
 PAEDIATRIC INTENSIVE CARE SOCIETY  
 SCIENTIFIC MEETING  
 GLASGOW 16TH-17TH NOVEMBER 2006

## Paediatric Transport Safety -

*What you can't afford not to know*

Nadine Levick, MD MPH  
 Research Director  
 BISS Safety Foundation  
 New York

### A tragic emergency health care intervention outcome



**It does happen....**

## Objectives

1. To identify the safety issues that are key regarding neonatal and pediatric transport
2. To educate participants about the existing safety guidelines
3. Instruct providers on strategies for preventing crashes and for reducing risk of injury during transport and update the latest transport safety developments

## Outline

- I. Review 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

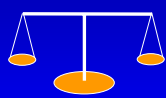
## This week in New York


**Ambulance Accident Injures Five**  
 An ambulance collided with an SUV in Manhattan Thursday evening, injuring at least five people. The accident occurred at the intersection of 40th and 3rd avenues in Bay Ridge. A Victory Memorial ambulance, involved with a steep clearance before sliding over 40-foot into a parked car.

## Major deal...



## Balance of concerns and risk during transport



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

<http://www.objectivesafety.net>  
 and your electronic handout awaits you online!



Science/Health


**Crash Testing for Pediatric Ambulance Transport Safety Begins**



**Jump start**  
A RoboRoo Series II kangaroo tests 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

## Driver dies after ambulance crash

**NEWS**

**Driver dies after ambulance crash**

A 60-year-old man died after his ambulance crashed into a car on a road in New South Wales, Australia.

The incident happened just before 10pm on Tuesday. The ambulance was on its way to a hospital when it crashed into the car.

The ambulance driver was not injured, but the 60-year-old man died of his injuries. The driver of the car was also injured.

The ambulance driver was not injured, but the 60-year-old man died of his injuries. The driver of the car was also injured.

## ASU - THE Union For UK Ambulance Staff

### Ambulance driver dies in Cork crash



17 September 2008 20:00

An ambulance driver has died and the patient he was carrying is in a serious condition after the ambulance crashed near Cork city, Ireland.

A 60-year-old ambulance driver was a passenger in the ambulance, which was on a shift in the city of Cork, Ireland.

The ambulance was on its way to a hospital when it crashed into a car. The ambulance driver was not injured, but the 60-year-old man died of his injuries. The driver of the car was also injured.

## Safety oversight of what and by .... whom

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

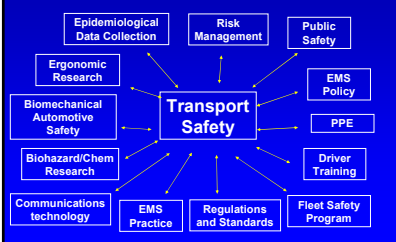
## Goals

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

## Safety in Pediatric/Neonatal Ambulance Transport

▶ Is part of a SYSTEM

## Paediatric Transport Safety IS Complex AND Multidisciplinary



## 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

TIME & PLACE

## The Emergency Department (ED)



## An ambulance is not an ED //ICU on wheels



Firstly!

▶ **An accident ?**

▶ or  
a predictable and preventable event

The Hartford Courant  
**courant.com**

Wednesday, October 8

03M 3AM 10/08/08 12:00:00 PM EST

Home News Business Entertainment Sports Arts

**Girl, medics injured in crash**

NEW HAVEN, Conn. — An 8-year-old girl got hurt in a crash Wednesday that injured two medics and a paramedic.



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

## This is not acceptable

### ▶ In the USA

- ~ 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

#AAS 8/75 2005

## USA Peds Transports

- ▶ ~One in ten (~ 6 million) ambulance transports involves a child
- ▶ Only ~ 1.8 million are children <5 yrs
- ▶ Ambulances ≠ standard passenger vehicles
- ▶ Pediatric patients in ambulances ≠ children in passenger cars
- ▶ Standard automotive safety practices cannot be applied directly to ambulances

## Neonatal/Peds Transport are Safety Leaders

- ▶ Neonatal and Pediatric dedicated services appear to be amongst the safer emergency medical transport services\*

\* Pediatric critical care transport—the safety of the journey: a five-year review of vehicular collisions involving pediatric and neonatal transport teams: GA Woodward, EW Flegler - Pediatr Emerg Care, 2002



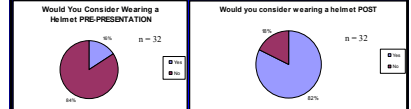
## head protection?



## Role of a head protective device

- ▶ A simple, immediate and inexpensive adjunct – a protective device -
  - To protect occupants from hazardous interiors
  - As vehicle crashworthiness design advances
  - As driver training advances
  - For when equipment becomes unsecured
  - As EMS Safety Standards are developed, for both EMS vehicles and EMS occupational safety

## Preliminary Study: Attitudes to Head Protection in EMS



Hmm...



