Edmonton 1st EMS Annual Safety Symposium,
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# Ambulance Safety – RU Safe in Your Rig??


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## 2001, 2003 & 2006


## 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

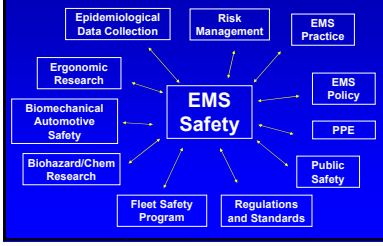
## USA EMS

- 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 - ~30 million patients
  (to Emergency Depts ~ 50%, < 1/3 emergent)
- Cost - ~$5 Billion annually
- Safety Oversight - ? Disparate

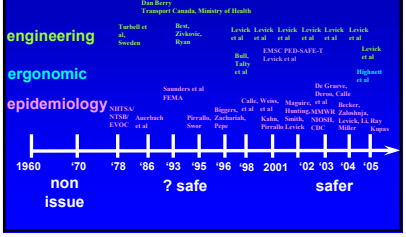
## Safety oversight of what and by …. whom

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

## EMS Safety IS Complex AND Multidisciplinary




## Ambulance Safety Research: A New Field




## So you are EMS personnel…

- What's going to kill you?
- What's going to injure you?

## 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, 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 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*

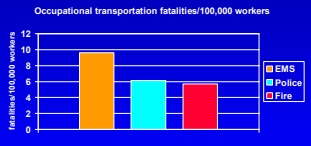
## and what is killing EMS ?

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*

## Goals

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

## 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

## Is there an acceptable rate of morbidity and mortality for pre-hospital transport systems??

## 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

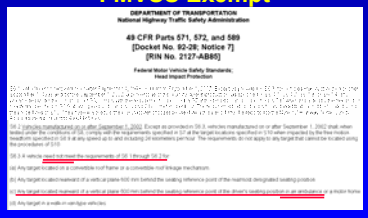
## Concerns

- 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: 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. 92-28; Notice 7]
[RIN No. 2127-AB80]

Federal Motor Vehicle Safety Standards;
Head Impact Protection

Rocky Mountain News.com

**Ambulance accident cuts caregivers' lives short**

Ride ends in tragedy on I-76 near Sterling

By Charlie Brennan and Ivan Moreno, Rocky Mountain News
May 11, 2006

Karen Woods, of Elizabeth, 43, a nurse and the mother of a 5-year-old daughter, was honored by her peers Tuesday.

Vicky Thomas, 35, a mother of three and an ultrasound technician at a North Platte, Neb., hospital, was keeping her pregnant sister-in-law company during an ambulance ride to Denver.

Woods and Thomas died Tuesday in a horrific crash on Colorado's eastern plains after the ambulance they were in clipped the rear of a semitrailer truck.

Colorado State Patrol ®

This ambulance, carrying a pregnant woman from North Platte, Neb., to Denver for prenatal care, collided with a tractor-trailer Tuesday on Interstate 76 west of Sterling. After the crash, the woman delivered a boy.

## The tragic toll?

- 2 Fatalities – Medic and the patient's mother
- 3 injuries – 1 critical requiring an airlift

**But what is the hidden and real toll?**

## 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

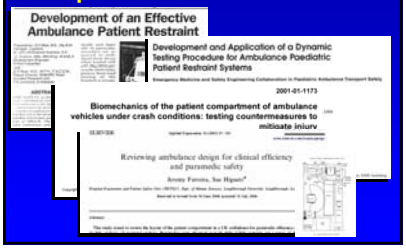
## This is about you and your safety

- 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




## Firstly!

- An accident ?
- or
  a predictable and preventable event

## EMS Research /Data Vacuum

- ? total no. of ambulances
- ? total no. of medics
- ? total no. of runs (per age & severity)
- ? total pt. miles (per age & severity)
- ? true crash fatality rate per mile
- ? crash injury rate
- ? adverse events

## What do we know now??

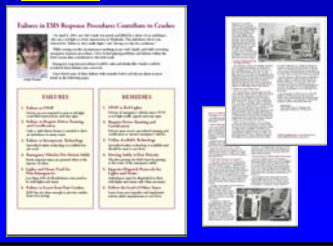
- Intersection crashes are the most lethal
- There are documented hazards, some which can be avoided
- Occupant and equipment restraint with standard belts is effective. (Over the shoulder harnesses for patients should be used, with the gurney in the upright position where medically feasible)
- Some 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??

## Launched today…

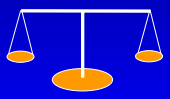

## Anecdotal crash log


## This is happening out there NOW….


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




## 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)

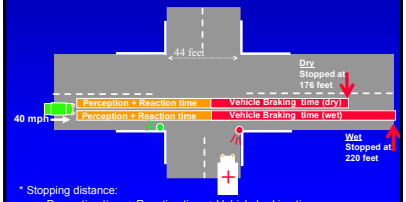
**Comparison of Crashes Involving Ambulances with those of similar sized vehicles – Adam Ray, Douglas Kupas, PEC Dec 2005;9:412-415*

## 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)**

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.

