AMBULANCE SAFETY
EMS - Is it Safe??!!!
What you should know if you DRIVE or RIDE in an Ambulance

Nadine Levick, MD MPH
CEO, Research Director
EMS Safety Foundation
Objective Safety LLC

Aspen EMS Safety Symposium, Aspen, CO, July 5-7th, 2007
Thursday July 5, 2007 @ 1600-1800
ASPEN VALLEY HOSPITAL CONFERENCE ROOM A
Saturday July 7, 2007 @ 0900-1100
CARBONDALE FIRE & AMBULANCE TRAINING CENTER

A tragic emergency health care intervention outcome

An ETT down the wrong hole may kill your patient and be a terrible burden for the pts family and for the medic involved
BUT an EMS crash can kill all involved AND wipe out an EMS systems response capacity……

A devastating tragedy…

Outline
I. Review of data on ambulance crashes and safety standards and guidelines that exist for the ground EMS
II. Identification of ground EMS transport safety issues, hazards and areas of risk to patients, providers and public
III. Highlight unacceptable mythology and challenges to advancing EMS transport safety
IV. Profile innovation, new safety technologies and strategies and knowledge transfer to enhance safety and reduce risks of ground EMS and patient transport

New paradigm - Integration of EMS

Public health departments
Social service agencies
Community outreach
Hospitals
Health care networks / Insurers
Industry

EMS Transport Safety

‘patient safety’
AND also
‘provider’ and ‘public safety’

Key Elements to Safety

Data Capture
Vehicle Biomechanics and Crashworthiness
Ergonomics and Biohazards
Transportation Environment
Safety Management – evaluation and analysis

Carl Craigle EMT-P, Chief Platte Valley Ambulance

“Ambulance transport has a death toll……”
What are the solutions?

- Training?
- Practice Policy?
- Transportation Systems Engineering?
- Automotive Engineering?
- Education of other road users??

Some recent adverse outcomes

UPS and Laundry trucks have very similar design and even more stringent safety requirements to EMS vehicles

BUT

very different cargo……

People are passengers and NOT packages or parcels

http://www.objectivesafety.net

News we don't want to see

Caught On Video: EMT Struck By Car

May 21st, 2007, Seattle

Some odd facts

- Ambulances are generally not built by the automotive industry
- Intelligent Transportation Systems (ITS), transportation safety engineering and transport systems engineering are not generally integrated into EMS systems
- Although all EMS systems have medical direction and oversight, it is rare for there to be transportation expertise oversight
Fatalities and funerals

An interhospital transport?

An accident?

Firstly!

An accident?

or

a predictable and preventable event

IMPORTANT ADVISORY

Due to respect for the wishes of the families of medics killed in the line of duty there is to be NO PHOTOGRAPHY of any aspect of the images in this presentation - that is NO video, NO photography, NO digital images of any type

EMS Best Practice, Sept 2006

1960 to 2006

Ambulance Safety Research: A New Field

We’ve known for 10 years that red fire trucks are twice as likely as lime yellow trucks to crash at an intersection

1960 to 2006
Recommendations

• EVOC

LICENSE RECORDS

NTSB 1979 Accident Report

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)


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##

* 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
# 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

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


Occupational Health and Safety.....?

• This IS an Automotive Safety issue

• WE HAVE A BIG PROBLEM HERE

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

A few weeks ago....

EMS PREVENTION

The Huntsville Times

June 2007
A problem
2007 Insurance data –
27 fold more likely to have a claim based on transport than related to medical care

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

USA EMS
- EMS Systems - >15,000
- Personnel - ~1 million
- ~30% F/T professional & 70% volunteer
- Vehicles - ~60,000
- (Type I, Type II, Type III, Freightliners, ?motorcycles)
- Transports - ~50 million
- (to Emergency Depts – 50%, < 1/3 emergent)
- Cost - ~$8 Billion annually
- Safety Oversight - ? Disparate

A Simple Question….
Unique workplace
- In vehicles
- At roadside and other emergency scenes

The ‘workplace’ IS a vehicle
- EMT’s often in vulnerable positions during transport.
  - Bench seat
  - Captains chair
  - Standing or kneeling

The ‘workplace’ is also a crash scene

the EMS transport 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

The Emergency Department (ED)
An ambulance is not an ED / ICU on wheels

EMS Transport Safety IS Complex AND Multidisciplinary

EMS Safety
  - Epidemiological Data Collection
  - Risk Management
  - Public Safety
  - EMS Policy
  - Driver Training
  - Fleet Safety Program
  - Ergonomic Research
  - Biomechanical Automotive Safety
  - Biohazard/Chem Research
  - Communications Technology

EMS Safety Regulations and Standards

EMS Practice

Ergonomic Research

Biomechanical Automotive Safety

Biohazard/Chem Research

Communications Technology

EMS Safety Regulations and Standards

Fleet Safety Program

Risk Management

Public Safety

EMS Policy

Driver Training

This is not acceptable

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

This IS an Automotive Safety issue

Occupational Health and Safety…..?