## So why is it...

- ▶ That the EMS providers -
  - Were wearing navy blue – one of the most difficult colors to see at night
  - Had no head protection, when all other emergency personnel at the scene did
  - Had no protective clothing, when other emergency personnel at the scene did???

## Air EMS is a role model for safety initiatives and focus

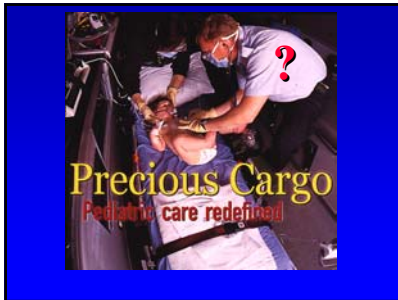


## Crash Occupant Protection

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

in a collision at 35 mph (60 km/hr), an unrestrained 15 kg child is exposed to the same forces\* as in falling from a 4th story window

\*550 kg/force in 0.03 sec



## Patients must be in the over the shoulder harness, medics restrained in seat belts, equipment secured

## Ambulance Safety Research: A New Field

Dana Berry  
University of Florida, Ministry of Health

engineering	Torkelson et al.	Reed, Zickman, Ryan	Leitch et al.	Leitch et al.	Leitch et al.	Leitch et al.	Leitch et al.	Leitch et al.
ergonomic								
epidemiology	NISHIDA, NISHIDA, Auerbach et al.	Schwartz et al.	Washburn, Pappas et al.	Washburn, Pappas et al.	Washburn, Pappas et al.	Washburn, Pappas et al.	Washburn, Pappas et al.	Washburn, Pappas et al.

## We should use the best safety practices demonstrated

**Development of an Effective Ambulance Patient Restraint**

Development and Application of a Dynamic Testing Procedure for Ambulance Pedoelastic Patient Restraint Systems

2001-01-1173

Biomechanics of the patient compartment of ambulance vehicles under crash conditions: testing countermeasures to mitigate injury

Reviewing ambulance design for clinical efficacy and paramedic safety

Anna Ferraro, Sue Hagan\*

## Automotive Safety World

SAE 2000 Future book

### The future of vehicle safety

A developing effort by the automotive industry and government has developed a new approach to vehicle safety. The goal is to reduce the number of traffic fatalities and injuries by integrating environmental controls to network active and passive vehicle safety systems. The goal is to create a new paradigm for vehicle safety that is more comprehensive and more effective. This requires greater coordination between industry and government. The industry must provide the data and information needed to develop a new paradigm for vehicle safety. The government must provide the regulatory framework and funding needed to support this effort. The industry and government must work together to create a new paradigm for vehicle safety that is more comprehensive and more effective.

## Knowledge, opinions and behaviors

**Clinical Practice**

**Child and Provider Restraints in Ambulances: Knowledge, Opinions, and Behaviors of Emergency Medical Services Providers**

Timothy D. Johnson, PhD, Daniel Lindholm, MEd/EMT-P, M, Denise Dwyer, MS, MPH

**Abstract**

Background: Ambulance providers are responsible for ambulance crash risk, and there are an estimated 4,000 ambulance crashes each year. Information about emergency medical services (EMS) provider knowledge, opinions, and behaviors regarding equipment restraint is lacking.

Objective: To measure the knowledge, opinions, and behaviors of EMS personnel regarding child and provider restraint use in ambulances.

Methods: A survey was conducted of 438 providers in two large ambulance services organizations and in a hospital-based pediatric ambulance service in a central United States.

Results: A total of 367 EMS providers were surveyed. For a survey rate of 83.7%, nearly half were involved in an ambulance crash in the last 12 months. 74% were paramedics and 26% were EMTs. The majority (75%) reported some training in child restraint use in an ambulance, and half reported that they have been in a very rough road driving with child in a child restraint. However, 80% did not identify the correct method of restraint for a child 7 years old and 40% did not know the correct method of restraining a child over the age of 10. Improving a child's use in a child seat is critical to EMS care and ambulance providers require targeted education in child seat. EMS organizations must not only help to fund research, but also provide the education and training needed to ensure that the research is used.