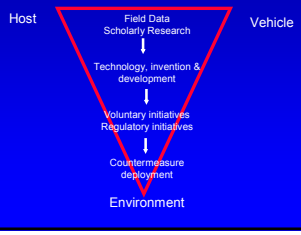
Bond for White was set at $10,000.

## Protective devices/concepts

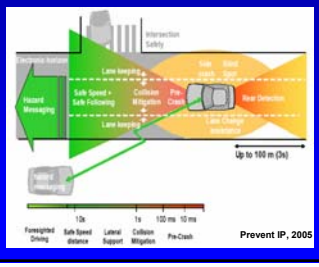
**In the event of a crash**
- Vehicle crashworthiness
- Seat/seat belt systems
- Equipment lock downs
- Padding
- Head protection

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

## Automotive Injury Triangle and Safety Development




## Intelligent Transport Safety Systems




Prevent IP, 2005


## Guidelines – standards

- Transport safety
- Practice protocols
- Occupational Health and Safety

## Technical Research

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

## 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.

## 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*

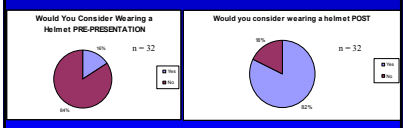
It does happen….

## 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




## Key Helmet Features

## 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

## New EMS Helmets for 2006

## The difference having data makes?


## 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

## 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.

## However, we know that intersection crashes are the most frequent & lethal


## Crash Prevention

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

## The "Black Box"

**Driver behavior monitoring and feedback device**

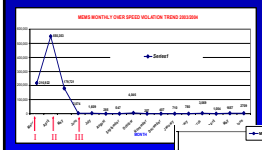
## Purpose of 'Black box' Program

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

## Video Demonstration

- Log on procedure
- Hard cornering
  - Freeway entrance ramp – tighten turn radius
- Over-speed
  - Shortened warning period to high overspeed
  - Low overspeed during deceleration
- Hard stop
  - Freeway exit – hard, but not a panic stop

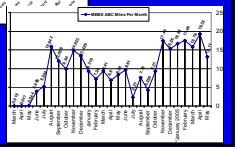
## Demonstrated Effectiveness



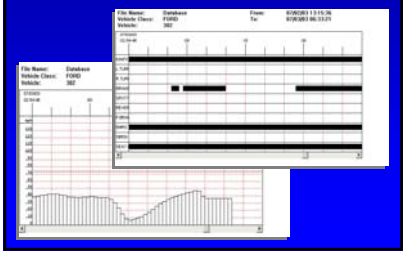
I – blind data, no growls

II – growls & tones ON unidentified data capture

III – identified data



## Unit 302 Accident



## 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

## What's missing

- What data is collected nationally
- What oversight is there
- Which organizations would determine policy

## 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

## Australia & New Zealand Ambulance restraint standard AS/NZS 4535:1999

- "Restraint systems shall apply to all equipment and people carried in an ambulance…"
- Dynamic Testing - 50th & 95th percentile manikins
- 24G in Forward and Rearward
- 10G in Transverse

## Common European Community (CEN) EN 1789:1999/A1:2003,

**European Committee for Standardization**

Medical vehicles and their equipment - Road Ambulances

- "Without exception, all persons, medical devices,equipment, and objects normally carried on the road ambulance shall be maintained to prevent them from becoming a projectile when subject to a force…"
- 50th percentile manikins - 10 G in Forward, Rearward, Transverse, & Vertical directions
- Certified by Notified Body and Ambulance Mfg.

## Commission on Accreditation of Medical Transport Systems - CAMTS Accreditation Standards

2006 revision underway

camts
Commission on Accreditation of Medical Transport Systems

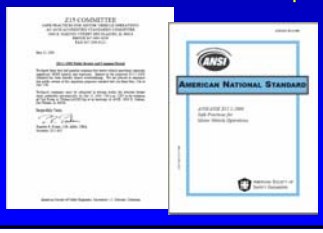
## Commission on Accreditation of Ambulance Services - CAAS


## 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**




## Scope of the Z15.1 Standard

- For the safe operation of motor vehicles owned or operated by organizations, including:
  - Definitions
  - Management Leadership Administration
  - 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.

