June 9th, 2010

EMS Safety – Current Issues

or

The Ride of Your Life:
What You Can't Afford Not To Know About Ambulance Safety

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CEO, Objective Safety
Faculty, Brookdale University Hospital. SUNY
New York, USA

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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?

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Emergency Medical Services (EMS)
An important and unique transport system

- Public safety, public health and emergency service
- Is there to save lives

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http://www.objectivesafety.net

Your Handout and Additional Resources

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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

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Patient Safety- A routine healthcare concept…

But Patient Safety is just one part of this system

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EMS Transport Safety

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

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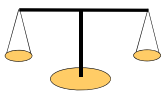
Balance of concerns and risk during transport



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

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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

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

Ambulance transport a serious transport safety problem…

In the USA

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

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

…and

- Is your ambulance crashworthy?
- Do you have a telematics monitoring and feedback system?
- Enhanced Stability Control (ESC) – Does your ambulance have it??
  - An estimated >16% decrease in vehicle crashes
- and what is your loading height??
  - …is it less than 27 inches (68cm)??

An interhospital transport ? "Do no harm…."?

LexisNexis®

Pa. ambulance involved in crash; patient pronounced dead at scene

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

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?

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 Stations/
- 10,000 citizens
- 100 km rural road length
- 1000 km² area

 # Staff/

 # EMS Transportation Units/
- 10,000 citizens
- 100 km rural road length
- 1000 km² area

EMS response times/

Firstly!

- An accident ?
- or

  a predictable and preventable event

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) & 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##

*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

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

A tragic emergency health care intervention outcome

Rollover Crash Kills Medical Technician

It does happen….

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

- Transport Medicine

Key elements

- Impact Biomechanics
- Transport Ergonomics
- Fleet Safety

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

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?
- What policies offer the safest system?
- How do I get my team to address safety issues?
- Do I need a helmet, and if so which one?
- What data should I collect when something goes wrong, and how to analyze it?

Safety Management

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

Creating a Safety Culture

within a company must start with upper management's commitment to safety

- Awareness
- Training
- Incentive

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

Challenges to Optimizing EMS Transport Safety

- Disparate and fragmented safety infrastructure
- Lack of a centralized EMS Safety oversight or data
- A large number of small groups of end users, with a mix of volunteers and professionals
- Ambulances are non-standard vehicles, a truck chassis and an after market box or a modified van
- EMS vehicle safety is not integrated as a part of the transport safety industry

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

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

TIME & PLACE

The Emergency Department (ED)

An ambulance is not an ED /ICU on wheels

The laws of physics prevail…

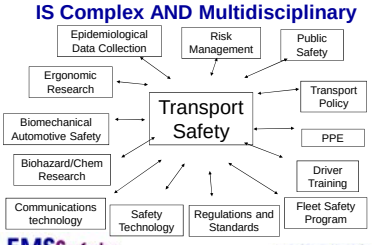
- and they don't care what your job title is or if you are a patient, a provider or a member of the public

Science behind Policy

- "For successful technology, reality must take precedence over public relations, for Nature cannot be fooled."

  Richard P. Feynman 1988

Ground Ambulance Transport Safety IS Complex AND Multidisciplinary



Do we ask vehicle builders to write cardiac arrest protocols…? Vehicle design and safety is not what we are trained to do!!!!

June 17th 2008
a paramedic and a patient killed

EMS CRASH KILLS PATIENT AND A SUSSEX COUNTY (DE) PARAMEDIC IN THE LINE OF DUTY
Tuesday, June 17, 2008

We regret to advise you that a female Sussex County (DE) Paramedic was killed in the Line of Duty as was a patient killed in a horrific crash involving an ambulance in Sussex County (DE) this morning.
The single vehicle crash happened around 0240 Hours on the John J. Williams Highway near the Lewes-Rehoboth joint fire company substation in Angola.
The Mid-Sussex Rescue Squad ambulance was transporting to Beebe Medical Center with a patient. 2 MSRS Squad members and the Sussex County Paramedic were on board when it struck a tree, which opened the side of the ambulance as seen on our home page. Tragically, the patient was killed as was the Sussex County EMS Paramedic, who was killed in the Line of Duty.
Sussex County EMS also suffered a close call last year when a Paramedic John Schnitt was seriously injured in a crash when a civilian struck the Milford Fire Company ambulance he was riding in, while returning from a run. Additional details on this mornings crash will follow.

