A devastating tragedy…

- 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 tragic emergency health care intervention outcome

It does happen.....

Outline

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

"Ambulance transport has a death toll....."

Carl Craigle EMT-P, Chief Platte Valley Ambulance
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

What are the solutions?
- Training?
- Practice Policy?
- Transportation Systems Engineering?
- Automotive Engineering?
- Education of other road users???

http://www.objectivesafety.net

Case Studies
- Crash 1 – Transporting a psychiatric patient
- Crash 2 – Transporting a child
- Crash 3 – Enroute to a routine call
- Crash 4 – Transporting a pregnant woman
- Crash 5 – Transporting a trauma patient
- Crash 6 – Transporting a routine transport stable patient

News we don't want to see
- May 21st, 2007, Seattle
- May 25th, 2007?
- Help is on the way ???
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? “Do no harm…”?
- First of all, for a predictable and preventable event.
- EMS Best Practice, Sept 2006
- 1970 to 2006

Best Practices?
Ambulance Safety Research: A New Field

We should use the best safety practices demonstrated in engineering and in ergonomics.

EMS Provider Fatalities

- 12.7 fatalities/100,000 EMS workers
- Greater than 2 × 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) & 75% of fatally restrained occupants (OR 2.5 vs unrestrained)
- 92% of fatally injured EMS rear occupants unrestrained
- Serious head injury in 65% of fatal occupant injuries
- 70% of fatal crashes EMS crashes during Emergency Use

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

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
  - Training and psychological counseling of personnel involved and others
  - Increased insurance rates

A few weeks ago....

The Huntsville Times

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

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 ~$8 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
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
  - Captain’s chair
  - Standing or kneeling

The ‘workplace’ is also a crash scene

the EMS transport process

- Communications/dispatch
- The patient
- Restraining device/seating
- 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
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

Is it your services tragic year?
- ~ 50 fatalities a year
- 15,000 EMS services
- Each year one in 300 services experiences a fatality

Key Issues
- Mythology
  - That Emergency Medical Service personnel are safe
- Injury Hazards
  - Blunt
  - Shrapnel
  - Chemical/Radiation
  - Physical/Mechanical trauma – THE BIG PROBLEM
- Motor Vehicle Crashes are the highest cause of death at work – EMS has a 3X the mean national rate
- An R & D and Regulatory Gap
  - Occupational Health and Safety – Exposure data are scant
  - Automotive Safety – a vehicle is the work place – 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
   - 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

EMS Injuries

- James Woodman
  - is a paramedic who, on literally his first day as a paramedic, suffered a severe TBI when the ambulance he was riding in (in the back) was t-boned and rolled onto its side. He remains in a persistent vegetative state in an ECF in Colorado. His father describes that when each week he visits him, tells him the news of the week, and goes home, knowing inside that he has been talking to himself.

- It is assumed that when the ambulance rolled onto its side, the lifepack 10 struck James in the head.

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, Specifications and Guidelines
- EMS Safety and Performance Standards
  - Australia & New Zealand 4835
  - 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

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

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

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.

F = ma
where
F – force
m – mass
a – acceleration

Bottom line
- The AMD should consider revising the standard comprehensively to reflect current accepted automotive safety practice, given the current vehicle crashworthiness and occupant protection knowledge and published literature.

Z15 Incident Rates
- Incident rate based on number of vehicles operated:
  - Incident rate = Number of incidents / Number of vehicles
- Incident rate based on vehicle mileage:
  - Incident rate = Number of incidents / Vehicle mileage
- Injury incident rate based on vehicle mileage:
  - Injury incident rate = Number of incidents with injury / Vehicle mileage
- Incident rate based on service activity:
  - Incidents per 10,000 transports = Number of incidents / Number of transports
- Incident rate based on work hours:
  - Incidents per 200,000 hours = Number of incidents / Number of hours worked
- Vehicle injury rate based on work hours:
  - Vehicle injury rate = Number of incidents with injury / Number of hours worked
Legal Perspectives on Z.15

And very Predictable...

Intersections are lethal environments

“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)

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

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??

Case Study 5

Transporting a trauma patient

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

*Stopping distance: Perception time + Reaction time + Vehicle braking time

** Dry

** Wet

** Stopping distance: Perception time + Reaction time + Vehicle braking time (varies with age, skill, agility, alertness + vehicle type, tire pressure, road etc)

Source: Anchorage Daily News

Source: Anchorage Daily News

Source: Anchorage Daily News
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 un-restrained 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 patients 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 chiefs 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

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

But what about head protection?

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

The difference having data makes?

Innovation

What’s new

• New automotive safety technologies
  • Crashworthiness
  • EVS
  • ITS
  • Monitoring and feedback enhancements
• New expertise
  • NHTSA
  • ASSE
  • IASE
  • UTRC
  • Ergonomics
  • Industrial Design

Last months JEMS

Safety at the scene
eg: Scandinavia Innovation in Vehicles, and Equipment

This looks cool AND SAFE!

Not rocket science...

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

**To prevent a crash**
- Driver feedback
- Driver monitoring
- Driver training
- Vehicle Intelligent Transportation System (ITS) technologies
- Tiered dispatch
- Appropriate policies

**In the event of a crash**
- Vehicle crashworthiness
- Seatbelt/safety belts
- Equipment lock downs
- Padding
- Head protection

#### Intelligent Transport Safety Systems

**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

**The “Black Box” - A transportation safety monitoring and feedback device**
- This technology is conceptually like a vehicle’s safety ‘pulse oximeter’ – that with auditory feedback - can save your life, your coworkers’ life, your patients’ life, and others on the road.
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

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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

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

The Crash Event - Crash Testing

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

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....
Choose the Best Option

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

Full Vehicle Crash Tests

Test 1 – Right side impact

Test 2 – Frontal

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 – Bullet vehicle, Type III ambulance

2 – Target vehicle, Type II ambulance

Closing speed 34 mph

Full Vehicle Crash Tests

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

VEGON

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...”

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

- Manufacturers' claims and sales drive safety, not science and data
- Vehicle design needs a scientific approach

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 sidefacing occupants are potentially lethal – and is in NO WAY SUPPORTED BY ANY DATA OR AUTOMOTIVE SAFETY EXPERTISE

Air EMS is a role model for safety initiatives and focus

- A Safety Culture
- Protective Policies
- Protective Devices
  - in the event of a crash
  - To prevent a crash
- Continuous Education and Evaluation

Safety Management

The squad bench??

and those rock climbing harnesses??

Were we safer in the Cadillac??

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

USA design initiatives

New Australian vehicles

Flexibility to manage two patients

UK Ambulance vehicles
Other successful models

Fleet Mix?

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

Predictable Preventable and NO ACCIDENT

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