## 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, Pirralo RD, Kuhn EM. *Pediatric Emergency Care* 2001 Jul-Sep;5(3):261-9  
 \*\*Lindholm, Zickman, Leitch, Li, Miller. *Acc Anal Prev* 2002  
 \*\*\*Maguire, Hunting, Smith, Leitch. *Journal Emerg Med* Dec 2002  
 #WGDW 2003  
 ##Maguire AM, Gabb DP. *Pediatric Emergency Care* 2005 Dec; 8:412-418  
 ###WHTSA, 49 CFR Parts 871, 872 & 889 Doctet no. 90-28; notice 7

## A word about occupational transportation fatalities..

Occupational transportation fatalities/100,000 workers

Occupation	Fatalities/100,000 workers
EMS	~10
Police	~6
Fire	~5

▶ **WE HAVE A BIG PROBLEM HERE**

\* Maguire, Hunting, Smith & Leitch. *Occupational Fatalities in Emergency Medical Services: A Hidden Crisis, Annals of Emergency Medicine*, Dec 2002

## 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??

## 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

## 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 amongst providers 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

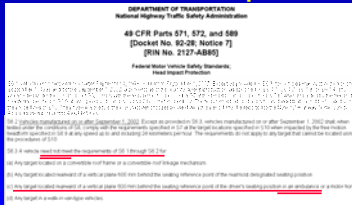
## What are the risks?

- 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

## Global EMS Vehicle Safety Standards v 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]
  - [New ASSE/ANSI Z15 – fleet vehicles]
- ▶ USA Other
  - Purchase Specification: KKK & NTEA – AMD
  - Guideline: EMSC Dos and Dents, and (CAAS and CAMTS)

## USA Ambulances: FMVSS Exempt



## Australia & New Zealand 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



## Common European Community (CEN) EN1789:1999, European Committee for Standardization

- ▶ “Without exception, all persons, medical devices, equipment, and objects normally carried on the road ambulance shall be maintained to prevent them from becoming a projectile when subject to a force...”
- ▶ 50th percentile manikins - 10 G in Forward, Rearward, Transverse, & Vertical directions
- ▶ Certified by Notified Body and Ambulance Mfg.



## USA ambulance purchase specifications GSA:KKK-A-1822D/E

- ▶ Static Pull test
- ▶ 2200 Lbs. (8G's) in Longitudinal and Lateral
- ▶ No dynamic test
- ▶ No definition to manikin mass
- ▶ No restraint for equipment
- ▶ Voluntary



## Some KKK spec info

- ▶ Text detail:
  - lighting systems
    - 151 lines of text, 2 tables and a diagram, over 5 pages
  - preparation of painting, color and markings
    - 107 lines of text, 1 table, over 3 pages
  - protection of patients and crew
    - 2 1/2 lines of text



## A key to safe ambulance transport



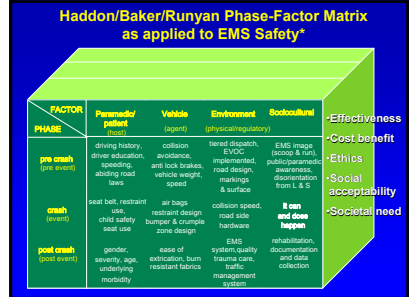
## Back up Camera..... Shouldn't all vehicles have one of these?

**VRBCS300 - Backup Camera**

**Backup Camera**

- Complete with all accessories. Nothing else to buy
- 3.5" HD Horizontal Camera Viewing Angle
- 800° Vertical Camera Viewing Angle
- Monitor Mounts on Dash or Visor
- For Use With 12 Volt DC Electrical Systems
- Great For Cars, SUVs, RVs and Delivery Vehicles!
- Helps Avoid Accidents & Injuries!

English product manual  
FAQs - English



## Australia, Melbourne



**NETS Transport**

### Newborn Emergency Transport Service (NETS) (Victoria)

Launch of Custom-built Ambulance for the Newborn Emergency Transport Service (NETS), Victoria

22nd Mar 2005

**Media Release**

**Special ambulance to transport sick tiny tots**

The Minister for Health, the Hon (Bromley) Price, MP, today officially launched the first of three new state-of-the-art ambulances to safely transport Victoria's critically ill and premature babies from around the State and bring them safely back to neonatal intensive care units in Melbourne.

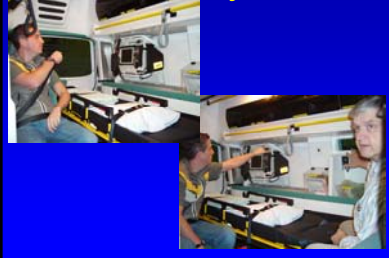
## Australia NSW



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



## Norway



## New Swedish vehicles



## New UK London Ambulance/neonatal vehicles



Produced by the Royal College of Physicians of Edinburgh, the Royal College of Surgeons of Edinburgh and the Royal College of Physicians and Surgeons of Glasgow.

