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Ambulance Safety Issues: Hazard Analysis and Crashworthiness, Where is the State of the Art?

Nadine Levick, MD MPH
CEO, Research Director
Objective Safety LLC
New York, USA

A tragic emergency health care intervention outcome

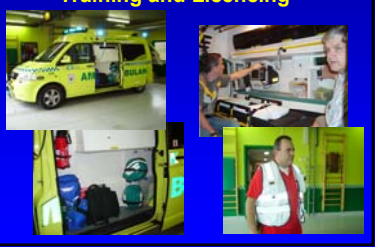
It does happen….

Even in Norway….

Norway…

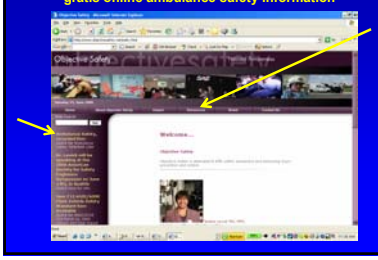
- Norway is a leader globally in ambulance vehicle safety design and performance
- Norway is a leader globally in ambulance driver training safety
- Norway is a leader in ambulance personnel safety equipment and design

Vehicles, Equipment AND Driver Training and Licencing



http://www.objectivesafety.net

gratis online ambulance safety information

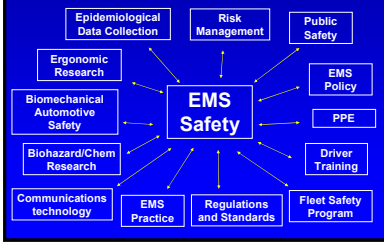


the EMS process

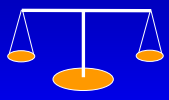
- communications/dispatch
- the patient
- restraining device/seat
- transporting device/gurney
- paramedics/transport nurses, doctors & family
- patient monitoring equipment
- clinical care & interventions
- protective equipment
- the vehicle
- the driver/driving skill
- other road users
- the road

TIME & PLACE

EMS Transport Safety IS Complex AND Multidisciplinary



Balance of concerns and risk during transport



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

Firstly!

- An accident ?
- or

a predictable and preventable event

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

Vision Zero:

An ethical approach to safety and mobility

- Claes Tingvall

Vision Zero is a philosophy of road safety that eventually no one will be killed or seriously injured within the road transport system. Vision Zero describes the view that safety cannot be traded for mobility. Sweden's Vision Zero is aimed at eliminating all deaths or long-term health losses arising from road crashes. The mobility in the road transport system should be a function of the safety and not vice versa".

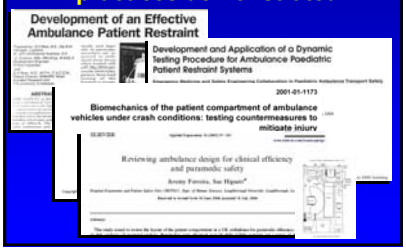
In the USA…

Ambulance safety is an issue*

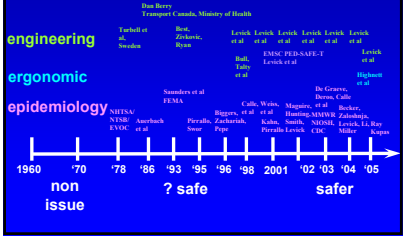
- ~ 5,000 crashes a year
- ~ One fatality each week
  - ~ 2/3 pedestrians or occupants of other car
  - Approximately 4 child fatalities per year
- ~10 serious injuries each day
- Cost estimates > $500 million annually
- USA crash fatality rate/capita 35x higher than in Australia

*FARS/BTS 2004-5

We should use the best safety practices demonstrated



Ambulance Safety Research: A New Field



Predictable risks

- More often at intersections, & with another vehicle (p < 0.001)*
- Most serious & fatal injuries occurred in rear (OR 2.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)*
- 82% of fatally injured EMS rear occupants unrestrained**
- > 74% of EMT occupational fatalities are MVC related***
- Serious head injury in >65% of fatal occupant injuries#
- 70% of fatal crashes EMS crashes during Emergency Use#
- More likely to crash at an intersection with traffic lights (37% vs 18% p=0.001) & more people & injuries/crash than similar sized vehicles##

*Kahn CA, Pirrallo RG, Kuhn EM, Prehosp Emerg Care 2001 Jul-Sep;5(3):261-9
**Becker, Zaloshnja, Levick, Li, Miller, Acc Anal Prev 2003
***Maguire, Hunting, Smith, Levick, Annals Emerg Med Dec 2002
#NIOSH, 2003
##Ray AM, Kupas DF, Prehosp Emerg Care 2005 Dec; 9:412-415
##NHTSA, 49 CFR Parts 571, 572 & 589 Docket no. 92-28; notice 7

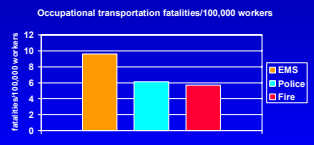
and what is killing USA EMS ?