In this vehicle…

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October 31, 2008 - Kentucky

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April 30, 2009 - Tennessee

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August 2009 – Impaired…

EMS RESPONDER

Kentucky EMT Indicted on Murder Charges after Crash

By Andy Alcock/WLKY

LOUISVILLE, Ky. --

A Louisville EMT who was driving an ambulance involved in a fatal crash has been indicted on seven criminal charges, including murder and operating a motor vehicle under the influence of intoxicants.

Tammy Brewer, 36, was behind the wheel when that crash took place in April 2008. The patient inside the ambulance, Vickie Whatley, 54, died of her injuries from the wreck.

Only WLKY was there April 30 when Brewer appeared in court to face a no proof of insurance charge after she was involved in an unrelated non-injury accident in her own vehicle.

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

Ambulance, TDOT truck collide on I-65; ambulance

An accident on Interstate 65 this afternoon killed a

Just before 3 p.m., a Rural/Metro ambulance transp
apparent run into a Tennessee Department of T
emergency lane, according to Metro police informati

The ambulance driver—David Cline, a firefighter in
Vanderbilt Medical Center, where he died.

The elderly patient died at the scene; her name has also not been released.

Nashville firefighter and Rural/Metro employee Evans Johnson, 51, was in the rear of the ambulance assisting the patient when the crash occurred. He was transported to Vanderbilt Medical Center, where he is in critical condition.

TDOT vehicle driver Robert Green, 50, of Columbia was transported to Vanderbilt Medical Center where he is in stable condition, Mumford said.

As of 5:45 p.m. traffic on the northbound lanes of I-65 was moving, but southbound traffic was moving slowly, Mumford said. There were also significant delays on I-440.

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January 14, 2010

WARREN COUNTY, N.J. NEWS
Real-time news for Belvidere, Phillipsburg and more

Ambulance accident on Route 519 in White Township claims patient in back - UPDATE

By Express-Times staff
January 14, 2010, 5:13PM

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Safety is a tool to save

- Lives
- Time
- Money

must be evidenced based

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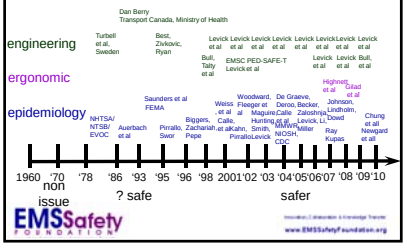
Ambulance Safety Research: A New Field



and what is an EMS crash?

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

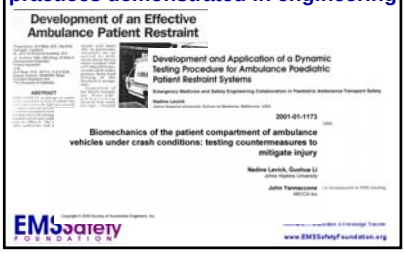
Denominator ….?

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

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

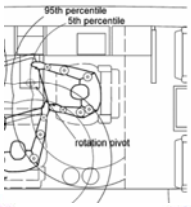
We should use the best safety practices demonstrated in engineering



…in automotive safety engineering

and in operational ergonomics

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



Important…

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

Goals

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

And…

This is in a setting where

- transport safety is the major and most costly adverse event in EMS
- and many practices are in conflict with, or not supported by, existing technical engineering science

A survivable impact??

Which of these two vehicles would you want?

