Ambulance Safety -
What You Can’t Afford Not To Know
A Crash Course in Vehicle Safety and Crashworthiness

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I’d like to know what can be done so this never happens again."

Friday July 20th 2007...
The worst ambulance crash in USA history

Five Killed in Crash of Ambulance and Semi

July 21, 2007 06:20 AM EDT

Five people were killed when a semi truck collided with an ambulance carrying a critically injured patient.

A tragic emergency health care intervention outcome

It does happen....

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......

Charged with Vehicular Homicide

Two EMTs, ambulance driver faces charges in crash - NBCNews.com

Joseph J. Haman, 22, of Allentown, drove the ambulance that struck another vehicle on the 100 block of Killian Street in Reading on August 27, 2007.

NBC News

Car, Ambulance Collide in Marshall Township; 2 Dead

July 29, 2007 09:26 AM EDT

Two people were killed in a head-on collision between a car and an ambulance in Marshall Township Wednesday.

Emergency personnel said the driver of the ambulance was not hurt and the patient he was transporting was not seriously injured.

Emergency personnel said the patient was not seriously injured.
…as he had been trained to do…??

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

Key Elements to Safety

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

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

Federal Motor Carrier Safety Administration….

A very serious gap in data, performance and oversight

- FMCSA Truck safety goals – to decrease the fatality rate of 2.8 per 100 million truck-miles in 1996 to 1.65 by 2008
- EMS crash fatality estimates are - 7.66 - 41.93 fatalities per 100 million ambulance-miles

Firstly!

- An accident?
- or a predictable and preventable event

Testing the real world
Some odd facts

- Ambulances are generally not built by the automotive industry.
- Intelligent Transportation Systems (ITS), transportation safety engineering is 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.

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.

Canada - Corporate Manslaughter Corporate Homicide Act: 8th April, 2008

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very different cargo.....

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1960 to 2007

A passenger vehicle - sure

A laundry or mail truck? 

A passenger vehicle.
It does happen...

But what about head protection?

EMS Transport Safety

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

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

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

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

*FARS/BTS 2005-6
The Emergency Department (ED)

An ambulance is not an ED/ICU on wheels

Ground Transport Safety IS Complex AND Multidisciplinary

- Epidemiological Data Collection
- Ergonomic Research
- Biomechanical Automotive Safety
- Biomechanical Research
- Communications Technology
- Safety Technology
- Resuscitation and Standards
- Fleet Safety Program

Transport Safety

Risk Management

Public Safety

Transport Policy

This IS a Transportation and Automotive Safety issue

This is a Systems safety issue

New Information 2006-2008

- Enhanced Safety of Vehicles (ESV), June 2007
- American Society of Safety Engineers (ASSE), June 2006 & June 2007
- International Ergonomics Association (IEA), June 2006
- Transportation Research Board – EMS Safety address, Jan 2007
- AND Engineering Public Comments, July 2007
- OSHA, August 2007
- OSHA September 11, 2007 Federal Register
- SAFETY 2006
- OSHA, Ergonomics
- Federal Register, Enhanced Safety of Vehicles Act
- State Strategic Highway Safety Plans, October 2007
- State EMS Council Policies
- APHA, Nov 2007
- OSHA EMS best practices late 2008
- Transportation Research Board – Inaugural EMS Safety
- Worker visibility Act, to be implemented, Nov 2008

Arizona, September 11th 2001

SAE MILITARY AND EMERGENCY VEHICLES SAFETY

Safety Management

- A Safety Culture
- Protective Policies
- Protective Devices
  - To prevent a crash
  - In the event of a crash
- Continuous Education and Evaluation
The Crash Event - Crash Testing
- An introduction
- What one needs to know
- What do the tests really mean
- And, what tests are meaningful

Intrusion vs Deceleration
- Intrusion
  - vehicle to vehicle or vehicle to fixed narrow object
- Deceleration
  - sudden stop – ie. sled test

Intrusion

Deceleration

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?

And this all takes place in 60 millisecs – the blink of an eye

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
Absence of standards and oversight

- Challenges in identifying best practice
- Myriad of unregulated commercial products
- No safety performance standards
- Absent national safety oversight

Ambulance Standards??

- KKK?
- AMD?
- FMVSS?
- NFPA?

USA Ambulances: FMVSS Exempt

Propaganda that kills...

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

KKK – static ‘safety testing’

- Ignorant of automotive safety principles – and specifies that a ‘successful test’ is -
  - 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.

