Safe Transport of Children
Pediatric Patient Transport & Ambulance Safety: Update

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AAP Transport Section
American Academy of Pediatrics NCE,
San Francisco, October 28th, 2007

Now, who have we here??

► Do you transport pediatric patients?
► Are you responsible for vehicle purchases?
► Do you manage the oversight of your vehicle performance and safety?
► Do you design your vehicles?
► Do you have ergonomic, automotive safety and crashworthiness, occupant protection and fleet safety scientific and technical data background and support?
► Do you rely on health care colleagues and aftermarket retrofitters for technical vehicle safety and fleet performance advice?

Objective

► To identify the safety issues that are key regarding pediatric patient transport for the patient, the provider and the public
► To describe safety innovation and dispel safety myths
► To instruct providers on strategies for preventing crashes and for reducing risk of injury to patients, providers and the public during transport

Your Interactive Handout
awaits you online gratis at...
► www.objectivesafety.net

This WILL be FAST!!
The goal is to provide info and access to other disciplines resources and info
No need to take any notes – all text slides will be awaiting you in your online Handout

Biomechanics
Ergonomics
Fleet safety

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
► Training simulation
► Driver performance monitoring
► Roadside and road design
► Integrated traffic safety technologies
► Scene safety and visibility
► Safety data capture
► Safety oversight

An interhospital transport
“Do no harm…”?

http://www.objectivesafety.net
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##

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??

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

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

Transport oversight?

- In contrast to the bus and truck industries, which have -
  - comprehensive safety oversight
  - transportation safety data capture via the Federal Motor Carrier Safety Administration (FMCSA)
- EMS has been focused more as an acute health care delivery and emergency medical service and largely "outside" of much of the other transportation oversight infrastructure that exists

What about FMCSA's Mission

To improve safety by:

- Conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding
- Adopting, testing, and deploying innovative driver, carrier, vehicle, and roadside best practices and technologies
- By expanding the knowledge and portfolio of deployable technology, the research and technology program will help FMCSA reduce crashes, injuries, and fatalities and will deliver a program that contributes to a safe and secure commercial transportation system.

A very serious gap in data, performance and oversight

- FMCSA Truck safety goals – to decrease the fatality rate of 2.8 per 100 million truck-miles in 1996 to 1.65 by 2008
- EMS crash fatality estimates are - 7.66 - 41.93 fatalities per 100 million ambulance-miles

Clinical Care? Occupational Health and Safety??

- This IS a Transportation and Automotive Safety issue
- This is a Systems safety issue
A problem
2007 Insurance data –
- 27 fold more likely to have a claim
  based on transport than related to medical care

National EMS data
In the USA*
- 50,000 vehicles
- 5,000 crashes a year
- One fatality each week
- 2/3 pedestrians or occupants of other car
- Approximately 1 child fatality per year
- ~10 serious injuries each day
- Cost estimates > $500 million annually
- USA crash fatality rate/capita 35x higher than in Australia

Peds Transport
- Collisions/crashes among pediatric transport teams are unusual
- Some resulted in deaths, injuries, and disability
- appear to be caused by the actions of a team member
- or driver of third party vehicle
- Collision-free teams attributed their safety record to specific policies of the team and/or the vehicle owner or vendor
- Specific safety policies on the part of the team, vehicle owner or provider may prevent or decrease collisions/crashes.


Neonatal Transport
- The continuous process of critical incident reporting and review can reduce the number of adverse events during the transfer of critically ill infants.

Knowledge, opinions and behaviors

What are the solutions?
- Training?
- Practice Policy?
- Transportation Systems Engineering?
- Automotive Engineering?
- Education of other road users???

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

Balance of concerns and risk during transport
- Response and transport time
- Clinical care provision
- Occupant safety/protection
- Public Safety

Absence of ground standards and oversight
- Challenges in identifying best practice
- Myriad of unregulated commercial products
- No safety performance standards
- Absent national safety oversight

*  Towards safer neonatal transfer: the importance of critical incident review. Moss SJ, D Embleton N, Fenton AC. Archives of Disease in Childhood 90 (7): 729-732 JUL 2005
Air and Ground EMS

- Major differences in safety culture and approach
- Dichotomy of Safety Standards
- Diverse safety oversight
- Absent ground safety regulatory control

Air EMS is a role model for safety initiatives and focus

We need

- Injury data
- Coordinated initiatives to promote safety (with strings attached)
- Input from science and technical data
- Knowledge transfer
- Safety oversight

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

Role of the NTSB

The National Transportation Safety Board (NTSB)

- EVOC
- LICENSE RECORDS

The National Transportation Safety Board (NTSB)

The National Transportation Safety Board is an independent Federal agency charged with investigating major accidents and determining the probable cause. The Board issues recommendations intended to prevent recurrent accidents.