**SHAKETHROUGH IN NEONATAL TRANSPORT: INDICATOR DESIGN**

**Author:** Dr Ian A Leding, Consultant Neonatologist, Glasgow Centre for Reproductive Health, Royal Infirmary of Edinburgh

**Presented by:** The Hon. Lord MacLennan, Edinburgh

**Reviewed by:** The Hon. Lord MacLennan, Edinburgh

**Abstract:** In Scotland there are about 1,000 neonatal transports carried out annually. Many of these infants require maximum intensive care en route. They are commonly extremely premature neonates, infants with congenital abnormalities or those suffering from parental substance or severe infections. The UK is currently undergoing a dramatic revolution in the way neonatal transports are organised.

**What do you think of this article?**

Share on Facebook

Share on Twitter

Share on LinkedIn

Share on Email

Share on Print

Share on RSS

Share on Facebook

Share on Twitter

Share on LinkedIn

Share on Email

Share on Print

Share on RSS



## "Are our policies killing people?"

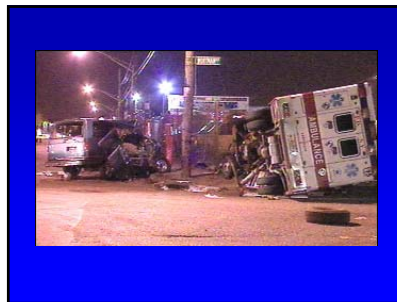
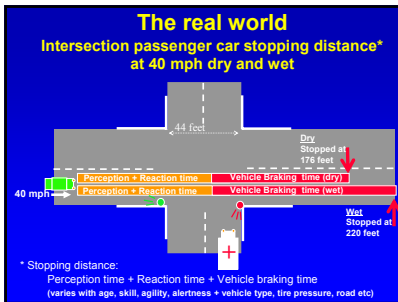
- ▶ 1991-2000, 302,969 Emergency vehicles were involved in MVCs - 1,565 involving fatalities\*
- ▶ In PA 1997-2001, ambulances were more likely than similar sized vehicles to be involved in\*:
  - 4 way intersection crashes (43% vs 23%, p=0.001)
  - Collisions at traffic signals (37% vs 18%, p=0.001)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





### Transport Safety Guidelines EMSC/NHTSA fact sheet

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

Do's	Don'ts
<ul style="list-style-type: none"> <li>DO drive cautiously at safe speeds observing traffic laws.</li> <li>DO verify secure all monitoring devices and other equipment.</li> <li>DO use available restraint systems as closely as possible.</li> <li>DO transport children who are not patients, properly restrained, in an alternate passenger vehicle, whenever possible.</li> <li>DO encourage utilization of the DOT NHTSA Emergency Vehicle Operating Course (EVO-C), National Standard Curriculum.</li> </ul>	<ul style="list-style-type: none"> <li>DO NOT drive at unsafe high speeds with rapid accelerations, decelerations, and turns.</li> <li>DO NOT use monitoring devices and other equipment unsecured in moving EMS vehicles.</li> <li>DO NOT allow parents, caregivers, EMTs or other passengers to be unrestrained during transport.</li> <li>DO NOT have the child/infant held in the parent, caregiver, or EMT's arms or lap during transport.</li> <li>DO NOT allow emergency vehicles to be operated by persons who have not completed the DOT EVO-C or equivalent.</li> </ul>

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

### American National Standard ANSI/ASSE Z15.1-2006

#### Safe Practices for Fleet Motor Vehicle Operations

- ### 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



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

- ### The Crash Event - Crash Testing
- ▶ An introduction
  - ▶ What one needs to know
  - ▶ What do the tests really mean
  - ▶ And, what tests are meaningful

## Dynamic Safety Testing

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

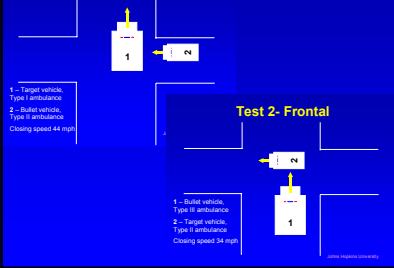
## If we know this – and its published....



## Why do we do this?



### 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

## Important Principles !

1. Ambulances are NOT standard passenger vehicles

## Important Principles !

2. Paediatric 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'**

## Conclusions

- ▶ Prevention is key - The ambulance transport environment includes predictable and preventable occupant risks.
- ▶ Unrestrained occupants and equipment are a potential injury risk to all occupants
- ▶ Every member of a paediatric transport program must play a role to actively manage risk and to avoid taking unnecessary risk.
- ▶ Focus on safety of ALL aspects of the transport environment
- ▶ Safer patient transport practices exist & should be used
- ▶ New technologies for vehicle design, occupant PPE and equipment restraint and driver performance are now available; be ready to integrate them into your practice
- ▶ There is a need for a defined pathway for translation of problem identification to resolution and policy implementation

## 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/transport providers and the public from injury or death

### Electronic Info:

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

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

