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Ambulance Transport Safety Trends: Separating Fact from Fiction

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Webinar Basics
- Raise Hand
- Text messaging
- Type in your name and location
- The 'mic'

Webinar Basics
- pick up the 'blue pen tool' and choose your color

Today's Webinar is recorded!
The presentation and all comments typed in the text box

is available for viewing via a public access link on www.objectivesafety.net

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

Who am I?
- Nadine Levick MD, MPH
- Emergency Medicine Physician and Public Health Academic, (USA-Hopkins, Harlem, Maimonides, Brookdale & Australia – Royal Melbourne, Royal Childrens Hospitals, Royal Australian Flying Doctor Service)
- Chair, National Academies Subcommittee TRB EMS Transport Safety, USA
- Founder of EMS Safety Foundation
- Recipient, International Society of Automotive Engineers, Women’s Leadership Award for EMS Safety

Emergency Medical Service Transport
- What are the transport safety issues that pertain to this important public service and public safety industry?
- What do we know of the risks and hazards and how can we measure these?
- How can the safety of this transport system be optimized?

Where am I really from? ...Yes, it IS that big!

San Francisco
Boston
Los Angeles
Baltimore
Sydney
Melbourne
Perth
Here!
Things can go wrong – but when there are sound safety policies and technologies in place, and the system is well prepared, you can minimize harm.

From birds to volcanoes...

The Iceland Volcano Eruption of 2010 (Eyjafjallajökull Volcano)

Your Interactive Handout and Recording link awaits you online at...

- [www.objectivesafety.net](http://www.objectivesafety.net)

This WILL be FAST!!
No need to take any notes – all text slides will be awaiting you in your online Handout.

So, what are the facts?

And how to determine what is fiction??

Sweden a world leader in ambulance safety testing

1876 - European Ambulance
2009 - State of the Art Swedish Ambulance

Safety design
Forward facing crew seats

Storage and Patient Loading

Emergency Medical Services (EMS)
An important and unique transport system
- Public safety, public health and emergency service
- Is there to save lives

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

EMS Transport Safety
- ‘patient safety’
- ‘provider’ and ‘public safety’

Ground Ambulance Transport Safety IS Complex AND Multidisciplinary

Transport Safety

The Public Health Paradigm
1. Define the problem
2. Measure its magnitude
3. Understand the key determinants:
   a. Biological etiology: host, agent, vector
   b. Environmental & biomechanical influences
   c. Social/behavioral practices of at risk pop.
4. Develop intervention/prevention strategies
5. Set policy/priorities
6. Implement and evaluate
Transport related aspects -

- dispatch of EMS/Medical transport vehicles
- transport policies and protocols
- vehicle fleets and vehicle design
- vehicle purchase standards
- Intelligent Transportation Systems (ITS) technology
- driver training
- driver performance monitoring
- roadside and road design
- integrated traffic safety technologies
- scene safety and visibility
- safety data capture
- safety oversight

Real world answers to real world questions -

- What features will enhance safety of my new vehicle purchase?
- What color scheme do I want on my vehicle to make it safest?
- Do I need a helmet, and if so which one?
- What policies offer the safest system?
- How do I get my team to address safety issues?
- What data should I collect when something goes wrong, and how to analyze it?

The Ostrich Syndrome?

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

and what is killing EMS?

- WE HAVE A BIG PROBLEM HERE

Predictable risks

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

Ambulance transport a serious USA transport safety problem...

- the most lethal vehicle on the road both per mile travelled and per vehicle
- is exempt from federal commercial fleet safety oversight (FMCSA)
- 2/3 fatalities not in the ambulance
- Exempt from most FMVSS standards

January 10, 2008
This is not a crashworthy environment.

Jan 28th, 2008

In this vehicle...

April 14th, 2008

June 17th 2008

a paramedic and a patient killed

October 31, 2008 - Kentucky

April 30, 2009 - Tennessee
What is your transport safety record in your service?