NTSB 1979 Accident Report

- Role of the NTSB
- NTSB 1979 Recommendations never implemented

- NTB 1979 Recommendations never implemented
- To NHTSA – Class II & III Priority Action
- To GSA – Class II Priority Action
- To National Committee on Uniform Traffic Laws

30 Years and 1,600 Fatalities later -
30 years later and still the same problem

Why AREN'T we on the NTSB's "Most Wanted List"??

A Simple Question....

C45 - A criminal offence to not act in a way that protects the worker

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

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

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

Thursday July 5th 2007 ......

"...I'd like to know what can be done so this never happens again...."
Friday July 20th 2007...
The worst ambulance crash in USA history

Five Killed In Crash of Ambulance and Semi
JAN 21, 2007 06:20 AM EDT

Two RAW VIDEO: fatal crash

The semi-raw video shows the ambulance involved in the fatal crash. The ambulance had a rider at the time of the accident. The semi had a rider at the time of the accident.

The passengers, who are seated in the ambulance, are riding in a regular ambulance on their way to the hospital. The ambulance had a rider on the way to the hospital.

A tragic emergency health care intervention outcome

It does happen.......

Recent adverse EMS transport outcomes

UPS and Laundry trucks have very similar design and even more stringent safety requirements to EMS vehicles BUT very different cargo......

People are passengers and NOT packages or parcels

Some odd facts

- Ambulances are generally not built by the automotive industry
- Intelligent Transportation Systems (ITS), transportation safety engineering and transportation systems engineering are 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

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

▶ An accident?
▶ or a predictable and preventable event

Safety in Pediatric/Neonatal Ambulance Transport
▶ Is part of a SYSTEM

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

The Emergency Department (ED)

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

Pediatric Transport Safety IS Complex AND Multidisciplinary

Epidemiological Data Collection
Ergonomic Research
Biomechanical Automotive Safety
Risk Management
EMS Safety
EMS Policy
PPE
Driver Training

How you don’t want to see your colleague transported...
What a novel idea...

EMS/Medical Transport Safety

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

and who's life was he racing to save?

and what is killing EMS?

EMS personnel fatalities:

- 74% transportation related
- 11% were cardiovascular
- 9% were homicide
- 4% needle sticks, electrocution, drowning and other


So does it make sense?

- Gloves and universal precautions...
  - good biohazard protection BUT
  - aren't going to give much protection in an ambulance crash

September 11, 2007

Ambulance Safety Research: A New Field

We should use the best safety practices demonstrated in engineering

and in ergonomics
Research papers in the past 30 years
- EMS transport safety
  - 40 papers - on ambulance safety
  - 1 paper - on ambulance ergonomics
  - 1 paper – on stretcher ergonomics
- Computer Workstations
  - 30,000 papers – on ergonomics of computer workstations
- Erectile Dysfunction
  - 100,000 papers – on Erectile Dysfunction

DOT Funding for Reptiles and Road Kill

The Crash Event - Crash Testing
- An introduction
- What one needs to know
- What do the tests really mean
- And, what tests are meaningful
- This is all about time – in milliseconds

Intrusion vs Deceleration
- Intrusion
  = vehicle to vehicle or vehicle to fixed narrow object
- Deceleration
  = sudden stop – i.e. sled test

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

Why do we do this?
Pre crash sled test configuration
(view of captains chair and patient area)

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

Post impact (from rear door)

Full Vehicle Crash Testing
Test 1 – Right side impact
And this all takes place in 60 milliseconds – the blink of an eye.

During impact:
- CTD dynamics
- Post-impact

In the absence of standards or automotive peer review:

Immobilization board
- Foldable

Choose the Best Option
Global EMS Vehicle Safety Standards
v Specifications and Guidelines

- EMS Safety and Performance Standards
  - Australia & New Zealand 4513
  - 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 Donts, and (CAAS and CAMTS)

USA ambulance purchase specifications

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

USA Ambulances: FMVSS Exempt

Propaganda that kills...

