

1st Neonatal/Pediatric Transport Conference,
Advances in Critical Care Transport, Akron, Ohio 2008

Ambulance Transport Safety: Where is the State of the Art

*Moving Sick Kids Safely - Optimizing
Transport Safety for Crew, Neonates, and
Children*



Nadine Levick, MD MPH
Director, Division Emergency Medicine Research
Maimonides Medical Center, New York

Welcome

- ▶ Cincinnati Children's
- ▶ Angel One – Arkansas Children's Hospital
- ▶ Carolinas Medical Center
- ▶ Children's Hospital Columbus Ohio
- ▶ Children's National Medical Center
- ▶ Akron Children's Hospital



Outline

- I. Look at the data on ambulance transport safety
- II. Highlight important predictable and preventable occupant risks and hazards during neonatal and pediatric transport
- III. Demonstrate what happens during an ambulance crash
- IV. Review of guidelines, standards and innovation
- V. Outline practices and strategies to enhance occupant safety and reduce risks of crash-related injury



Jump start
A Rabbitool Series II kangaroo test dummy is used in New South Wales, Australia, to help automobile designers study a unique Australian road safety issue – traffic accidents with kangaroos.



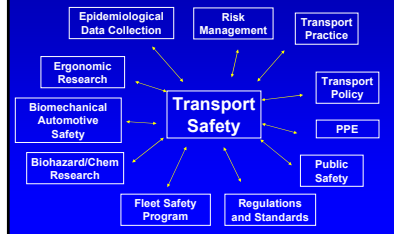
Key Issues

- ▶ Mythology
 - That Emergency Medical Service personnel are safe
- ▶ Injury Hazards
 - Biohazard
 - Chemical/Radiation
 - Physical/Mechanical trauma – THE BIG PROBLEM
- ▶ Motor Vehicle Crashes are the highest cause of death at work – EMS has > 2X the mean national rate
- ▶ An R & D and Regulatory Gap
 - Occupational Health and Safety
 - the workplace is in a vehicle – exposure data are scant
 - Automotive Safety
 - a vehicle is the work place – 'exempt' from automotive research and regulation

Safety oversight of what and by whom

- ▶ Vehicle Safety
- ▶ Vehicle Design
- ▶ Safety Equipment Design
- ▶ Vehicle and Safety Equipment Testing and Standard development
- ▶ Safety policies

Pediatric Patient Transport Safety IS Complex AND Multidisciplinary



Ideally Who, What and Where ?

- ▶ Occupational Health and Safety
 - Epidemiology, Bio/Chem Hazards and Ergonomics
 - Regulation and Research
- ▶ Automotive Safety
 - Epidemiology, Engineering and Impact Biomechanics
 - Regulation and Research
- ▶ EMS Industry
 - Occ. Health, Automotive, Technical, Clinical & Fiscal data
 - Practice Policy, Risk Management and Fleet Safety
- ▶ Academia
 - Independent and collaborative
 - R & D and evaluation of all of the above

Goals

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

The NTSB

History and Mission

The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in the other modes of transportation – rail, road, highway, marine and pipeline – and issuing safety recommendations aimed at preventing future accidents. The Safety Board determines the probable cause of:

- all U.S. civil aviation accidents and certain public-use aircraft accidents;
- selected highway accidents;
- railroad accidents involving passenger trains or any train accident that results in at least one fatality or major property damage;
- major marine accidents and sea marine accidents involving a public and a navigable vessel;
- pipeline accidents involving a facility or substantial property damage;
- selected transportation accidents that involve problems of a recurring nature.

The Board derives its authority from Title 49 of the United States Code, Chapter 1. The rules of the Board are located in Chapter 1001, Title 49 of the Code of Federal Regulations.

The NTSB is responsible for maintaining the government's database of civil aviation accidents and also conducts special studies of transportation safety issues of national significance. The NTSB provides development to serve as U.S. Accredited Representative in

pressofAtlanticCity.com
Only 1000 pages to read!

Multiple crash on Route 30 injures 7 in Abscon

By AP/WIDE WORLD for The Press, 08/23/2006
Published Sunday, January 15, 2006
Updated Sunday, January 15, 2006

→ A series of roadkill accidents involving several vehicles and an unlicensed driver were possible in the recent daytime afternoon, including three deaths within a period of three hours on the same road.

Police said the accident began at about 1 p.m. when a sports utility vehicle ran into a car waiting to pull out and strike the motorist and driver at a hot light on the westbound side of Route 30 in the town of Abscon.

