November 18, 2010, Quebec, Canada

EMS - How fast and how safe

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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 Subcommitte TRB EMS Transport Safety, USA
- Founder of EMS Safety Foundation
- Recipient, International Society of Automotive Engineers, Women’s Leadership Award for EMS Safety

Your Interactive Handout awaits you online at…
- www.objectivesafety.net

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

http://www.objectivesafety.net
Your Handout and Additional Resources

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

And….
- Le participant comprendra mieux l'enjeu entre le temps de réponse préhospitalier et la sécurité routière par l'organisation de systèmes préhospitaliers

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?
- What can we learn from international colleagues
Outline

I. Identification of ground EMS transport safety issues, hazards and areas of risk to patients, providers and public
II. Highlight unacceptable mythology and challenges to advancing EMS transport safety
III. Profile innovation, new safety technologies and strategies and knowledge transfer to enhance safety and reduce risks of ground EMS and patient transport

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

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

October 19th, 2010

Tragedy you don’t want to be involved in

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 AND Canada there are more safety standards for moving cattle than for moving patients

Absence of standards and oversight
- Challenges in identifying best practice
- Myriad of unregulated commercial products
- No safety performance standards
- Absent national safety oversight
Patient Safety UK - A routine concept...

But Patient Safety is just one part of this system

Safety of the...
- Provider
- Public
- Patient

And..
- In the vehicle
- At the scene
- During transport

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

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

A tragic emergency health care intervention outcome

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
Negative impact on system performance…

- BUT an EMS crash can kill all those involved AND wipe out a rural EMS system AND negatively impact a region's response capacity……

Creating a Safety Culture

within a company must have leadership and support of upper management

- Awareness
- Training
- Incentive

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 EMS transport process

- communications/dispact
- the patient
- restraining device/seal
- 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

Ground Ambulance Transport Safety

IS Complex AND Multidisciplinary

Driver Training

Do we ask vehicle builders to write cardiac arrest protocols…?
Vehicle design and safety is not what we are trained to do!!!
Would we…?
Seeing that we are health care providers – let’s look at it this way –
• Would we use medical equipment that was built by folks who were not technically qualified or trained biomedical engineers and who just said – “this device is safe”?
• Or would we expect them to be qualified in this field and that their products were tested in a meaningful way to ensure that they were safe?

Some odd USA and also Canadian 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

Ontario EMS Occupant Safety
30 August 2010

November 11, 2010

Predictable risks
• Fatals crashes more often at intersections, & with another vehicle (p < 0.001)*
• 72% of fatal EMS crashes during Emergency Use*
• 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#
• More likely to crash at an intersection with traffic lights (37% vs 18% p=0.001) & more people & injuries/crash than similar sized vehicles##

USA EMS transport safety data estimates
• ~ 50,000 vehicles
• ~ 9,000 crashes a year
• ~ One fatality each week
• ~23 pedestrians or occupants of other car
• ~10 serious injuries each day
• Cost estimates > $500 million annually

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
Denominator ....?

- # vehicles
- # types of vehicles
- # runs
- # miles/kms
- Nature of patient
- Severity of patient

Moose crash data...? – not EMS crash data

Jan 2010 - Evaluating Trauma Management Performance in Europe

Yongjun Shen, Elke Hermans, Da Ruan, Geert Wets, Tom Brijs and Koen Vanhoof

Data Envelopment Analysis

- EMS Population
  10,000 citizens
  100 km rural road length
  1000 km² area
- # Staff
- EMS Transportation Data
  10,000 citizens
  100 km rural road length
  1000 km² area
- EMS response time

EMS Safety

We have a big problem here


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

Ambulance transport a serious 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

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

Current accepted safety design and transport system technologies are being ignored, and worse...

Data...

- 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
ESC – Does your ambulance have it??

- Transport Canada announced that effective August 31, 2011, automakers must install Electronic Stability Control (ESC) technology in Canadian vehicles.
- Vehicles equipped with ESC are involved in fewer severe collisions caused by loss of control, resulting in significantly fewer deaths and injuries.

So

- What’s important
- What’s not important

What’s going to save your life
What might take your life

What’s going to hurt you
What’s going to protect you

What is factual
What is garbage

What is new
What is not new

Some new dimensions

- Vehicles – smarter, sleeker, safer – CHEAPER!
- Fleet Operations – new technology tools
- Interdisciplinary infrastructure – new global platforms

A “Fleet” to many in Emergency Medical care means….

Systems safety of:

- Selecting, dispatching and managing your fleet
- Getting you, your patient and equipment in and out of the vehicle
- Providing patient care inside the vehicle
- Occupant protection in crash and near miss situations
Safety Performance

- Measurement
- Outcomes
- Technical expertise

When is it safe to do what...?

- What are your policies???
  - If your patient is pink, warm and talking?
  - Are you required to notify the driver if you are out of your seat belt?
  - Are ‘routine procedures’ putting you at risk?

What is a safe speed and how do we identify that?

What is a survivable impact?

E = \frac{1}{2} mv^2

~ 30 mph - survivable

~ 60 mph - not survivable

What is a survivable impact?