Occupant protection......??
July 2007

Unacceptable, and ridiculous current
2007 USA ambulance ‘safety testing’ practices !?!

FMVSS exempt......

No ‘a’... then NO ‘F’ !!!!

- F = ma

where:
F – force
m – mass
a – acceleration
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.

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

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Systems safety failure AND dangerous practice for pediatric patients

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?

NASCAR inspired?
"Safety" approaches being driven by manufacturers claims and sales rather than by science and data?

Rash of "Safety Concept" vehicles.....
Devoid of substantive automotive safety engineering input or testing?

NO automotive safety engineer
NO crashworthiness engineer
NO ergonomist

NO reference to ANY existing or relevant automotive safety or crashworthiness technical publications....
yet multiple occupant fatalities and injuries annually....

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NO reference to ANY existing or relevant automotive safety or crashworthiness technical publications....
yet multiple occupant fatalities and injuries annually....

Sept 26th, 2007

So.. The real world for an EMS vehicle approaching a red light

- You think they heard you...
- You know they must have seen you...
- And maybe they did
- ... But...
- There is NO way humanly possible that they could stop.....

The real world
Intersection passenger car stopping distance* at 40 mph dry and wet

- Perception time + Reaction time + Vehicle braking time
- *Stopping distance varies with age, skill, road, vehicle type, tire pressure, road etc.
Safety Management
- A Safety Culture
- Protective Policies
- Protective Devices
  - In the event of a crash
  - To prevent a crash
- Continuous Education and Evaluation

Innovation

What's new
- New automotive safety technologies
  - Crashworthiness
  - DVS
  - ITS
  - Monitoring and feedback enhancements
- New expertise
  - TRB
  - ASSE
  - SAE
  - UTRC
  - Ergonomics
  - Industrial Design

New concepts out there now
- Driver feedback boxes
- Tiered dispatch
- Helmets
- Enhanced ambulance vehicle design
- Intelligent Transport Technologies - ITS
- New Safety Standards

Intelligent Transport Safety Systems

Back up Camera….. Shouldn’t all vehicles have one of these?

NAEMT July 2006 Position statement
Policy makes a difference...

We are part of the problem...

Use proven safety tools

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

Automotive Injury Triangle and Safety Development

Protective devices/concepts

What about changing driver behavior in the real world??

The “Feedback Box” - A transportation safety monitoring and feedback device

Purpose of ‘Feedback box’ Program

As an emergency medical technician, I have to deal with the fact that many drivers are not using any kind of safety equipment. The consequences of this can be severe. Therefore, it's crucial to advocate for policies that make a difference in reducing the risk of accidents.

We are part of the problem when we do not adhere to safety protocols. As healthcare providers, we have a responsibility to ensure the safety of our patients and our colleagues. Using proven safety tools and technologies can help mitigate these risks.

Patients must be secured in the over the shoulder harness, medics restrained in seat belts, and equipment secured. This is crucial to prevent injuries during transport.

The Automotive Injury Triangle and Safety Development represents the various components that contribute to safety:

- Host Vehicle
- Environment
- Field Data
- Technology, invention & development
- Scholarly research
- Regulatory initiatives
- Protective devices/concepts
- Countermeasure deployment
- Environment

To prevent a crash:
- Driver feedback
- Driver monitoring
- Driver training
- Vehicle Intelligent Transportation System (ITS) technologies
- Timed dispatch
- Appropriate policies

In the event of a crash:
- Vehicle crashworthiness
- Seatbelt/airbag systems
- Emergency vehicle support
- Padding
- Head protection

What about changing driver behavior in the real world??

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.

The “Feedback Box” - 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.

Purpose of ‘Feedback box’ Program:
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation
**Demonstrated Effectiveness**

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<th>II</th>
<th>III</th>
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<td>I - blind data, no growls</td>
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<td>II - growls &amp; tones ON</td>
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<tr>
<td>III - identified data capture</td>
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- **A key to safe ambulance transport**
  - 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

- **Other monitoring devices**
  - Safety at the scene
  - New Australian vehicles
  - Flexibility to manage two patients

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

New UK London Ambulance/neonatal vehicles

Scotland neonate/peds transport

Clear safety message

Major events for innovation sharing – but regional and often language isolation

Vehicle Occupant Safety design

Ergonomic design

Sweden initiatives

Norway initiatives
Securing equipment

Science not, next best guess

Visibility and Conspicuity ...?