How can you improve if you don’t have a meaningful measure of safety performance?

Transport safety is not guesswork, it is a science

Data...

Haddon/Baker/Runyan Phase-Factor Matrix as applied to EMS Safety
USA EMS

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

USA EMS transport safety data estimates

- ~ 50,000 vehicles
- ~ 9,000 crashes a year
- ~ One fatality each week
- ~ 2/3 pedestrians or occupants of other car
- ~10 serious injuries each day
- Cost estimates > $500 million annually

and what is an EMS crash?

- Definition of an EMS crash
- Definition of Emergency Response Mode

USA Emergency Vehicles

Minimum Annual Fatalities 1995-2007

FARS – A National Data Set?
Small numbers – but NO data captured from 20% of the nation in 10 years

Safety oversight of what and .... by whom

- Vehicle Safety
- Vehicle Design
- Transportation systems safety
- Safety Equipment Design
- Vehicle and Safety Equipment Testing and Standard development
- Safety policies

In the USA there are more safety standards for moving cattle than for moving patients

the EMS transport process

- communications/dispatch
- the patient
- restraining device/seats
- 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

The laws of physics prevail...
• and they don’t care what your job title is or if you are a patient, a provider or a member of the public

Science behind Policy
• “For successful technology, reality must take precedence over public relations, for Nature cannot be fooled.”
  Richard P. Feynman 1988

Balance of concerns and risk during transport
• Response and transport time
• Clinical care provision
• Occupant safety/protection
• Public Safety

Safety is Good Business

Safety Management
• A Safety Culture
• Protective Policies
• Protective Devices
  – To prevent a crash
  – In the event of a crash
• Continuous Education and Evaluation

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

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

Testing the real world

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

Impact residue

During Impact

CTD dynamics

Impact residue

Impact residue

Impact residue

Impact residue

Impact residue

Impact residue

Impact residue

Impact residue
Deceleration Sled test (upon impact) 24 G, 30mph


PPE from the stationary environment can be highly hazardous in the automotive setting

NOT new technical data...


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 over both shoulders for sidefacing occupants are potentially lethal – and in NO WAY SUPPORTED BY ANY DATA OR INDEPENDENT AUTOMOTIVE SAFETY EXPERTISE

What do we know now??

• Intersection crashes are the most lethal
• There are documented hazards, some which can be avoided
• Occupant restraint with standard belts is effective. (Over the shoulder belts for patients, with the gurney in the upright position where medically feasible)
• All equipment should be locked down
• Some vehicle design features are beneficial - automotive grade padding in head strike areas, seats that can slide toward the patient
• Head protection??
• Electronic Driver monitoring/feedback systems appear to be highly effective

Creating a Safety Culture

• Awareness
• Training
• Incentive

The inevitable bottom line...

June 2007
A USA problem

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

2003 Insurance data –
- 10 fold more likely to have a claim based on transport than related to medical care

Expensive….

Very Expensive

Transport Medicine
- Impact Biomechanics
- Transport Ergonomics
- Fleet Safety

Ambulance Safety Research: A New Field

April 2010, Resuscitation – Going fast can really hurt your patient clinically!

March 2010, Annals EM
Golden Hour – not so hot

and…
Golden Hour Summary

- This study suggests that in our current out-of-hospital and emergency care system time may be less crucial than once thought. Routine lights-and-sirens transport for trauma patients, with its inherent risks, may not be warranted. [Ann Emerg Med. 2010;55:247-248.]

Priorities......
Research papers in the past 30 years

- EMS Safety
  - 42 papers – on ambulance safety
  - 2 papers – on ambulance ergonomics
  - 1 paper – on stretcher ergonomics

- Computer Workstations
  - 30,000 papers – on ergonomics of computer work stations

We should use the best safety practices demonstrated in engineering

EMS Safety

‘Workplace’ Hazards

Ambulance Transport Safety Summit
October 29, 2009
National Academies Transportation Research Board

http://www.objectivesafety.net/TRBSummit2009.htm
TRB Summit Focus

'Bridging the gap between what we do and what is known - Enhancing ambulance transport safety through shared knowledge of technical data'.

