Now, who have we here?

- Do you transport pediatric/neonatal 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?

Objectives

- 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

Transport related aspects -

- dispatch of EMS/Medical transport vehicles
- transport policies and protocol
- 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
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

January 30th, 2008

February 4th, 2008

Feb 21st, 2008
Predictable risks

- Fatal crashes more often at intersections, & with another vehicle (p < 0.001)²
- Most serious & fatal injuries occurred in rear (OR 3.7 vs front) & to improperly restrained occupants (OR 2.5 vs restrained)²
- 82% of fatally injured EMS rear occupants unrestrained ²
- 70% of fatal crashes EMS crashes during Emergency Use*³
- 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 ²
- > 74% of EMT occupational fatalities are MVC related ³
- 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 vehicles⁵

*Kahn CA, Pirrallo RG, Kuhn EM, Prehosp Emerg Care 2001 Jul-Sep;5(3):261-9
**Becker, Zaloshnja, Levick, Li, Miller, Acc Anal Prev 2003
#NIOSH, 2003
##Ray AM, Kupas DF, Prehosp Emerg Care 2005 Dec; 9:412-415

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

General Patient Transport Concerns

- 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??

Other high speed vehicles (eg. racing cars) have a different safety paradigm

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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

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Clinical Care? Occupational Health and Safety.....?

- This IS a Transportation and Automotive Safety issue
- This is a Systems safety issue

In contrast to the bus and truck industries, which have -
- comprehensive safety oversight
- transportation safety interventions
- 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

USA data

- ~ 50,000 vehicles
- ~ 5,000 crashes a year
- One fatality each week
- 23 pedestrians or occupants of other car
- Approximately 4 child fatalities per year
- ~10 serious injuries each day
- Cost estimates > $500 million annually
- USA crash fatality rate/capita 35x higher than in Australia

- Towards safer intercity travel the importance of critical incident reporting and review can reduce the number of adverse events during the transfer of critically ill infants.

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.

* Towards safer intercity transfer the importance of critical incident reporting and review can reduce the number of adverse events during the transfer of critically ill infants.

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

Towards safer intercity travel the importance of critical incident reporting and review can reduce the number of adverse events during the transfer of critically ill infants.

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Knowledge, opinions and behaviors

Knowledge, opinions, and behaviors of Emergency Medical Services Providers

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

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

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

A Simple Question....

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

**1960 to 2007**
- A passenger vehicle - sure
- A 'laundry or mail truck'? ?
- A passenger vehicle - yes!

**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 transport 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

**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/seat
- transporting device/journey
- paramedic/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

EMS Practice
- epidemiological data collection
- ergonomic research
- biodynamic research
- biomechanical research
- automotive safety
- fleet safety program
- risk management
- public safety
- EMS policy
- EMS protocol
- EMS training

How you don’t want to see your colleague transported...

EMS/Medical Transport Safety
- ‘patient safety’
- AND also
- ‘provider’ and ‘public safety’
IMPORTANT ADVISORY

Due to respect for the wishes of the families of medics killed in the line of duty there is to be NO PHOTOGRAPHY of any aspect of the images in this presentation - that is NO video, NO photography, NO digital images of any type.

But what about 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

Hmm...

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???
and what is killing EMS?

EMS personnel fatalities*

- 74% transportation related
- 1/5 of ground transport fatalities were struck by moving vehicles
- 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 a ambulance crash

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 – ie. sled test
Intrusion

Deceleration

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

Why do we do this?

Full Vehicle Crash Testing

Test 1 – Right side impact

Preparation of test vehicles

Pre-impact CTD positioning
And this all takes place in 60 millisecs – the blink of an eye

In the absence of standards or automotive peer review

Most trucks, SUVs do poorly in whiplash test
A few key words about restraint systems...

Immobilization board

Foldable

Choose the Best Option

And now for some MYTH BUSTING

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
KKK – static ‘safety testing’

- Ignorant of automotive safety principles – and specifies -
- No structural damage to any load bearing or supporting members, i.e., torn or broken material, broken welds, popped or sheared body rivets, bolts, and/or fasteners, shall be evident during the application of the force and after the release of the force.

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

\[ F = ma \]

where 
- \( F \) – force
- \( m \) – mass
- \( a \) – acceleration

No ‘a’… then NO ‘F’ !!!!

FMVSS exempt……

NOT new technical data……

And in the absence of standards……

Systems safety failure AND dangerous

Being seated IN an automotive seat is what will protect you

- Anything that allows or encourages you to get up out of your seat will also encourage you to be injured or killed – it is potentially lethal to be out of your seat in any fashion
- 4 or 5 point harnesses for side-facing occupants are potentially lethal – and is in NO WAY SUPPORTED BY ANY DATA OR AUTOMOTIVE SAFETY EXPERTISE

Bigger is not necessarily better……
‘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.

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>

Perception + Reaction time + Vehicle Braking time (varies with age, skill, attention, vehicle type, road pressures, road etc)

Safety Management:
- A Safety Culture
- Protective Policies
- Protective Devices
- Continuous Education and Evaluation

Innovation:
- Driver feedback boxes
- Tiered dispatch
- Helmets
- Enhanced ambulance vehicle design
- Intelligent Transport Technologies - ITS
- New Safety Standards

NAEMT July 2006 Position statement

* Stopping distance: Perception time + Reaction time + Vehicle braking time (varies with age, skill, attention, vehicle type, road pressures, road etc)
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

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 “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

Safety at the scene
New Australian vehicles

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

2007 European design
Safety technology is a key focus

Ergonomic design

Ergonomic layout and equipment

Securing equipment

Science not, next best guess

Another excellent example - From this to ... this!
Operating in an environment where many aspects of safety are still devoid of safety standards – requires technical knowledge and understanding.

Help is on the way?!
November 24th 2008

This looks cool AND SAFE!

Not rocket science...

Day visibility

Night visibility
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

Important Principles!

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

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 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.
- 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