Under Way... Emergency Vehicle Visibility and Conspicuity Study
- Funded by the USFA
- Conducted by IFSTA
- Looking at the effectiveness of reflective markings used on emergency vehicles
- Doing best practice research and working with manufacturers

Under Way... Emergency Vehicle Visibility and Conspicuity Study
- These concepts/practices are more common in Europe
- Our research will draw from their experiences

Recent Visibility Webinar www.GlobalEMSForum.org

This looks cool AND SAFE!
We've known for 10 years that red fire trucks are twice as likely as lime yellow trucks to crash at an intersection.

- **Day visibility**
- **Night visibility**
Ground Transport Safety

Recent Projects, July 2007

- Commercial Motor Vehicle Driver Training Curricula and Delivery Methods and Their Effectiveness
- Commercial Motor Vehicle Carrier Safety Management Certification
- The Role of Safety Culture in Preventing Commercial Vehicle Crashes
- The Impact of Behavior-Based Safety Techniques on Commercial Motor Vehicle Drivers
- Health and Wellness Programs for Commercial Motor Vehicle Drivers

Knowledge transfer

July 2007

The truck and bus industry is on the right track at the TRB

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

Valuable information from the transportation industry

September 2007, its not magic…..
UPS: The ‘Big Brown’

- No left turns – instead make three rights
- Don’t back up
- Don’t employ any drivers under 25 years of age
- Don’t employ anyone with a history of driving convictions

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

ANSI/ASSE Z.15 Fleet Safety.....

http://www.objectivesafety.net/TransActions%20Z15.pdf

BHP - Key learnings for the organization were:
- Fatalities often have similar underlying causes
- High near miss reporting often correlates with declining injuries or fatalities
- Leadership visibility in the field is vital
- Hazard identification and risk awareness are fundamental to success.

Safety Improvement Roadmap

No need to reinvent the wheel...

These folks know what we need to know....

August 2007
An excellent model

USFA Emergency Vehicle Safety Initiative

Tips for Emergency Vehicle Operations

Major crash investigation
NTSB has expertise to do this comprehensively

Who has read this information???

Hours of service? Not new in other realms of ground transport...

The Driver

- Driver selection
- Driver monitoring and feedback
- Driver impairment
- Driver training

July 2007 Report
Breaking News!!
National Academies
TRB EMS/Medical Transport Safety
Subcommittee – Jan 16, 2008

Policy Changes
Integration of clinical care with fleet
management using an aviation model

CPR?
EMSNetwork

New York too...

Important changes underway

蹙幅摻騅柺奐
EMSNetwork

Integration and Collaboration
EMS Transport Safety Strategies - 2006-2007 New York State
Strategic Highway Safety Plan

Creating a Safety Culture
within a company must start with upper
management’s commitment to safety
➤ Awareness
➤ Training
➤ Incentive

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.

What do we know works...

- Policy
- Lap seat belts
- Over the shoulder harnesses
- Securing equipment
- Forward and rear facing seating
- Some electronic technical devices
- Safety awareness
- Cultural change

Future

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

Future Research

- Interdisciplinary Epidemiology
- Ergonomic hazards
- Transport
  - Vehicle/Occupant automotive safety testing
  - Vehicle design innovation
  - Driver behavior (Real time and Simulated)
  - Intelligent Transportation Systems
  - Operations tracking
  - Data systems/reporting systems
  - Enhanced practice policies evaluation

PREDICTABLE PREVENTABLE and NO ‘ACCIDENT’

small changes can make a BIG DIFFERENCE

- PREPARE – TEACH – REACH – RESPOND
  - Look at your own safety record
  - Teach safety and hazard awareness
  - Reach out with safety information to all your EMS providers
  - Respond with the best safety practices
Conclusions

- Prevention is key - The pediatric 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 pediatric transport program must play a role in actively managing risk and to avoid taking unnecessary risk.
- Focus on safety of ALL aspects of the transport environment.
- Safe patient transport practices exist & should be used.
- New technologies for vehicle design, occupant PPE and equipment design 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....

- Flight Safety and Fleet Safety are valuable models for systems safety.
- It is no longer acceptable for patient transport to be functioning outside of automotive and transportation safety and PPE safety standards for prevention of and protection of EMS/transport providers and the public from injury or death.

Thank you!
Any Questions??
Electronic handout available online
http://www.objectivesafety.net