Paediatric Transport Safety -
What you can’t afford not to know

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. To 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

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!
Key Issues

- Mythology
  - The Emergency Medical Service personnel are safe
- Injury Hazards
  - 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 workplace – "except" 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

Paediatric Transport Safety IS Complex AND Multidisciplinary

Goals

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

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
- paramed/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

Firstly!

- An accident?
- or
- a predictable and preventable event

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
  - ~320 pedestrians or occupants of other car
  - ~4 child fatalities per year (CDC, Virginia 2004-2005)
  - ~10 serious injuries each day
  - Cost estimates > $500 million annually
  - USA Crash fatality rate/capita 35x higher than in Australia

USA Peds Transports

- One in ten (~ 6 million) ambulance transports involves a child
- Only ~1.4 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 Fleegler - Pediatr Emerg Care, 2002
Health care interventions that are a risk to:
- Patients (their families?)
- Providers
- Public

Predictable risks
- Serious occupational hazard
- Predictable fatal injuries

What a novel idea...

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

The 'workplace'
- Transport provider's often in vulnerable positions during transport.
  - Bench seat
  - Captains chair
  - Standing or kneeling

Bigger is not necessarily better......

USA EMS Risk/Hazards

Risk to who?
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

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>84%</td>
<td>16%</td>
</tr>
</tbody>
</table>

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

We should use the best safety practices demonstrated.

We have a big problem here.

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

A word about occupational transportation fatalities

- Intersection crashes are the most lethal
- There are documented hazards, some which can be avoided
- Occupant and equipment restraint with standard belts is effective
- Some vehicle design features are beneficial

- WE HAVE A BIG PROBLEM HERE
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.

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
Understanding and poorly studied occupant and equipment restraint
The only design standards that are written specifically for ambulance vehicles (KKK spec) are purchase specifications, not performance specifications

Concerns

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 ASIE/ANSI Z15 - fleet vehicles]
USA Other
Purchase Specification: KKK & NTEA – AMD
Guideline: EMS Dos and Don’ts, 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
- 121 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
- 2½ lines of text
What do EMS crashes really cost?
- Loss of life and injury
- Negative impact on EMS system
- Collisions are the largest liability cost and exceed malpractice or negligence
- Besides the direct financial costs of replacing a damaged ambulance and equipment, there are additional hidden costs incurred:
  - Investigating the ambulance collision
  - Litigation/settlement/lawsuit
  - Medical/disability costs of injured EMTs
  - Hiring of new employees to replace injured personnel
  - Training and psychological counseling of personnel involved and others
  - Increased insurance rates

Identifying predictable and preventable transport related risks and hazards
- Systems approach
  - Communications
  - Personnel
  - Transport
  - Equipment
  - Environment

Protective devices/concepts
- To prevent a crash
  - Driver feedback
  - Driver monitoring
  - Driver training
  - Vehicle ITS Technologies
  - Tiered dispatch
  - Appropriate policies
- In the event of a crash
  - Vehicle crashworthiness
  - Seatbelt systems
  - Equipment lock downs
  - Padding
  - Head protection

Automotive Injury Triangle and Safety Development
- Host
- Vehicle
- Environment
- Field Data
- Scholarly Research
- Technology, invention & development
- Regulatory changes
- Countermeasure deployment

Intelligent Transport Safety Systems

Purpose of a ‘Black Box’ Program
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

It is like a ‘pulse oximeter’, that will save your life, your coworkers life, your patients life, and others on the road

Demonstrated Effectiveness

MEMS ABC Miles Per Month

MEMS MONTHLY OVER SPEED VIOLATION TREND 2003/2004

<table>
<thead>
<tr>
<th>Series</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2004</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

MEMS MONTHLY OVER SPEED VIOLATION TREND 2003/2004

<table>
<thead>
<tr>
<th>Series</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2004</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

Purpose of a ‘Black Box’ Program
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

It is like a ‘pulse oximeter’, that will save your life, your coworkers life, your patients life, and others on the road

Demonstrated Effectiveness

MEMS ABC Miles Per Month

MEMS MONTHLY OVER SPEED VIOLATION TREND 2003/2004

<table>
<thead>
<tr>
<th>Series</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2004</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

Purpose of a ‘Black Box’ Program
- Enhance Safety
- Improve Driver Performance
- Save Maintenance Dollars
- Aid Accident / Incident Investigation

It is like a ‘pulse oximeter’, that will save your life, your coworkers life, your patients life, and others on the road

Demonstrated Effectiveness

MEMS ABC Miles Per Month

MEMS MONTHLY OVER SPEED VIOLATION TREND 2003/2004

<table>
<thead>
<tr>
<th>Series</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2004</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>2005</td>
<td>100</td>
<td>500</td>
<td>1500</td>
<td>2000</td>
<td>1000</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>
A key to safe ambulance transport

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

Haddon/Baker/Runyan Phase-Factor Matrix as applied to EMS Safety*

**Factor**

**Phase**

- Effectiveness
- Cost benefit
- Ethics
- Social acceptability
- Societal need

**Australia, Melbourne**

**Australia NSW**

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

**Newborn Emergency Transport Service (Victoria)**

Launch of Costar ambulance for the Newborn Emergency Transport Service (NETS) babies.

**Norway**

**New Swedish vehicles**
New UK London Ambulance/neonatal vehicles

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

<table>
<thead>
<tr>
<th>Condition</th>
<th>Stopping Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>176 feet</td>
</tr>
<tr>
<td>Wet</td>
<td>220 feet</td>
</tr>
</tbody>
</table>

* Stopping distance: Perception time + Reaction time + Vehicle braking time (varies with age, skill, agility, alertness, vehicle type, tire pressure, road etc)

Transport Safety Guidelines
EMSC/NHTSA fact sheet
http://www.emsc.org
http://www.nhtsa.dot.gov

Do's
- DO drive cautiously at safe speeds observing traffic laws.
- DO tightly secure all monitoring devices and other equipment.
- DO ensure available 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 accelerations, decelerations, and turns.
- DO NOT leave monitoring devices and other equipment unsecured in moving EMS vehicles.
- DO NOT allow parents, 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.

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

The difference having data makes?

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?

Johns Hopkins University Test 1 – Right side impact
1 – Target vehicle, Type I ambulance
2 – Bullet vehicle, Type II ambulance
Closing speed 44 mph

Johns Hopkins University Test 2- Frontal
1 – Bullet vehicle, Type III ambulance
2 – Target vehicle, Type II ambulance
Closing speed 34 mph

Preparation of test vehicles
Pre-impact CTD positioning
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

Conclusions
- Prevention is key - The ambulance transport environment includes predictable and preventable risks
- Unrestrained occupants and equipment are a potential injury risk to all occupants
- Every member of a paediatric transport program must play a role in actively manage 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 restraint and driver performance are now available; be ready to integrate them into your practice
- There is 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

PREDICTABLE PREVENTABLE and NO ‘ACCIDENT’
Electronic Info:
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