Occupant protection??

July 2007

30 years later, 1,600 fatalities and still the same problem

Unacceptable, and ridiculous current 2007 USA ambulance ‘safety testing’ practices!!??

Medic Survivors

Medic Fatality

30 years later, 1,600 fatalities and still the same problem
No ‘a’… then NO ‘F’ !!!!!

\[ F = ma \]

where
- \( F \) = force
- \( m \) = mass
- \( a \) = acceleration

FMVSS exempt…….

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)

Side facing 4-point harnesses demonstrated to be lethal, even at slow ground vehicle speeds

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

And very Predictable…

- Intersections are lethal environments
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

40 mi/h

<table>
<thead>
<tr>
<th>Condition</th>
<th>Stopped at</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>176 feet</td>
</tr>
<tr>
<td>Wet</td>
<td>220 feet</td>
</tr>
</tbody>
</table>

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

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??

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....."

Rash of “Safety Concept” vehicles..... Devoid of substantive automotive safety engineering input or testing

Most recent - Attention to vehicle visibility... but failures of occupant protection and systems engineering

?!?
Bigger is not necessarily better……

An admirable goal – BUT… implementing interventions that have not in anyway been demonstrated to be effective let alone safe is a very serious problem

NO automotive safety engineer
NO crashworthiness engineer
NO ergonomist
NO reference to ANY existing or relevant automotive safety or crashworthiness technical publications…. yet multiple occupant fatalities and injuries annually….

There is NO vehicle safety without real world injury data and automotive safety expertise

With what authority has ground EMS squandered $3,000,000 on these concept vehicle shams??

We NEED meaningful injury data to better understand the mechanism of injury and fatality

A crash test program without automotive safety expertise and real world representative injury data is irresponsible

Without real world injury data it is not possible to effectively measure the burden of the hazard NOR the effectiveness of any interventions

What’s new

- New automotive safety technologies
  - crashworthiness
  - EVS
  - ITS
  - Monitoring and feedback enhancements

- New expertise
  - TRB
  - ASSE
  - SAE
  - UTRC
  - Ergonomics
  - Industrial Design

Benefit of Safety

- Safe practices save lives, time and money

Safety concepts out there now

- Driver feedback technologies
- Tiered dispatch
- Enhanced ambulance vehicle design
- Intelligent Transport Technologies - ITS
- New Safety Standards

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
Ergonomic layout and equipment

NSW Australian vehicles
Flexibility to manage two patients
Australia, Melbourne

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?

Were we safer in the Cadillac???

Technical information available

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Technical information available
“Ripoff and Duplicate”
- Avoid reinventing the wheel at all costs
- Where are the best practices that we need to transfer knowledge from

Risk/Hazards
- Predictable risks
- Predictable fatal injuries
- Serious occupational hazard
- Public safety hazards

Ergonomics of transport SAE 2007 papers

Safe Practices for Fleet Motor Vehicle Operations

What Z15 encompasses
- Safety Program
- Safety Policy
- Responsibilities and Accountabilities
- Driver Recruitment, Selection and Assessment
- Organizational Safety Rules
- Orientation and Training
- Reporting Rates and Major Incidents to Executives
- Oversight

Z15 Incident Rates
- Incident rate based on number of vehicles operated:
  Incident rate = Number of incidents / 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 rate = Number of incidents with injury x 1,000,000 / Vehicle mileage
- Incident rates based on service activity:
  Incident rate based on service activity:
    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

Best Practices?
- The technology described in your junk mail is far more advanced than that used in your truck
EMS Best Practice, Sept 2006

September 2007, Its not magic......

Valuable information from the transportation industry

These folks know what we need to know...

IAFC June 2007

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

The truck and bus industry is on the right track at the TRB

Knowledge transfer

Active Projects, July 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

July 2007
August 2007

Tips for Emergency Vehicle Operations

An excellent model

www.EveryoneGoesHome.com

September 11, 2007

www.GlobalEMSForum.org recent Visibility Webinar

Science not, next best guess

UMTRI TRANSIT-TRANSIT (UMTRI)

Distance of Nighttime Visibility

www.UMTRI.org

Figure 3. The xenon strobe lamp and projectable social stimuli of "steering" handwrist, simulating the spatial cue that the vehicle is rounding a curve.
We've known for 10 years that red fire trucks are twice as likely as lime yellow trucks to crash at an intersection.

Elwood Fire/EMS Day visibility

Night visibility

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

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