October 29, 2009 TRB Summit

The realm of burden and benefit
- measuring the safety of the system
- determining the economic, ethical and risk benefit challenges

Transport System Management
- fleet safety and oversight technologies and policies
- logistics management - dispatch, congestion modeling, deployment of resources, benchmarking

Vehicle safety
- occupant protection design and testing
- vehicle performance safety
- vehicle and personnel human factors issues

Dissemination and Policy
- Knowledge transfer
- Standards, specifications and policy

TRB 2009 Summit – addressed the key and interdisciplinary issues, in one day – please seek that information out.

There have been two TRB Summits held, 2008, 2009 and both with vehicle engineering and transportation systems technical expertise


Global EMS Vehicle Safety Standards v Specifications and Guidelines

- EMS Safety and Performance Standards
  - Australia & New Zealand 4535
  - Common European Community (CEN) EN1799
- Non EMS Specific USA Standards
  - [Aviation - FAA/CAUA]
  - [Fleet vehicles - ASSE/ANSI Z15]
- USA Other
  - Purchase Specification: KKK
  - "Standards" - NTEA – AMD, ASTM F 20, NFPA (devel)
  - Guideline: EMSC Dos and Don’ts, and (ASTNA, CAAS and CAMTS)

October 2008 JEMS Article "Rig Safety – 911"

http://www.objectivesafety.net/JEMS/RigSafety911.pdf

What could you learn from the National Academies – right NOW and gratis

- The realm of burden and benefit
  - measuring the safety of the system
- Transport System Management
  - fleet safety and oversight technologies and policies
- Vehicle safety
  - occupant protection design and testing

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

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

Safe Practices for Fleet Motor Vehicle Operations
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: KKK ambulance purchase specifications
- Specifications for the purchase of a Star of Life Ambulance
- Static Pull test
- 2200 Lbs. static stretcher test in longitudinal, lateral & vertical
- No dynamic test for vehicle, occupants or equipment
- No automotive test manikin

USA Ambulance Manufacturing Division (AMD)
Ambulance Standards – August 2007
- No dynamic or impact test
- No automotive test manikin
- Mandates NO ‘crumple zone’
- No impact tested anchorages for occupant restraint or equipment
- Internal, not independent

Visibility and lighting issues

2010 USA ambulance ‘safety testing’ ?? – Is NOT consistent with accepted automotive safety practice...

No ‘a’… then NO ‘F’ !!!!!

\[ F = ma \]

where

- F – force
- m – mass
- a – acceleration

ISO – 39001
Road-traffic Safety management systems

Occupant protection – July 2007
News we don’t want to see

This addresses some very real risks, very creatively – and currently ONLY available in London Ontario!

Day visibility

Policy and practice ignorant of existing technical safety data

Emergency Vehicles – Viewer Awareness

- Location
- Shape
- Speed
- Intended path

Night visibility

Impressive high visibility clothing and gear

- Having access to that technical knowledge supports changes to improve safety practice
But whatever color .... If you run a red light someone will be killed

What about changing driver behavior in the real world??

Involved technologies to enhance transport safety
- Aftermarket in vehicle electronic e-safety devices with monitoring and feedback

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

Purpose of ‘Feedback 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

- Objectively improved performance
- No increase in response times
- At fault accidents reduced
- Accepted into the culture

However:
- The system requires monitoring
- Must be reinforced by management
- Must be incentives for good performance
- Must be consequences for poor performance

Extensive Indirect cost savings
- Fewer out of service vehicles
- Improved transport times
- Decreased administrative lost in managing unsafe behaviors
- Decreased legal burden
- Automatic system wide data
- Insurance benefits

A key to safe ambulance transport

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

And when a rare crash happens….