## 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

## Goals

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

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

## Peds Transports

- ~One in ten ( ~ 6 million) ambulance transports involves a child
- Only ~ 1.8 million are children <5 yrs
- Ambulances ≠ standard passenger vehicles
- Pediatric patients in ambulances ≠ children in passenger cars
- Standard automotive safety practices cannot be applied directly to ambulances

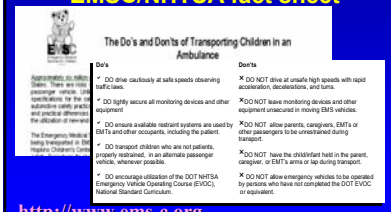
## Kids are not little adults

- Behavior
- Communication skills
- Fear
- Development
- Size and shape
- Biomechanics

in a collision at 35 mph (60 km/hr), an unrestrained 15 kg child is exposed to the same forces* as in falling from a 4th story window

*550 kg/force in 0.03 sec

## Transport Safety Guidelines EMSC/NHTSA fact sheet



The Do's and Don'ts of Transporting Children in an Ambulance

**Do's**

- ✓ DO drive cautiously at safe speeds observing traffic laws.
- ✓ DO tightly secure all monitoring devices and other equipment
- ✓ DO ensure available restraint systems are used by EMTs and other occupants, including the patient.
- ✓ DO transport children who are not patients, properly restrained, in an alternate passenger vehicle, whenever possible.
- ✓ DO encourage utilization of the DOT NHTSA Emergency Vehicle Operating Course (EVOC), National Standard Curriculum.

**Don'ts**

- ✗ DO NOT drive at unsafe high speeds with rapid acceleration, decelerations, and turns.
- ✗ DO NOT leave monitoring devices and other equipment unsecured in moving EMS vehicles.
- ✗ DO NOT allow parents, caregivers, EMTs or other passengers to be unrestrained during transport.
- ✗ DO NOT have the child/infant held in the parent, caregiver, or EMT's arms or lap during transport.
- ✗ DO NOT allow emergency vehicles to be operated by persons who have not completed the DOT EVOC or equivalent.

http://www.ems-c.org
http://www.nhtsa.dot.gov

## Crash Occupant Protection

- collision speed
- direction of impact
- vehicle stiffness and mass
- compartment size & projectiles
- passive protection
- head protection
- occupant restraint/belts

## Crash Prevention

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

## Deer me! … or is that duck?!

Struck deer smashes through ambulance windshield

Lands partially in rear compartment where a patient was being transported

Princeton Animal Control Officer Mark Johnson had the unenviable — and probably once-in-a-lifetime — task of removing a deer from the back of an ambulance Tuesday.

The private Able Ambulance was traveling southbound on Route 206 in Princeton Township shortly before 11 a.m., moving at a normal non-emergency speed, when a deer leapt out into the roadway and was hit. The animal crashed through the windshield, spread-eagled the driver, and landed partially in the rear compartment, where a

## 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

## Multidisciplinary collaboration and the way forward

- Development of interdisciplinary teams
  - healthcare professionals
  - safety engineering expertise
  - regulatory bodies
  - manufacturers
- Safer practices save lives, time and money

## Dynamic Safety Testing

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

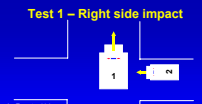
## Dynamic Sled Testing of Ambulance Pediatric Restraints

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


## Why do we do this?

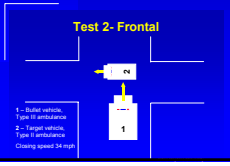
## Full Vehicle Crash Tests - 2000

Test 1 – Right side impact

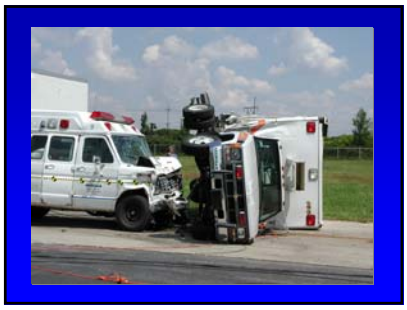



1 – Target vehicle, Type I ambulance
2 – Bullet vehicle, Type II ambulance
Closing speed 44 mph

Test 2- Frontal




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

## Safety Enhancements Being Implemented

- EVOC
- Tiered dispatch
- Monitoring & Feedback devices
- Helmets
- Optimized ambulance vehicle design
- New Standards

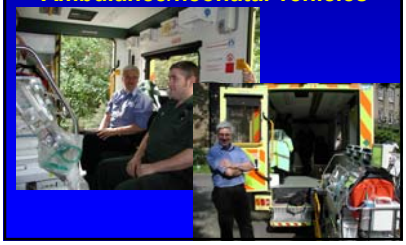
## USA design initiatives


## New Swedish vehicles

## New Australian vehicles

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


## New UK London Ambulance/neonatal 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?

## A glimpse of the future


## What we know:

- 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

## 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

## EMS Transport Safety

**Policy that Reflects SCIENCE**

## Important Principles !

1. Ambulances are NOT standard passenger vehicles

## Important Principles !

2. Design, performance and practice policy should be based on properly conducted science

## Very Important Principle

3. Ambulance transport safety is part of a SYSTEM, the overall balance of risk involves the safety of all occupants and the public

## Very 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

## 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

Thank you! Any Questions??

http://www.objectivesafety.net