This IS an Automotive Safety issue

Is it your services tragic year?

- 50 fatalities a year
- 15,000 EMS services
- Each year one in 300 services experiences a fatality

Paramedic charged in crash that killed 2

- Paramedic charged in crash that killed 2

- Paramedic charged in crash that killed 2
Key Issues

- Mythology - that Emergency Medical Service personnel are safe
- Injury Hazards
  - Violence
  - Cheernradiatorad
  - 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

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 transportation 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?

Balance of concerns and risk during transport

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

Case Study 1

- Transporting a psychiatric patient

An 'Accident'…? 

- On their way TO the hospital
- With a patient who was not in cardiac arrest or in a life threatening situation
- All 5 in the ambulance critically injured

Case Study 2

- Transporting a child

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 about you and your safety

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

NAEMT July 2006 Position statement

The truck and bus industry is on the right track.... Where is EMS??

EMS Transport 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

Case 3

- Enroute to a routine call

FMVSS exempt......
Case 4

- Transporting a pregnant woman

Predictable

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 Don'ts
  - ASTM, CAAS and CAMTS

USA ambulance purchase specifications


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

Occupant protection......??

KKK – static ‘safety testing’

- Ignorant of automotive safety principles – and specifies -
  - No structural damage to any load bearing or supporting members, i.e., torn or broken material, broken welds, popped or sheared body rivets, bolts, and/or fasteners, shall be evident during the application of the force and after the release of the force.

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:
  \[ \text{Incident rate} = \frac{\text{Number of incidents}}{\text{Number of vehicles}} \times 100 \]

- Incident rate based on vehicle mileage:
  \[ \text{Incident rate} = \frac{\text{Number of incidents}}{\text{Vehicle mileage}} \times 1,000,000 \]

- Injury incident rate based on vehicle mileage:
  \[ \text{Injury incident rate} = \frac{\text{Number of incidents}}{\text{Vehicle mileage}} \times 1,000,000 \]

- 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.
  
  \[ \text{Incidents per 10,000 transports} = \frac{\text{Number of incidents}}{\text{Number of transports}} \times 10,000 \]

- Vehicle injury rates based on work hours:
  \[ \text{Vehicle incidents per 200,000 hours} = \frac{\text{Number of incidents}}{\text{Number of hours worked}} \times 200,000 \]

Legal Perspectives on Z15

And very Predictable…

- Intersections are lethal environments

The real world

Intersection passenger car stopping distance at 40 mph dry and wet

\[ \text{Stopping distance} = \text{Perception time} + \text{Reaction time} + \text{Vehicle braking time} \]

Injury incident rate based on vehicle mileage:

\[ \text{Injury incident rate} = \frac{\text{Number of incidents}}{\text{Vehicle mileage}} \times 1,000,000 \]

Increasing awareness …

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??

'Workplace' Hazards
Case Study 5
Transporting a trauma patient

The ‘accident’ scenario...
- There were three personnel in the back of the ambulance plus the patient.
- The patient being treated had a self inflicted laceration with an arterial bleed to an upper extremity.
- The ambulance was traveling lights and sirens and moving slowly through an intersection when they were involved in a T-bone collision.
- They were struck on the passenger side of the vehicle near the rear of the box.

At the time of the ‘accident’...
- The paramedic with the serious head injury was seated and unrestrained on the bench seat over the rear wheel well on the impact side of the vehicle.
- At the time of impact, the paramedic with the head injury had just finished starting an IV and he was discarding his needle in a wall mounted sharps container.
- A second Paramedic was standing at the head of the patient involved in an unknown activity. An EMT was standing near the front of the bench seat, holding direct pressure and elevating the patient's arm upright.

