Ambulance Transport Safety: The State of the Art: Separating Fact from Fiction

To quote Steve “Sid” Caesar – Director IHS ES
“We want everyone to get home safely each day”

To quote Steve “Sid” Caesar – Director IHS ES
“We want everyone to get home safely each day”

Outline
1. Review of data on ambulance crashes and safety standards and guidelines that exist for the ground EMS
2. Identification of ground EMS transport safety issues, hazards and areas of risk to patients, providers and public
3. Highlight unacceptable mythology and challenges to advancing EMS transport safety
4. Profile innovation, new safety technologies and strategies and knowledge transfer to enhance safety and reduce risks of ground EMS and patient transport

Emergency Medical Service Transport
What are the transport safety issues that pertain to this important public service and public safety industry?
What do we know of the risks and hazards and how can we measure these?
How can the safety of this transport system be optimized?

http://www.objectivesafety.net

Nadine Levick MD, MPH
Emergency Medicine Physician and Public Health Academic, (USA & Australia)
Founder of EMS Safety Foundation
Chair, National Academies Subcommittee TRB EMS Transport Safety, USA
Recipient, International Society of Automotive Engineers, Women’s Leadership Award for EMS Safety

Where am I really from?
Yes, it IS that big!

RFDS Established 1928

Royal Flying Doctor Service of Australia
RFDS Innovations
- pedal wireless
- medical chests
- portable gurney/stretcher lift device
- customized features on medical equipment

Things can go wrong – but when there are sound safety policies and technologies in place, and the system is well prepared, you can minimize harm

Now, who have we here??
- Do you transport 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 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?

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

Objectives
- To identify the safety issues that are key regarding 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
An interhospital transport?
“Do no harm…”?

Predictable risks
- Fatal crashes more often at intersections, & with another vehicle (p < 0.001)
- 79% 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
- 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

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

EMS Transport General Concerns
- Intersection crashes are the most lethal
- There are documented hazards, some which can be avoided
- Occupant restraint with standard belts is effective. (Over the shoulder belts for patients should be used, with the gurney in the upright position where medically feasible)
- All equipment should be locked down
- 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??

Firstly!

An accidnet?
or a predictable and preventable event

A tragic emergency health care intervention outcome
It does happen....

A devastating tragedy...
- An ETT down the wrong hole may kill your patient and be a terrible burden for the pts family and for the medic involved
- BUT an EMS crash can kill all involved AND wipe out an EMS systems response capacity......

Ambulance Transport Safety
- Emergency care, public health, public safety, and patient transportation.
- Important Principle: Ambulance transport safety is part of a system, the overall balance of risk involves the safety of all occupants and the public
- All get home safely
Real world answers to real world questions -

- What features will enhance safety of my new vehicle purchase?
- What color scheme do I want on my vehicle to make it safest?
- Do I need a helmet, and if so which one?
- What policies offer the safest system?
- How do I get my team to address safety issues?
- What data should I collect when something goes wrong, and how to analyze it?

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

In the USA there are more safety standards for moving cattle than for moving patients

2008 - Air EMS on the NTSB’s “Most Wanted List”, where is ground EMS??

A Simple Question....

USA EMS data

In the USA*

- ~ 50,000 vehicles
- ~ 5,000 crashes a year
- ~ 1 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

2008 - Air EMS on the NTSB’s “Most Wanted List”, where is ground EMS??

A Simple Question....

USA EMS data

In the USA*

- ~ 50,000 vehicles
- ~ 5,000 crashes a year
- ~ 1 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

October 2008 JEMS Article “Rig Safety – 9-1-1”

USA EMS data

In the USA*

- ~ 50,000 vehicles
- ~ 5,000 crashes a year
- ~ 1 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

Is It your service’s tragic year?

- ~ 50 fatalities a year
- 15,000 EMS services
- Each year one in 300 services experiences a fatality

EMT Indicted On Murder Charges

Tammy Brewer Driving Ambulance Involved in Fatal Crash

October 15, 2008

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.

October 15, 2008

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.

