vehicle Safety Standards v Specifications and Guidelines

- EMS Safety and Performance Standards
  - Australia & New Zealand 4535
  - Common European Community (CEN) EN1789
- Non EMS Specific USA Standards
  - [Aviation - FAA/CAA/JAA]
  - Z15 – Fleet vehicles safety management
- USA EMS Specification & Guidelines
  - Purchase Specification: KKK & NTEA – AMD
  - Guideline: EMSC Dos and Donts
    CAAS and CAMTS

ASTM F 1086 - 94



Designation: F 1086 – 94 (Reapproved 2002)

Standard Guide for
Structures and Responsibilities of Emergency Medical Services Systems Organizations[1]

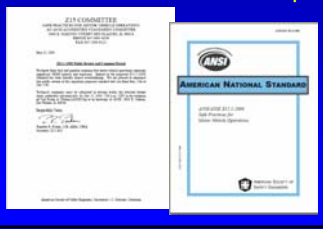
12.6 *Safety*—EMS system should ensure that standards for safety of rescuers, providers, patients, and bystanders are developed and enforced.

USA ambulance purchase specifications GSA:KKK-A-1822E, 2002

- Static Pull test
- 2200 Lbs. (8G's) in Longitudinal and Lateral
- No dynamic test
- No definition to manikin mass
- No restraint for equipment
- Voluntary

American National Standard ANSI/ASSE Z15.1-2006

Safe Practices for Fleet Motor Vehicle Operations



Z15 COMMITTEE

ANSI

AMERICAN NATIONAL STANDARD

Scope of the Z15.1 Standard

- For the safe operation of motor vehicles owned or operated by organizations, including:
  - Definitions
  - Management Leadership Ad-ministration
  - Operational Environment
  - Driver Considerations
  - Vehicle Considerations
  - Incident Reporting and Analysis
- These practices are designed for use by those having the responsibility for the administration and operation of motor vehicles as a part of organizational operations.

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

Legal Perspectives on Z.15

ANSI Z15.1 Standard: A Tool for Preventing Motor Vehicle Injuries and Minimizing Legal Liability
By Adele L. Abrams, Esq., CMSP
Law Office of Adele L. Abrams P.C.

Motor vehicle crashes that occur on American roadways have historically been the leading cause of occupational fatalities in this country. In the decade between 1992 and 2001, more than 13,000 civilian workers died in such incidents – accounting for 22 percent of all injury-related deaths. According to the Occupational Safety and Health Administration (OSHA), every 12 minutes someone dies in a motor vehicle crash, every 10 seconds an injury occurs and every 5 seconds a crash occurs.[1]

Employers whose workers are involved in such crashes have tremendous liability exposure, especially if the individuals injured or killed are third parties (non-employees), where no worker's compensation liability shield exists as an exclusive legal remedy. They bear not only the worker's compensation costs for their employees, and the potential damage awards from third party tort claims, but also the costs of equipment replacement and the indirect costs of workforce disruption and lost productivity associated with such incidents.

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

Leaders in focus on optimizing safety practice

- Richmond Ambulance Authority
- Cetronia Ambulance Service
- American Medical Response
- Nova Scotia Ambulance, Canada
- New South Wales Ambulance, Australia
- Melbourne Neonatal transport Service, Australia

Canada, Nova Scotia

- Since 2000 working towards a goal of zero loss ratio with insurance provider
- 10 million kilometers per year
- 150 emergency response ambulance units
- Collision claim history measured in dollars per 100,000 kilometers traveled:
  - 2000/2001 $ 1725.00
  - 2001/2002 $ 1049.00
  - 2002/2003 $ 751.00
  - 2003/2004 $ 416.00
  - 2004/2005 $ 229.00

Richmond Ambulance Authority

- Patient Care
  - QUICNET/CodeStat Suite
- Road Safety Technology
  - Driver Reports
- Risk & Safety Reviews
  - 100% sentinel incident review
    - Workers Compensation/Automotive Incidents
- National Safety Initiative
  - Themes of the Month
- Vehicle Maintenance
  - “A” and “B” preventative Maintenance schedules

What we know that helps:

- Have safety policies and procedures
- Secure providers and other seated occupants with existing restraints
- Secure patient with over the shoulder harness
- Secure Equipment
- Use driver and vehicle monitoring and feedback technology
- Use tiered dispatch

Goals

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

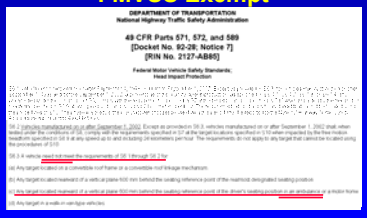
General Concerns

- 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

What needs to happen NOW?