The car's three occupants were undergoing treatment at a nearby ambulance parked on the shoulder of the highway, after another car bearing left to leave the scene, and was the driver and control of the ambulance.

The accident occurred three days earlier, as well as the three patients they were being from the first crash.

The car caught fire and the ambulance was driven off the road. The only patient the ambulance carried, was an adult and child, and the patient died of a heart attack. The ambulance was driven to the hospital.

EMS Update

February, 2006

The Office of Emergency Medical Services

The National Highway Traffic Safety Administration (NHTSA) is pleased to announce the creation of the Office of Emergency Medical Services (EMS). Recognizing the consistent and long-standing contributions of the EMS program and its increasing responsibilities created by Congressional action, NHTSA is elevating the status of the EMS Division to match its expanding role effective February 9, 2006.

NHTSA, and its predecessor agency, have taken the lead in Federal support of national Emergency Medical Services systems development since 1966. NHTSA has always held that an EMS system, ready every day for every emergency, is the best preparation for response to all medical emergencies as well as catastrophic events. Ongoing programs and projects, including The EMS Agenda for the Future, the Next Generation 9-1-1 Initiative, the National EMS Education Agenda for the Future, A System Approach, the National Research Agenda and the National EMS System, continue to be developed.



<http://www.objectivesafety.net>

Safety in Pediatric Ambulance Transport

- ▶ Is part of a SYSTEM

the Peds EMS/transport process

- ▶ communications/dispatch
- ▶ policies and procedures
- ▶ the pediatric patient
- ▶ restraining device/seat
- ▶ transporting device/gurney
- ▶ paramedics/transport nurses, doctors & family
- ▶ patient monitoring equipment
- ▶ clinical care & interventions
- ▶ the vehicle
- ▶ the driver/driving skill
- ▶ the road



Firstly!

▶ An accident ?

- ▶ or a predictable and preventable event

"Are our policies killing people?"

- ▶ 1991-2000, 302,969 Emergency vehicles were involved in MVCs - 1,565 involving fatalities*
- ▶ In PA 1997-2001, ambulances were more likely than similar sized vehicles to be involved in*:
 - 4 way intersection crashes (43% vs 23%, p=0.001)
 - Collisions at traffic signals (37% vs 18%, p=0.001)
 - MVCs with more people injured (76% vs 61%, p=0.001)

*Comparison of Crashes Involving Ambulances with those of similar sized vehicles – Adam Ray, Douglas Kupas, PEC Dec 2005;9-412-415

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.....

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

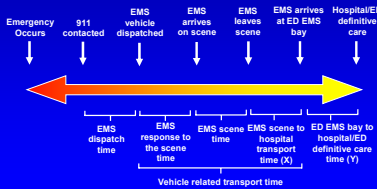
Vision Zero is a philosophy of road safety that eventually no one will be killed or seriously injured within the road transport system. Vision Zero describes the view that safety cannot be traded for mobility. Sweden's Vision Zero is aimed at eliminating all deaths or long-term health losses arising from road crashes. The mobility in the road transport system should be a function of the safety and not vice versa¹.

This is not acceptable

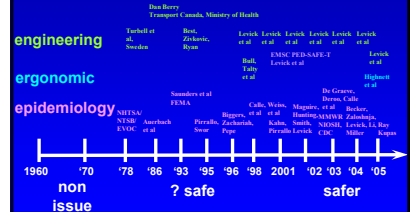
- ▶ ~ One fatality each week#
 - ~ 2/3 pedestrians or occupants of other car
 - ~ 4 child fatalities per year (>2X airbags 2004-2005)
- ▶ ~10 serious injuries each day
- ▶ Cost estimates > \$500 million annually
- ▶ USA Crash fatality rate/capita 35x higher than in Australia

PARIS BT2 2004

911 Call to Hospital/ED Definitive Care Time Intervals*



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[#]

*Kohn CA, Pirato RD, Kuhn EM. *Prehospital Emergency Care* 2001 Jul-Sep;5(3):261-9
^{**}Wacker, Zaslavsky, Levin, Li, Mitty, *Acc Anal Prev* 2002
^{***}Magnus, Hastings, Smith, Levin, *Journal of Emergency Medical Services* Dec 2002
[#]WQJEM, 2003
[#]Boyer AM, Gabb DP. *Prehospital Emergency Care* 2005 Dec; 8:412-415
[#]BMJ 2004; 329:1175A, 49 CRRP Parts 871, 872 & 889 Docket no. 80-28; notice 7

We should use the best safety practices demonstrated

What do we know now??