October 15, 2008

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.

October 15, 2008

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.

October 15, 2008

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.

October 15, 2008

Tammy Brewer, 36, was indicted for vehicular homicide and operating a motor vehicle under the influence of alcohol.
Safety is Good Business

June 2007

The inevitable bottom line...

Safety saves time, lives AND money

Canada, Nova Scotia

- Since 2000 working towards a goal of zero loss ratio with insurance provider
- 10 million kilometers per year
- 150 emergency response ambulance units
- Collision claim history measured in dollars per 100,000 kilometers traveled:
  - 2000/2001 $1725.00
  - 2001/2002 $1049.00
  - 2002/2003 $751.00
  - 2003/2004 $416.00
  - 2004/2005 $229.00

Are you self insured???

Very Scary insurance data – the $10 million dollar EMT

<table>
<thead>
<tr>
<th>Year</th>
<th>Payroll</th>
<th>Incurred Indemnity</th>
<th>Incurred Medical</th>
<th>Total Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>14.1</td>
<td>540</td>
<td>88</td>
<td>9,925</td>
</tr>
<tr>
<td>2002</td>
<td>12.8</td>
<td>547</td>
<td>255</td>
<td>2,778</td>
</tr>
<tr>
<td>2001</td>
<td>11.3</td>
<td>454</td>
<td>128</td>
<td>657</td>
</tr>
<tr>
<td>2000</td>
<td>10.6</td>
<td>405</td>
<td>144</td>
<td>549</td>
</tr>
<tr>
<td>1999</td>
<td>10.1</td>
<td>405</td>
<td>117</td>
<td>522</td>
</tr>
<tr>
<td>1998</td>
<td>9.6</td>
<td>511</td>
<td>51</td>
<td>511</td>
</tr>
</tbody>
</table>

Workers Compensation Rate increased by 26.5% from $5.86/$100 payroll in 2005-2006 to $7.41 for 2006-2007

A problem

2007 Insurance data –
- 27 fold more likely to have a claim based on transport than related to medical care

2003 Insurance data –
- 10 fold more likely to have a claim based on transport than related to medical care

Expensive....

Very Expensive

The Huntsville Times

Ambulance suit gets $3.1 million

Amber McGee reflects on her self-operating vehicle.

Title: "The Huntsville Times"

Caption: "Ambulance suit gets $3.1 million"
EMS CANNOT Afford to keep paying out like this…

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

the EMS transport process
- communications/dispatch
- the patient
- restraining device/seat
- transporting device/gurney
- paramedics/transport nurses, doctors & family
- patient monitoring equipment
- clinical care & interventions
- protective equipment
- the vehicle
- the driver/driving skill
- other road users
- the road

The Emergency Department (ED)
An ambulance is not an ED /ICU on wheels

What is a survivable impact?
- 12 mph (20 km/hr)?
- 30 mph - survivable
- 60 mph – not survivable

What is a survivable impact?
- $E = \frac{1}{2}mv^2$  
  \[ v^2 = 2as \]

What is a survivable impact?
- $E = \frac{1}{2}mv^2$  
  \[ v^2 = 2as \]
A survivable impact??

By Friday July 20th 2007

The worst ambulance crash in USA

history

June 17th 2008

a paramedic and a patient killed

In this vehicle...

April 14th, 2008

Tragedy you don’t want to be involved in

Thursday July 5th 2007......

Paramedic Allan Parson’s killed
April 20, 2008

October 31, 2008 - Kentucky

February 11, 2009 – North Carolina

April 30, 2009 - Tennessee

Minnesota - June 20, 2009

August 2009 – Impaired…

October 22, 2009, TN Patient and Provider killed, Attendant Critical

Monday November 30, 2009 Smithfield
An interhospital transport
“Do no harm...”? Do we ask our vehicle builders to write cardiac arrest protocols? Vehicle design and safety is not what we are trained to do!!!