A survivable impact??

A serious problem...

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
Safe Systems Approach

Source: Road Safety Branch, Infrastructure and Aviation Transport Policy, Department of Infrastructure, Transport, Regional Development and Local Government, Australia.

Key Elements to Safety

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

Impact biomechanics

- Crashworthiness
- Vehicle design
- Occupant protection

Transport Ergonomics

- Operational tasks
- Human factors analysis
- Range of reach
- Patient loading and unloading

Fleet safety

- Operational policies – dispatch, safety
- Fleet mix
- Vehicle selection – safety, ESC, loading height
- Driver performance and monitoring
- Scene safety
- Visibility and conspicuity
- Safety measurement and management

April 14th, 2008

Under age 25 years you are more likely to crash anything - including an ambulance...

Conclusion: When extracting fuel and taking a decision, the role of having been in an accident and their role in the event may never be replaced or replaced by using
EMS. If the end goal is to develop an effective data analysis technique that can be used in trauma injury management, CMS (Clinical Management System) for providing.

Under age 25 years you are more likely to crash anything - including an ambulance...
June 17th 2008

a paramedic and a patient killed

In this vehicle...

April 30, 2009 - Tennessee

August 2009 – Impaired...

EMT Indicted On Murder Charges

October 22, 2009, TN
Patient and Provider killed, Attendant Critical

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

January 14, 2010

Corporate Manslaughter Act
An ambulance lies on its side after a crash with an SUV in Cooper City, Fla. Three paramedics and one patient were inside the vehicle at the time.

This IS a Transportation and Automotive Safety issue

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

Safety is a tool to save
- Lives
- Time
- Money

must be evidenced based

Ambulance Safety Research: A New Field

Benefit of Safety
- 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

- Erectile Dysfunction
  - 100,000 papers - on Erectile Dysfunction

Priorities......
Research papers in the past 30 years
- EMS Safety
- Computer Workstations
- Erectile Dysfunction
We should use the best safety practices demonstrated in engineering

...in automotive safety engineering

and in ergonomics

Golden Hour – not so hot
• March 2010 Annals EM

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.]

Is response time really a meaningful measure of patient outcome??
• What are the confidence limits?
• What about demographics, population density?

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

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
Policy makes a difference…

MedStar Ambulances Will No Longer "Run Hot" When Transporting Cardiac Arrest Patients (4/21/2010)

"MedStar ambulances will no longer 'run hot' - when paramedics inside are giving chest compressions to patients in cardiac arrest, officials say." This "policy, which took effect Friday, will affect about 1,400 of the more than 100,000 calls to which MedStar responds annually in the 15 Tarrant County cities it serves."

Safety is Good Business

A 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

Very Expensive

EMS CANNOT Afford to keep paying out like this....

Safety saves time, lives AND money

Canada, Nova Scotia

- Since 2000 working towards a goal of zero loss ratio with insurance provider
- 10 million kilometers per year
- 150 emergency response ambulance units
- Collision claim history measured in dollars per 100,000 kilometers traveled:
  - 2000/2001 $1725.00
  - 2001/2002 $1949.00
  - 2002/2003 $751.00
  - 2003/2004 $418.00
  - 2004/2005 $229.00

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

P + R + V = B (T)

Dry
Stopped at 176 feet

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

Wet
Stopped at 220 feet

Testing the real world

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

During impact
CTD dynamics

Impact residue
A few key words about restraint systems…

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

Systems safety failure AND dangerous

Overwhelming existing evidence these practices are HIGHLY dangerous
NO evidence whatsoever that these practices are NOT dangerous, let alone safe

NOT new technical data…

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

‘Workplace’ Hazards

Range of reach.. This is a well defined technical science

Bigger is not necessarily better……

It does happen…..
But what about head protection?

New EMS helmet prototypes

Tort Claims from Adverse Events in Emergency Medical Services

- Patient handling errors and emergency vehicle movement/collisions are the most common adverse events resulting in tort claims against EMS.

Henry E. Wong, Rollin J. Fairbanks, Manish N. Shah, Donald M. Yealy, University of Pittsburgh, Pittsburgh, Pennsylvania, Jan 2007

The science of Stretcher lifting & loading

- A stretcher system that doesn’t harm your back... or your services wallet
- 27 inch loading height

So what’s important...

And what is the loading height of your ambulance??

Size matters.... Less than 27 inches will save your back!!!!
Air EMS is a role model for safety initiatives and focus

Air Safety Approach

- Safety Program Planning
- Evaluating
- Analysis of Safety Performance
- Analysis of Safety Information and Data
- Analysis of Risk Profiles and Plans

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

Rash of “Safety Concept” vehicles…..

Devoid of substantive automotive safety engineering input or testing

Yes, the ride of your life….

- Sure… these vehicles all parade around the EMS and Fire shows BUT…
- NOT ONE of these vehicles has been to the automotive safety shows or scrutinized by the automotive safety industry

Which of these two vehicles would you want?