Unit 302 Accident

Feedback box Summary
- The system works
- Objectively improved performance
- No increase in response times
- At fault accidents reduced
- Accepted into the culture

However:
- The system requires monitoring
- Must be reinforced by management
- Must be incentives for good performance
- Must be consequences for poor performance
The EMS Safety Foundation
November 2009 Webinar for Public Access
www.EMSSafetyFoundation.org and www.objectivesafety.net

Interdisciplinary and Operational
- Innovation
- Collaboration
- Knowledge transfer

Mission
- This is a team of like-minded innovators across EMS Medical Transport and a number of technical disciplines, who share the common mission of enhancing the safety of EMS delivery for all involved.

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

EMS Safety Foundation Delegation seeking out International Innovation

Safe and Ergonomic design

Loading Patients Without Breaking EMT Backs

Ergonomic layout and equipment
Flexibility to manage two patients

EMS Safety Foundation Ambulance Vehicle & Ergonomics Workshop, October 2009

Important...
- Ergonomics and automotive safety issues are interrelated
- Crashworthiness priorities override the ergonomic issues

Automotive engineers addressing EMS Safety Foundation Workshop

VEHICLE DESIGN and SAFETY
- ESC ELECTRONIC STABILITY CONTROL

Passive Safety-Seat Structure

Ergonomist Chris Fitzgerald addressing the Workshop

Stretcher lifting & loading
Collaboration and Outcomes

- Interdisciplinary Collaboration is what is key – not orthopedic folks talking to cardiologists – BUT collaboration between the health care folks appropriate automotive and occupant protection engineers and transportation system design, ergonomists and industry standards that make sense – and
- Meaningful measures of outcome and performance

Perspective from Norway

Ronald Rolfsen
Adviser
Oslo university hospital - Emergency医学部 / Ambulance department

Geir Vidhammer Engaly
Head, Emergency Medical Technicians
Oslo university hospital - Emergency医学部 / Ambulance department

Norwegian Public Roads Administration Motor Vehicle and Driving License Inspectorate:
Liv Bråmark
Coordinator, Ambulance group
Stein Erichsrud
Senior Engineer

Ambulance Investigation - Norway

“Together for your safety”

National analysis group

- National Health Authority
  Licensing health professionals
- National Vehicle & Roads Administration
  Approval and technical control of ambulances
- Paramedics from Oslo university hospital
Ambulance investigation

- Accidents involving an ambulance with injury or death
- Accidents involving an ambulance with major damage to property
- Accidents where equipment inside the ambulance cause injury / danger of injury

Technical Collaboration is key

- We are NOT the experts in this science
- We cannot afford to play the silo game here, it is costing lives, time and money
- We MUST have a meaningful evidenced based approach to design, operations and policy
- We must be outcomes driven

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
- Head protection??
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Access the following documents here at the Resources/documents tab at www.objectivesafety.net

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

Tips for Emergency Vehicle Operations

USFA Emergency Vehicle Safety Initiative

Traffic Incident Management Systems (TIMS)

- Released April 2008
- FEMA, USFA, IFSTA
- Covers setting up safe roadway incident work areas and using unified command at these incidents

Risk/Hazards

- Predictable risks
- Predictable fatal injuries
- Serious occupational hazard
- Public safety hazards
What do we know works...

- Vehicle Operations Safety Policies
- Squad bench lap seat belts
- Patient over the shoulder belts
- Securing equipment
- Forward and rear facing seating
- Some electronic technical devices
- Safety awareness
- Cultural change

Fleet Mix?

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

PREDICTABLE PREVENTABLE and NO ACCIDENT

Be ready for...

- New Infrastructure
- New information
- New collaborations
- New events
- Innovation in safety technologies, strategies and policy
- Knowledge transfer
- Unacceptable mythology
- Challenges to advancing EMS transport safety

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

Thank you!

Any Questions??

Electronic handout available online
http://www.objectivesafety.net