- Implement a Fleet Safety Program
- Correct the basic policies and procedures regarding -
  - Intersections
  - Use of occupant restraints
  - Securing equipment
  - Driver performance
- Data
  - Epidemiology
  - Ergonomic
- Safety oversight

NAEMT July 2006 Position Statement

NAEMT

National Association of Emergency Medical Technicians Statement on Safety Restraint Use in Emergency Medical Services

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

The 'workplace' IS a vehicle

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

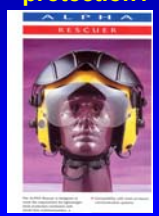
View of Ambulance interior from Rear

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

New EMS helmet prototypes for 2006-2007

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.

Automotive Safety PPE

- Automotive restraint in the EMS environment IS a specialized form of PPE
- Ergonomic or Occupational Health and Safety expertise is key to workplace safety – but is outside of expertise with a history of automotive crash safety or vehicle/restraint safety testing
- The automotive safety industry is THE industry where the safety of devices that are for the protection of occupants in a moving vehicle, are best evaluated

Other Devices

- In both the military and the automotive industry being ambulant in a moving vehicle or crash, in any device, is a dangerous practice and is not supported
- Use of current 'seated' crash dummies to demonstrate that such ambulatory devices may be safe is a fallacy, and misleading
- Peer review at ESV (Enhanced Safety of Vehicles)!

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 ?

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

"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)

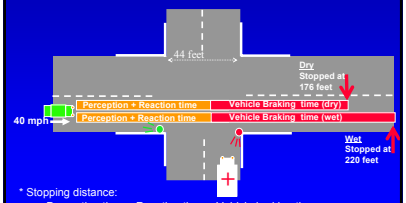
**Comparison of Crashes Involving Ambulances with those of similar sized vehicles – Adam Ray, Douglas Kupas, PEC Dec 2005;9:412-415*

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)

Crash Prevention

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

Ambulance Driver Safety - Australia

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...

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???

Not rocket science..

It isn't like this outside of the USA

Automotive Safety World

Protective devices/concepts

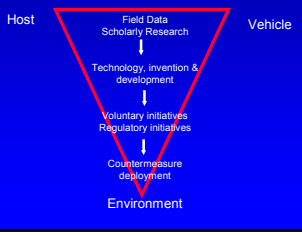
To prevent a crash

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

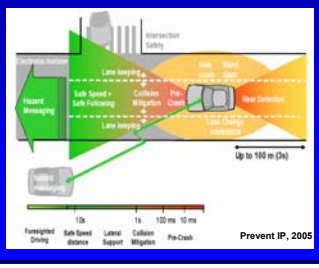
In the event of a crash

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

Automotive Injury Triangle and Safety Development



Intelligent Transport Safety Systems



Prevent IP, 2005

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

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.

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

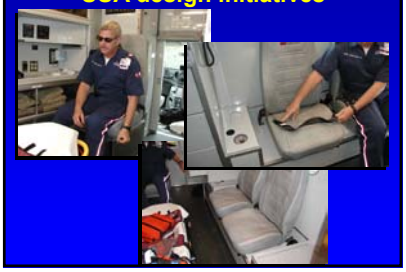
The jury is out on

- Opticon
- Simulators

The Crash Event - Crash Testing

- An introduction
- What one needs to know
- What do the tests really mean
- And, what tests are meaningful

USA design initiatives



concept vehicles I & II

New Australian vehicles

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

Flexibility to manage two patients

UK Ambulance vehicles

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

What's missing

1. What data is collected nationally?
   - We have no denominator data
   - We have incomplete numerator data
2. Absent population based national injury data or injury mechanics data
3. Absent structured automotive safety engineering input

   1+ 2 +3 = resultant inability to design and evaluate efficacy of injury interventions

4. What oversight is there
5. Which organizations would determine policy

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'

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

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

PREDICTABLE
PREVENTABLE
and
NO ACCIDENT

Any Questions??

Electronic handout available online

http://www.objectivesafety.net