Sprinter v Ford Transit crash test
http://www.youtube.com/watch?v=C3kN6WF5vAA&feature=related

Ambulance Vehicle Standards??

- KKK?
- AMD?
- FMVSS?
- CMVSS?
- NFPA?
- SAE…?
- ASTM…?
- International – ASA – CEN
Global EMS Vehicle Safety Standards 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
  - [ Fleet vehicles - ASSE/ANSI Z15 ]
- USA Other
  - Purchase Specification: KKK
  - “Standards” - NTEA – AMD, ASTM F 20, NFPA (devel)
  - Guidelines: EMSC Dos and Don’ts, and (ASTNA, CAAS, and CAMTS)

October 2008 JEMS Article “Rig Safety – 911”

http://www.objectivesafety.net/JEMSRigSafety911.pdf

Ridiculous current 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

Yes a “nationally recognized testing lab” – BUT - NOT an automotive/occupant safety crash test lab!!

May 2010

NTSB 1979... and 30 years later and still the same problem


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
Hmm…

It isn’t like this in the rest of the world

Visibility and lighting issues

Here’s the real world at 6 ft…

Policy and practice ignorant of existing technical safety data

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

“The multicolored (patterned) ambulance while distinctive, may suffer decreased conspicuity because of the effects of camouflage” De Lorenzo & Eilers Annals EM 1991

Emergency Vehicles – Viewer Awareness

For a timely, appropriate and safe response

- Location
- Size
- Shape
- Speed
- Intended path

“X”
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.

Transport performance
- Driver training?
- Real time safety performance outcomes?

What about changing driver behavior in the real world??

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

Safety concepts out there now
- Driver feedback technologies
- Tiered dispatch
- Enhanced ambulance vehicle design
- Intelligent Transport Technologies – ITS
- New platforms for interdisciplinary exchange
- New Safety Standards

Innovation
- Enhanced ambulance vehicle design
- Intelligent Transport Technologies – ITS
- New platforms for interdisciplinary exchange
- New Safety Standards
The “Feedback box”
Driver behavior monitoring and feedback device

A smart phone App that is a safety tool

Realtime mapping from London for 2.5hr of a trip of attempting to park in NYC after a snow storm and whilst ‘Law and Order’ filming was underway

How did the UK pilot drivers perform??

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<th>Driver</th>
<th>Total distance (Miles)</th>
<th>Total number of trips</th>
<th>Distance per Trip (Miles)</th>
<th>Harsh breaking &lt; -4.0</th>
<th>Severe Harsh breaking &lt; -4.6</th>
<th>Breaking/1,000 Mile</th>
<th>Harsh breaking/1,000 Mile</th>
<th>Severe HB/1,000 Mile Break/Trip</th>
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Harsh Braking per 100 trips

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

- The realm of burden and benefit
  - Measuring the safety of the system
  - Determining the economic, ethical and risk benefits challenges
- Transport System Management
  - Fleet safety and oversight technologies and policies
  - Operations management – dispatch, congestion routing, 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

What the independent technically expert occupant protection and automotive safety engineers say about our current ambulances and ‘safety’ approaches:

- “The rear compartment Death Vault”
- “The Kitchen Design must go”
- “The Kill, Kill, Kill (KKK) spec”
- “The organ donor harness system”

October 29, 2009 TRB Summit
Its out there NOW

- 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

The EMS Safety Foundation
www.EMSSafetyFoundation.org

The EMS Safety Foundation:
A practical and functional model
Interdisciplinary and Operational and International

- Innovation
- Collaboration
- Knowledge transfer

R & D
“Ripoff and Duplicate”

- Avoid reinventing the wheel at all costs
- Where are the best practices that we need to transfer knowledge from

Automotive engineers addressing
EMS Safety Foundation Workshop

International approaches

- The state of the art non-USA vehicles have NO squad bench nor the after market structural vehicle modifications that can potentially decrease crashworthiness integrity that were seen in study vehicles.

EMS Safety Foundation Delegation seeking out International Innovation

RETTmobil 2010
Europe’s Leading Trade Show for Rescue and Mobility
Vehicle Occupant Safety design
European design
Safety technology is a key focus

Safe and Ergonomic design

Flexibility to manage two patients
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

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

this vehicle is safety crash tested by automotive experts

Unlike this vehicle
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?

Fleet Mix?

 Were we safer in the Cadillac???

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

Risk/Hazards

- Predictable risks
- Predictable fatal injuries
- Serious occupational hazard
- Public safety hazards

Goals

- Standards for safety
- Policy based on Science
- Databases to demonstrate outcome

Safety Management

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

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
Future

- Meaningful Goals
- New policies
- New practices
- New standards
- New vehicles
- New technologies

Conclusion

- EMS transport has serious hazards and safety issues
- Major advances in EMS safety research, infrastructure and practice over the past 5 years
- Development of substantive EMS safety standards is a necessity and a reality
- Multidisciplinary safety issue that EMS cannot solve internally
- 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, transportation and occupational safety

And....

- It is no longer acceptable for EMS to be functioning outside of transportation, automotive 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 and resources available online
http://www.objectivesafety.net