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

Balance of concerns and risk during transport



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

Haddon/Baker/Runyan Phase-Factor Matrix

FACTOR	Parameds/ patient	Vehicle	Environment	Sociocultural	
PHASE		(agent)	(physical/regulatory)		
pre crash (pre event)	driving history, driver education, speeding, abiding road laws	collision avoidance, and lock brakes, vehicle weight, speed	tiered dispatch, EVIDOC implementation, road design, roadway & surface	EMS image (coop & non), public/private partnerships, documentation from L & S	-Effectiveness -Cost/benefit
crash (event)	seat belt, restraint use, child safety seat use	air bags restraint design bumper & crumple zone design	collision speed, road side hardness	It can and does happen	-Ethics -Social acceptability
post crash (post event)	gender, severity, age, underlying morbidity	ease of extraction, burn resistant fabrics	EMS system quality trauma care, traffic management system	rehabilitation, documentation and data collection	-Societal need

EMS Research /Data Vacuum

- ▶ ? total no. of ambulances
- ▶ ? total no. of medics
- ▶ ? total no. of runs (per age & severity)
- ▶ ? total pt. miles (per age & severity)
- ▶ ? true crash fatality rate per mile
- ▶ ? crash injury rate
- ▶ ? adverse events

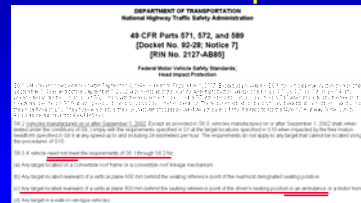
Concerns

- ▶ 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
- ▶ Much uncertainty as to what is safe and what is unsafe occupant protection practice
- ▶ 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

What are the risks?

- Lack of tiered dispatch systems
- Frequent use of high speed
- Issues of adherence to road laws
- High use of L & S.
- Rear cabin
 - not subject to any automotive safety regulation
 - minimal structural crashworthiness features
 - inadequate and poorly studied occupant and equipment restraint utilization and safety
- The only design standards that are written specifically for ambulance vehicles (KKK specs) are purchase specifications, not performance specifications

USA Ambulances: FMVSS Exempt



Identifying predictable and preventable transport related risks and hazards

- ▶ Systems approach
 - Communications
 - Personnel
 - Transport
 - Equipment
 - Environment

Multidisciplinary collaboration and the way forward

- ▶ Development of interdisciplinary teams
 - healthcare professionals
 - safety engineering expertise
 - regulatory bodies
 - manufacturers
- ▶ Safer practices save lives, time and money

Protective devices/concepts

In the event of a crash

- ▶ Vehicle crashworthiness
- ▶ Seat/belt systems
- ▶ Equipment lock downs
- ▶ Padding
- ▶ Head protection

To prevent a crash

- ▶ Driver feedback
- ▶ Driver monitoring
- ▶ Driver training
- ▶ Vehicle and other technologies
- ▶ Tiered dispatch
- ▶ Appropriate policies

This is happening out there NOW....

Is a license enough for ambulance drivers?

Extent of EMT training questioned by witness

By DAVID DIEHL
<http://www.fox42.com>

Published: November 16, 2005 11:19 AM
<http://www.fox42.com>

While waiting for the victim's death in the office of the cop and an ambulance, the witness saw a young ambulance driver who said she had no license.

"The ambulance driver was an individual with a valid driver's license."

It is unclear if the witness administered CPR, but the witness observed at least one ambulance and one person who was not wearing an ambulance uniform in the state. The call coming from the scene was "It's a child who is having a seizure."

It was pointed out that not all ambulance drivers or paramedics are required to have an ambulance license. There are many "volunteer" ambulance drivers who do not have a license.

"It is not different from someone who delivers pizzas."