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..



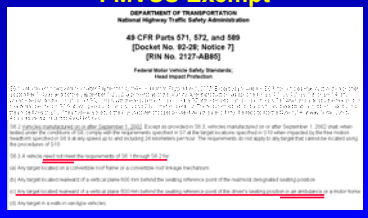
- WE HAVE A BIG PROBLEM HERE

** Maguire, Hunting, Smith & Levick, Occupational Fatalities in Emergency Medical Services: A Hidden Crisis, Annals of Emergency Medicine, Dec 2002*

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

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

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.

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

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

We need to share information globally on ambulance safety

Only two technical symposia (next planned for 2007)

The Crash Event - Crash Testing

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

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

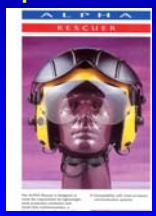
Hazards


Rollover Crash Kills Medical Technician

Ambulance Runs Off I-66 and Rolls Over, Injuring Two Employees and a Patient

It does happen….

But what about head protection?



Role of a head protective device

- A simple, immediate and inexpensive adjunct – a protective device -
  - To protect occupants from hazardous interiors
  - As vehicle crashworthiness design advances
  - As driver training advances
  - For when equipment becomes unsecured
  - As EMS Safety Standards are developed, for both EMS vehicles and EMS occupational safety

New EMS helmet prototypes for 2006-2007

Hmm…

It isn't like this outside of the USA

A number of potential interventions to enhance safety have been identified:

- Safety Policy
- Safety performance standards
- Vehicle crashworthiness
- Vehicle interior ergonomics
- Personal Protective Equipment design
- Driver training and simulation
- Safety and risk awareness modification
- Risk behavior modification
- Intelligent Transportation Systems (ITS)

The "Black Box"

Driver behavior monitoring and feedback device

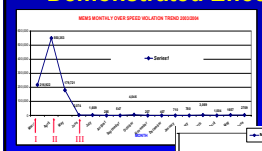
Purpose of 'Black box' Program

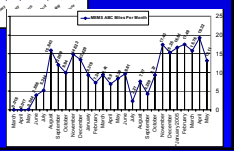
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

How the Device Works

- Computerized monitoring device installed on each vehicle to measure spectrum of 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



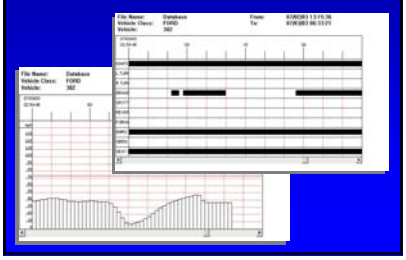


I – blind data, no growls

II – growls & tones ON unidentified data capture

III – identified data

Unit 302 Accident



Monitoring and feedback devices

- Implementation well received by the providers.
- 20% cost saving in vehicle maintenance within 6 months.
- No increase in response times
- Fewer crashes and less severe crashes
- Sustained improvement in safety proxies, with no inservice or retraining after the initial introduction period.

What we know that helps:

- Have safety policies and procedures
- Crashworthy vehicles and design
- Secure providers and other seated occupants with existing restraints
- Secure patient with over the shoulder harness
- Secure Equipment
- Effective driver training and licencing programs
- Use driver and vehicle monitoring and feedback technology
- Protective equipment
- Use tiered dispatch

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

PREDICTABLE
PREVENTABLE
and
NO ACCIDENT

Conclusion

- Major advances in EMS safety research, infrastructure and practice over the past 5 years
- There are clear and very serious safety risks and hazards in ambulance transport
- Technologies for safe vehicle design, occupant PPE and equipment restraint and driver performance are available
- Enhanced cross disciplinary and global collaboration in development and dissemination of safety initiatives are key