Sprinter v Ford Transit crash test

http://www.youtube.com/watch?v=C3kN6WF5vAA&feature=related

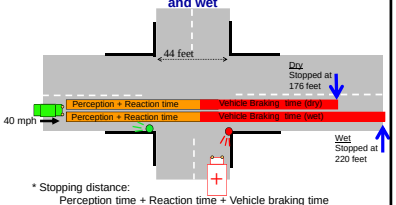
High speed crash, rolled and the occupants (patient and medics) had only minor scratches

And very Predictable…

- Intersections are lethal environments

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)

New Interdisciplinary Knowledge Transfer Platforms

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EMS/Medical Transport Safety Summit
November 7, 2008 & October 29, 2009

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- Bridging the gap between what we do and what is known
- Technical expertise in data capture, transportation safety, vehicle safety, fleet management, human factors, standards development and EMS
- Enhancing ambulance transport safety through shared knowledge of technical data

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October 29, 2009 TRB EMS Summit

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

- 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
  - 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

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Gratis public access to TRB Summit archives Its out there NOW

- www.objectivesafety.net/TRBSummit2008.htm
  www.objectivesafety.net/TRBSummit2009.htm

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Independent Automotive Safety Technical Expertise

- The "kitchen design" is completely unacceptable and a failure in health care delivery, occupant protection and ergonomics.
- Independent technical expertise must be sought and involved

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Safety is Good Business

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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

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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 $ 1049.00
  - 2002/2003 $ 751.00
  - 2003/2004 $ 416.00
  - 2004/2005 $ 229.00

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Testing the real world

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

CTD dynamics

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 stretcher patients, with the gurney in the upright position where medically feasible)
- All equipment should be locked down
- Some vehicle design features are beneficial – ESC, forward and rear facing seating
- Head protection??
- Electronic Driver monitoring/feedback systems appear to be highly effective

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

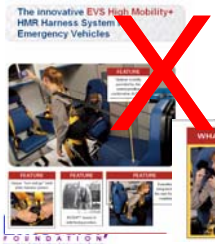
A few key words about restraint systems…

Chest and thigh belts alone are inadequate to secure the patient

Levick NR, et al. Development and Application of a Dynamic Testing Procedure for Ambulance Pediatric Restraint Systems, SAE Australasia 1998;58:2:45-51

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

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…

Richardson S.A., et al, Int. J. of Crash., 4:3, 239 – 259, 1999

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

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

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

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

Global EMS Ground Safety Standards v Specifications and Guidelines

- EMS Vehicle Safety and Performance Standards
  - Australia & New Zealand 4535
  - Common European Community (CEN) EN1789
- Non EMS Specific Standards
  Global
  - Road Traffic Safety Management - ISO 39001 (devel)
  USA
  - Fleet vehicles - ASSE/ANSI Z15
- USA EMS Vehicle Other
  - Purchase Specification: GSA -KKK
  - "Standards" - NTEA – AMD, ASTM F 20, NFPA (devel)
  - Guideline: EMSC Dos and Donts, and (ASTNA, CAAS and CAMTS)

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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

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Common European Community (CEN) EN 1789:1999/A1:2007

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.

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ISO – 39001 Road-traffic Safety management systems

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American National Standard ANSI/ASSE Z15.1-2006

Safe Practices for Fleet Motor Vehicle Operations

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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

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Visibility and lighting issues

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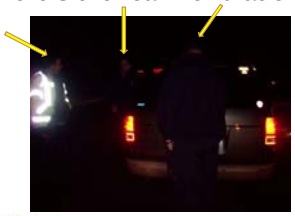
Here's the real world at 6 ft…



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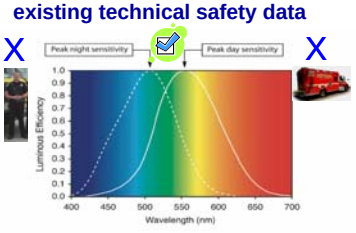
Policy and practice ignorant of existing technical safety data

