

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*



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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.



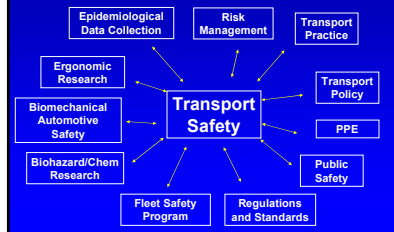
Key Issues

- ▶ **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 ambulance resulted in seven injuries in the coastal Delaware town of Abscon, including three deaths, within a period of three weeks in the first week.

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 of a 1997 light-colored Chevrolet pickup truck parked in the road.

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 town control and strike the smaller and smaller truck the ambulance, according to police.

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

The car caught fire and ambulance was struck by the car and the car pulled the ambulance into the road, where it was struck by a 1997 light-colored Chevrolet pickup truck, police said.

(AP/Wide World)

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 drive the development of the EMS system.



<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

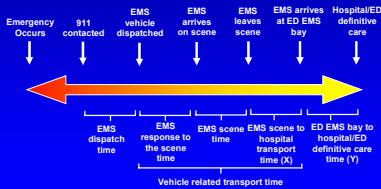
Vision Zero is a philosophy of road safety that eventually no one will be killed or seriously injured within the road transport system. Vision Zero describes the view that safety cannot be traded for mobility. Sweden's Vision Zero is aimed at eliminating all deaths or long-term health losses arising from road crashes. The mobility in the road transport system should be a function of the safety and not vice versa³.

This is not acceptable

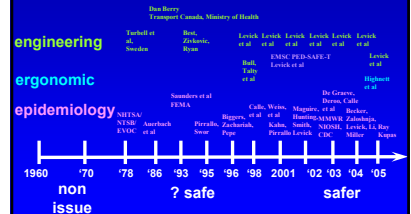
- ▶ ~ One fatality each week#
 - ~ 2/3 pedestrians or occupants of other car
 - ~ 4 child fatalities per year (>2X airbags 2004-2005)
- ▶ ~10 serious injuries each day
- ▶ Cost estimates > \$500 million annually
- ▶ USA Crash fatality rate/capita 35x higher than in Australia

PARIS/BTS 2004

911 Call to Hospital/ED Definitive Care Time Intervals*



Ambulance Safety Research: A New Field

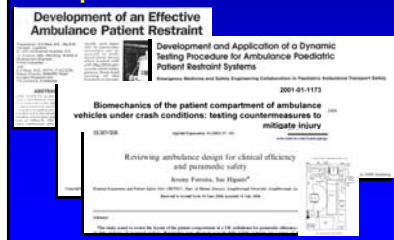


Predictable risks

- ▶ More often at intersections, & with another vehicle ($p < 0.001$)¹
- ▶ Most serious & fatal injuries occurred in rear (OR 2.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)²
- ▶ 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##

¹Kohn CA, Pirralo RD, Kuhn EM. *Prehospital Emergency Care* 2001 Jul-Sep;5(3):261-9
²Wolcott, Zaslavsky, Levin, Li, Mitty, *Acc Anal Prev* 2002
³Maguire, Hastings, Smith, Levin, *Journal of Emergency Medical Services* Dec 2002
^{##}WJOM, 2003
[#]Billy AM, Gabb DP. *Prehospital Emergency Care* 2005 Dec; 8:412-415
^{###}WJOM, 49 CRR Parts 871, 872 & 889 Docket no. 90-28, 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 training, case, 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

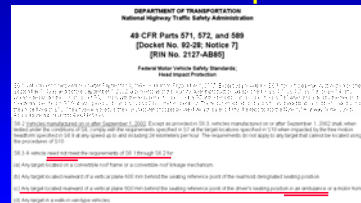
Concerns

- ▶ 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 DORSE
<http://www.foxnews.com>

Associated Press, Feb. 19, 2005

While waiting for the victim's death in the office of the car and an ambulance, the witness said, a person who said they were an ambulance driver.

"The ambulance driver was in a vehicle with a valid driver's license."

"It is unclear if the witness administered first aid, but the witness stated that the ambulance driver was not licensed to drive an ambulance."

"I was shocked to see that an unlicensed driver or certification is required to drive an ambulance," the witness said. "This is not what I would expect."

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

— Gregg Theunes, (EMT) and former Assistant Fire Marshal



Quoteable

It's no different than someone who delivers pizzas.

— Gregg Theunes, (EMT) and former Assistant Fire Marshal

Gregg Theunes Appeal to his Senator, December 29, 2005

Letter to EMS Response: President's Committee on Goals

Dear Senator, I am writing to you regarding the President's Committee on Goals and Objectives for the EMS profession. I am a former EMT and a current Fire Marshal. I am writing to you regarding the President's Committee on Goals and Objectives for the EMS profession. I am a former EMT and a current Fire Marshal. I am writing to you regarding the President's Committee on Goals and Objectives for the EMS profession. I am a former EMT and a current Fire Marshal.

EMERGENCIES	RECOMMENDATIONS
1. Public safety	1. Public safety
2. Emergency response	2. Emergency response
3. Patient care	3. Patient care
4. Professionalism	4. Professionalism
5. Education	5. Education
6. Research	6. Research
7. Advocacy	7. Advocacy
8. Quality of care	8. Quality of care
9. Safety	9. Safety
10. Cost-effectiveness	10. Cost-effectiveness



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

Transport Safety Guidelines EMSC/NHTSA fact sheet

<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

(Additional Photos: Jeff Kohn and Bobb Over, Reporting from Englewood and a Patient)

(Small text describing the incident)

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

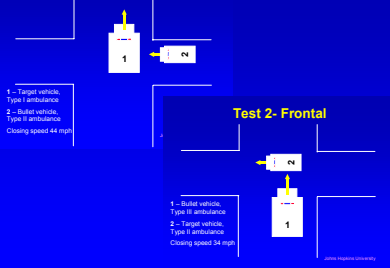
Identifying predictable and preventable transport related risks and hazards

- ▶ 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



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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