The tip of the iceberg of the ‘accident’ outcome..
- The second paramedic and the EMT received minor soft tissue injuries only.
- The paramedic with the head injury was intubated for a short time and then extubated later that same evening.
- He is back to work after a couple of months off the job. He is not working as a paramedic yet, but he is back on the line as a chief's aid until his doctor gives him permission to return to active duty status. He has been dealing with memory problems and the need to sleep for longer hours than normal.

Case Study 6
Transporting a routine stable patient

But what about head protection?

It does happen...
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

Problems

- No Standards
- Unique safety and hazard protection needs
- A number of less than appropriate devices out there

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???

It isn’t like this outside of the USA

Innovation

What’s new

- New automotive safety technologies
  - Crashworthiness
  - EVS
  - ITS
  - Monitoring and feedback enhancements
- New expertise
  - TRB
  - ASSE
  - SAE
  - UTRC
  - Ergonomics
  - Industrial Design
Last months JEMS

eg: Scandinavia Innovation in Vehicles, and Equipment

This looks cool AND SAFE!

Tips for Emergency Vehicle Operations

Transportation Research Board is an excellent resource... we should be using it!!

No need to reinvent the wheel...

USFA Emergency Vehicle Safety Initiative

March 2007 - FHWA
Ambulance Driver Safety - Australia

Fleet Driver Training...

Dynamics of Fleet Safety - NSC

Automotive Injury Triangle and Safety Development

Protective devices/concepts

Intelligent Transport Safety Systems

Back up Camera…. Shouldn’t all vehicles have one of these?

Purpose of ‘Black Box’ Program

The “Black Box”
Driver behavior monitoring and feedback device

- Decreases injury and property damage
- Helps identify high risk drivers
- Improves driver behavior

Purpose of ‘Black Box’ Program
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation
How the Device Works
- Computerized monitoring device installed on each vehicle to measure parameters
- Each driver has individual key “fob”
- Data collected every second including: vehicle speed and performance, driver behaviors and emergency mode
- Auditory feedback of warning ‘growls’, and penalty tones
- Data downloaded automatically every day

Demonstrated Effectiveness
- 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 in-service or retraining after the initial introduction period.

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 in-service or retraining after the initial introduction period.

A key to safe ambulance transport
- 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

Active Projects
(all due early 2007)
- 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

How the Device Works
- Computerized monitoring device installed on each vehicle to measure parameters
- Each driver has individual key “fob”
- Data collected every second including: vehicle speed and performance, driver behaviors and emergency mode
- Auditory feedback of warning ‘growls’, and penalty tones
- Data downloaded automatically every day

Patients must be in the over the shoulder harness, medics restrained in seat belts, equipment secured

Foldable

Johns Hopkins University

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 - Target vehicle, Type II ambulance
2 - Bullet vehicle, Type III ambulance
Closing speed 34 mph
High speed crash, rolled and the occupants (patient and medics) had only minor scratches.

Major events for innovation sharing – but regional and often language isolation.

Vehicle Occupant Safety design

2007 European design

Safety technology is a key focus.

Ergonomic design

Securing equipment

Ergonomic layout and equipment
Policy Changes

Safety leadership... from the IAFC and USFA

CPR?

Integration and Collaboration

‘Safety’ approaches being driven by manufacturers claims and sales rather than by science and data

Vehicle design and safety

- The principles of automotive safety involve a complex science, engineering technical skill, expertise, training and knowledge

- “Give the engineers a working list of our needs and let them tell us how it should be built to accomplish those tasks...”

The squad bench??

Being seated IN an automotive seat is what will protect you

- Anything that allows or encourages you to get up out of your seat will also encourage you to be injured or killed – it is potentially lethal to be out of your seat in any fashion

- 4 or 5 point harnesses for side-facing occupants are potentially lethal – and is in NO WAY SUPPORTED BY ANY DATA OR AUTOMOTIVE SAFETY EXPERTISE
Were we safer in the Cadillac???

Air EMS is a role model for safety initiatives and focus

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

Creating a Safety Culture
within a company must start with upper management’s commitment to safety
- Awareness
- Training
- Incentive

An excellent model

http://www.EveryoneGoesHome.com

New Australian vehicles

Firefighter Fatalities in the United States in 2005

Fires were a primary cause of both firefighter and civilian fatalities in 2005.
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 Policies and 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

Conclusion

- EMS transport has serious hazards and safety issues
- 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
- Failure to transfer knowledge from transportation and automotive safety is unacceptable and dangerous
- 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