— Gregg Theunes, (CASH and EMS)
 Assistant, (on training)



Gregg Theunes Appeal to his Senator, December 29, 2005

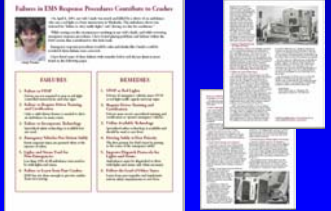
Letter to EMS Response Procedures Committee to Congress

EMERGENCIES

- 1. Public safety
- 2. Emergency response
- 3. Emergency medical services
- 4. Emergency medical services
- 5. Emergency medical services
- 6. Emergency medical services
- 7. Emergency medical services
- 8. Emergency medical services
- 9. Emergency medical services
- 10. Emergency medical services

RECOMMENDATIONS

- 1. Public safety
- 2. Emergency response
- 3. Emergency medical services
- 4. Emergency medical services
- 5. Emergency medical services
- 6. Emergency medical services
- 7. Emergency medical services
- 8. Emergency medical services
- 9. Emergency medical services
- 10. Emergency medical services



This is where automotive safety is happening – where is EMS???

Enhanced Safety of Vehicles (ESV) – The Definitive Vehicle Safety Forum

Ambulance vehicle safety has only been presented at one ESV meeting, the 17th ESV in 2001



Crash Occupant Protection

- ▶ collision speed
- ▶ direction of impact
- ▶ vehicle stiffness and mass
- ▶ compartment size & projectiles
- ▶ intelligent vehicle technology
- ▶ passive protection
- ▶ head protection
- ▶ occupant restraint/belts

Safety for emergency transport

Policy that reflects SCIENCE

Global EMS Vehicle Safety Standards v Specifications and Guidelines

- ▶ EMS Safety and Performance Standards
 - Australia & New Zealand 4535
 - Common European Community (CEN) EN1789
 - (International Joint Commission on Medical Transport)
- ▶ Non EMS Specific USA Standards
 - [Aviation - FAA/CAA/JAA]
 - [New ASSE/ANSI Z15 – fleet vehicles]
- ▶ USA Other
 - Purchase Specification: KKK & NTEA – AMD
 - Guideline: EMSC Dos and Don'ts, and (CAAS and CAMTS)

American National Standard Safe Practices for Motor Vehicle Fleet Operations New ANSI/ASSE Z15.1-2006

215 COMMITTEE

215.1 PURPOSE

215.2 SCOPE

215.3 REFERENCES

215.4 DEFINITIONS

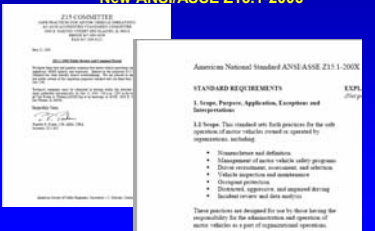
215.5 STANDARD REQUIREMENTS

5.1. Emergency Preparedness, Application, Extension and Interpretation:

5.2. Emergency: This standard sets forth practices for the safe operation of motor vehicles owned or operated by organizations, including:

- Recruitment and education
- Management of motor vehicle safety programs
- Driver assessment, recruitment, and selection
- Vehicle inspection and maintenance
- Operator performance
- Dispatch, assignment, and operational strategy
- Incident response and data analysis

These practices are designed for use by those bearing the responsibility for the safe operation and operation of motor vehicles as a part of organizational operations.



Transport Safety Guidelines EMSC/NHTSA fact sheet

The Do's and Don'ts of Transporting Children in an Ambulance

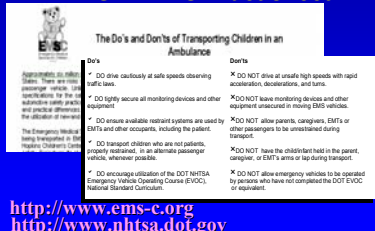
Do's

- DO drive cautiously at safe speeds observing traffic laws.
- DO tightly secure all monitoring devices and other equipment.
- DO ensure suitable restraint systems are used by EMTs and other occupants, including the patient.
- DO transport children who are not patients, properly restrained, in an alternate passenger vehicle, whenever possible.
- DO encourage utilization of the DOT NHTSA Emergency Vehicle Operating Course (EVOC), National Standard Curriculum.

Don'ts

- DO NOT drive at unsafe high speeds with rapid acceleration, deceleration, and turns.
- DO NOT leave monitoring devices and other equipment unsecured in moving EMS vehicles.
- DO NOT allow patients, caregivers, EMTs or other passengers to be unrestrained during transport.
- DO NOT have the child/infant held in the parent, caregiver, or EMT's arms or lap during transport.
- DO NOT allow emergency vehicles to be operated by persons who have not completed the DOT EVOC, or equivalent.

<http://www.ems-c.org>
<http://www.nhtsa.dof.gov>



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

Cost ?