Your fleet
Some odd USA facts
- Ambulances are generally not built by the automotive industry
- Intelligent Transportation Systems (ITS), transportation safety engineering is 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

Unique workplace
- In vehicles
- At roadside and other emergency scenes

The ‘workplace’ IS a vehicle
- EMT’s often in vulnerable positions during transport.
  - Bench seat
  - Captain’s chair
  - Standing or kneeling

The ‘workplace’ is also a crash scene

Absence of standards and oversight
- Challenges in identifying best practice
- Myriad of unregulated commercial products
- No safety performance standards
- Absent national safety oversight
What we need to consider, where is the 'bang for buck' in ambulance transport safety:

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

1960 to 2009

A passenger vehicle - sure

A 'laundry or mail truck' - ?

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

A passenger vehicle - sure

A 'laundry or mail truck' - ?

Some recent adverse 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

Nascar Safety Expert

⇒ On ambulance patient compartment

“It is a death vault”

Tom Gideon, Head of Safety, GM Nascar

⇒ On ambulance patient compartment

“It is a death vault”

Tom Gideon, Head of Safety, GM Nascar

and who’s life was he racing to save?

⇒ “Ambulance transport has a death toll....”

Carl Craig EMT-P, Chief Platte Valley Ambulance

‘Real world’ head-on post crash
It does happen....

But what about head protection?

New EMS helmet prototypes for 2008-2009

The EMS Safety Foundation
www.EMSSafetyFoundation.org
brings this presentation to you

Background:
EMS Safety Foundation has been established to fill a gap in technical knowledge transfer
- practical interdisciplinary R & D
- evaluation and implementation of system safety enhancements for EMS and Medical Transport
- It is a not-for-profit institute

Mission
This is a team of like minded innovators across EMS Medical Transport and a number of technical disciplines, who share the common mission of enhancing the safety of EMS delivery for all involved.

In a nutshell
EMS Safety Foundation is a not-for-profit multidisciplinary virtual think – tank and test bed for safety innovation and knowledge transfer
- It is a virtual network integrating the end users and the technical experts
- A tool to enhance the safety of delivery of EMS services
R & D
“Ripoff and Duplicate”
- Avoid reinventing the wheel at all costs
- Where are the best practices that we need to transfer knowledge from

Patient Safety- A routine concept...

EMS Safety
- ‘patient safety’ AND also
- ‘provider’ and ‘public safety’

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

This IS a Transportation and Automotive Safety issue

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

Important...
- Ergonomics and automotive safety issues are interrelated
- Crashworthiness priorities override the ergonomic issues

Ambulance Safety Research: A New Field

We should use the best safety practices demonstrated in engineering
...in automotive safety engineering

and in ergonomics

Range of reach. This is a well defined technical science

Ground Transport Safety IS Complex AND Multidisciplinary

Air EMS is a role model for safety initiatives and focus

Air Safety Approach

» Safety Program Planning
» Evaluating
» Analysis of Safety Performance
» Analysis of Safety Information and Data
» Analysis of Risk Profiles and Plans

An Aviation Safety Plan
Duke Policies

Duke Risk Assessment Approach
Integrating Risk Assessment and Operational Practice!!
- Green
- Blue
- Yellow
- Red

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

Global EMS Vehicle Safety Standards & Specifications and Guidelines
- EMS Safety and Performance Standards
  - Australia & New Zealand 4035
  - Common European Community (CEN) EN1789
- Non EMS Specific USA Standards
  - [Aviation - FAA/CAA/JAA]
  - [New ASSE/ANSI Z15 – fleet vehicles]
- USA Other
  - Purchase Specifications: KKK & NTEA – AMD
- Guidelines: EMS Code of Do and Don’ts, and (CAAS and CAMTS)

30 years later and still the same problem
- KKK-A-1822F, AMD and FMVSS state and don’t state...