X X



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

Color-blindness affects 10% of the population

- As seen with normal vision

- As seen with color blind vision

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Emergency Vehicles – Viewer Awareness

For a timely, appropriate and safe response

- Location
- Size
- Shape
- Speed
- Intended path

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But whatever color …. If you run a red light someone will be killed

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- Having access to that technical knowledge supports changes to improve safety practice

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Innovation

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What's new

- New automotive safety technologies
  - crashworthiness
  - ESC
  - ITS
  - Monitoring and feedback enhancements
- New expertise
  - TRB
  - SAE
  - UTRC
  - Ergonomics
  - Industrial Design

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Safety concepts out there now

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

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In-vehicle telematics - 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

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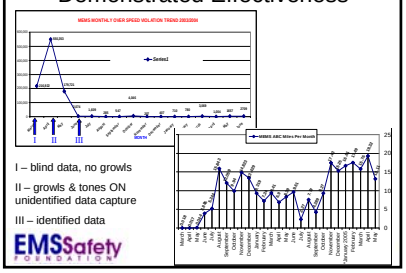
Demonstrated Effectiveness



I – blind data, no growls

II – growls & tones ON unidentified data capture

III – identified data

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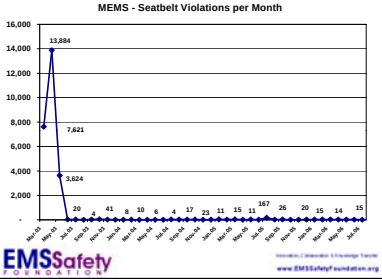

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Extensive Indirect cost savings

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

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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

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Resource availability and allocation technologies to enhance system performance

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The jury is out on

- Opticon
- Simulators

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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.

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RETTmobil is -

- A major European Emergency Rescue Congress, Trade show and Symposium
- Held in Fulda, Germany
- Established in 2001
- Attended by ~ 20,000 attendees
- Brainchild of Prof Peter Sefrin

Vehicle Occupant Safety design

European design

Safety technology is a key focus

Safe and Ergonomic design

Patient Transferring Slides

Ergonomic layout and equipment

Flexibility to manage two patients

The EMS Safety Foundation:

A practical and functional model for sharing interdisciplinary and operational technical information

www.emssafetyfoundation.org

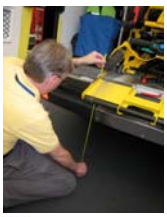
- Innovation
- Collaboration
- Knowledge transfer

EMS Safety Foundation Delegation
bringing Interdisciplinary and International Innovation to you!

Automotive engineers addressing the EMS Safety Foundation

EMS Ergonomist Chris Fitzgerald addressing the EMS Safety Foundation

Loading Patients Without Breaking EMT Backs



The science of stretcher lifting & loading

Stretcher Load - # 1 (CNLOAD01)

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

Texas - Careflite's new vehicle

Manitoba's new fleet

"Together for your safety"

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

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

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 ?

Risk/Hazards

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

So what do we need to do ??

- Reach out to the appropriate experts – they sure do want to help us
- STOP being philistines and be the scientists we are trained to be and at least seek a scientific approach
- Get your heads out of the sand – there is plenty of valid technical information – FMCSA, TRB, SAE
- Make policy and purchase decisions on technically sound data, not a marketing brochure
- HAVE MEANINGFUL AND TRANSLATABLE OUTCOME MEASURES FOR YOUR SERVICES SAFETY PERFORMANCE

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What is the EMS Transport Safety Research Agenda?

- Shouldn't it be driven by data, and appropriate technical expertise

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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

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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

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Future

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

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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

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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

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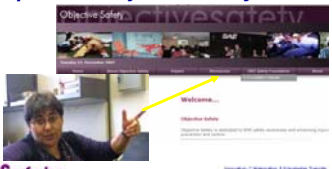
Thank you!

Any Questions??

Electronic handout and resources available online

http://www.objectivesafety.net



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