- ▶ Loss of life and serious injury to EMS providers, patients, public
- ▶ Insurance payouts per serious crash \$10- 35 million
- ▶ Estimated in excess of \$500 million annually

Risk to who?

- ▶ Health care interventions that are a risk to:
 - Patients (their families?)
 - Providers
 - Public

USA EMS Risk/Hazards

- ▶ Predictable risks
- ▶ Serious occupational hazard
- ▶ Predictable fatal injuries

This is about you and your safety

- ▶ What safety practices do you use??
 - Seat belts ?
 - EVOC training ?
 - Equipment lock down ?
 - Helmets ?
 - "Black Box" technology ?
 - Tiered dispatch ?

Air EMS is a role model for safety initiatives and focus



Rollover Crash Kills Medical Technician

Amherst, Mass. (AP) — A 14th and 15th Street, Springfield, Mass., on Tuesday.

It does happen....

head protection?



Key Helmet Features



Creating a Safety Culture

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

- ▶ Awareness
- ▶ Training
- ▶ Incentive

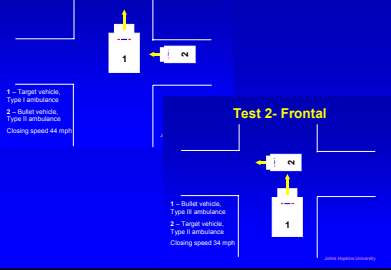
Identifying predictable and preventable transport related risks and hazards

- ▶ Systems approach
 - Communications
 - Personnel
 - Transport
 - Equipment
 - Environment

Dynamic Safety Testing

- ▶ requires sophisticated, expensive equipment
- ▶ measurably demonstrates forces generated during collision
- ▶ accepted international standard for vehicle restraint systems

Test 1 – Right side impact



New concepts out there now

- ▶ Black Boxes
- ▶ Tiered dispatch
- ▶ Helmets
- ▶ Enhanced ambulance vehicle design
- ▶ Intelligent Transport Technologies - ITS
- ▶ New Safety Standards

The "Black Box"

Driver behavior monitoring and feedback device

How to quantify the risk taking behavior of ambulance drivers in patient transport?

Dr. Bruce A. Brown, MD, PhD, The University of Michigan

University Hospital, Department of Emergency Medicine, The Michigan EMS, Dr. Bruce A. Brown, MD, PhD, The University of Michigan

Michigan State University, Department of Emergency Medicine, The Michigan EMS, Dr. Bruce A. Brown, MD, PhD, The University of Michigan

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?

Important Principles !

1. Ambulances are NOT standard passenger vehicles

Important Principles !

2. Pediatric patients in ambulances have needs which differ from children in passenger cars

Important Principles !

3. Design, performance and practice policy should be based on properly conducted science

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

Very 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

**PREDICTABLE
PREVENTABLE
and
NO 'ACCIDENT'**

Future Directions

- ▶ Rational use of limited resource
- ▶ Avoid reinventing the wheel
- ▶ Formal safety research agenda
- ▶ Framework bridging key research and infrastructure
 - Society of Automotive Engineers
 - Involvement with ESV activities
 - EMS safety research funding
 - Foster evidence based initiatives

Future

- ♦ Goals
- ♦ New vehicles
- ♦ New technologies
- ♦ Futuristic vehicles
- ♦ New policies
- ♦ New practices
- ♦ New Standards

Conclusion

- ▶ Major advances in EMS transport safety research, infrastructure and practice over the past 5 years
- ▶ EMS is still way behind the state of the art in vehicle safety and occupant protection
- ▶ Enhanced cross disciplinary collaboration in development of safety initiatives now exist
- ▶ Focus on safety of ALL aspects of the ambulance environment - safer patient transport practices exist & should be used
- ▶ New safety developments are underway; be ready to integrate them into your practice
- ▶ And above all WE NEED DATA

And....

- ▶ It is no longer acceptable for patient transport to be functioning outside of automotive safety and PPE safety standards for prevention of and protection of EMS providers and the public from death or injury

Electronic Info:

www.objectivesafety.net

- ▶ **Electronic Handout of today's presentation**
- ▶ **"Ambulance Safety: Where is the State of the Art?"
Webinar June 14, 2005**
Recorded online - Free access via the internet
- ▶ **Comprehensive Reference List on EMS Safety**



Acknowledgements

- ▶ EMSC funding – Targeted Issues Grant, PED-SAFE-T
- ▶ The late Capt. Garry Criddle – ExNHTSA/EMSC
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