USA Ambulances: FMVSS Exempt
- Specifications for the purchase of a Star of Life Ambulance
- Static Pull test
- 2200 Lbs. static stretcher test in longitudinal, lateral & vertical
- No dynamic test for vehicle, occupants or equipment
- No automotive test manikin
- Voluntary

USA KKK ambulance purchase specifications
- Specifications for the purchase of a Star of Life Ambulance
- Static Pull test
- 2200 Lbs. static stretcher test in longitudinal, lateral & vertical
- No dynamic test for vehicle, occupants or equipment
- No automotive test manikin
- Voluntary
USA Ambulance Manufacturing Division (AMD) Ambulance Standards – August 2007

- No dynamic or impact test
- No automotive test manikin
- Mandates NO 'crumple zone'
- No impact tested anchorages for occupant restraint or equipment
- Internal, not independent


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

Mandates NO 'crumple zone'
No impact tested anchorages for occupant restraint or equipment
Internal, not independent

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.

Ridiculous current 2009 USA ambulance ‘safety testing’?!!? – Is NOT consistent with accepted automotive safety practice…

- FMVSS exempt……

Australia & New Zealand Ambulance restraint standard 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

European Committee for Standardization
Medical vehicles and their equipment – Road Ambulances

- “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.
Standards Update

- NFPA – forthcoming meeting in December
- SAE – x2 standards underdevelopment
  - General vehicle crashworthiness and occupant safety standard
  - Specific equipment and occupant restraint standard
- ISO - ISO/AWI 39001 - Road-traffic Safety management systems
  - Recent update meeting in Canada

ISO – 39001
Road-traffic Safety management systems

SAE development

Vehicles Update

- As of January 1, 2010
  - USA the Sprinter will be distributed by Mercedes and Freightliner
  - Canada the Sprinter will be solely distributed by Mercedes
- State policy developments
- EMS Safety Foundation Innovation Consortium new vehicle and fleet purchases

EMS Best Practice, Sept 2006

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

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

National Academies
Transportation Research Board’s Ambulance Transport Safety Summit
October 29, 2009

http://www.objectivesafety.net/TRBSummit2009.htm
TRB Summit Focus

'Bridging the gap between what we do and what is known - Enhancing ambulance transport safety through shared knowledge of technical data'.

Thank you to the EMS Safety Foundation Speakers and Moderators who assisted with the TRB Summit

- Matt Crossman
- Sandy Beers
- Charisse Cobb
- Comilla Sasson
- Ken Beers
- Wayne Czyzwicki
- Mike Reid
- Martha Florey
- Art Cooper
- Dan Garstang
- Gene Lukianov
- Chris Fitzgerald
- Jeff Welch
- Eileen Frazer
- Jon Swanson
- Jim Love
- Kevin Peters
- Dia Garner

TRB Summit Downloads
http://www.objectivesafety.net/TRBSummit2009.htm

October 2009, TRB Ambulance Transport Safety Summit Agenda

- Session 1: Burden/Benefit - Safety Data Economics Ethics and Risk Benefit
- Session 2: Transport System Management Fleet/Vehicle Operations Safety Operations Management
- Session 3: Vehicle Safety - Assessment and design Vehicles Special Populations
- Session 4: Information Sharing and Policy Knowledge Transfer/Dissemination Standards/Specifications/Policy An international perspective from Oslo, Norway
- Session 5: Panel and Research Priorities -

2009 TRB Summit
http://www.objectivesafety.net/TRBSummit2009.htm

- Brought together a spectrum of diverse expertise and representation:
  - Government agencies
    - National Highway Traffic Safety Administration (NHTSA)
    - Department of Transportation ITS (DOT)
    - National Transportation Safety Board (NTSB)
    - Federal Highways Administration (FHWA)
    - Federal Motor Carrier Safety Administration (FMCSA)
    - Bureau of Labor and Statistics (BLS)
    - Department of Homeland Security (DHS)
  - Teamsters
  - EMS State Directors
  - EMS Services private and municipal from across North America
  - Fire/EMS Volunteer EMS
  - EMS Physicians
  - Industry partners
    - EMS Equipment Vehicles, both OEM and aftermarket
  - Academics
  - Technical experts
    - Automotive safety engineering, occupant protection
    - Ergonomics and human factors.

USA Emergency Vehicles (ground)

FARS – A National Data Set?
Small numbers – but NO data captured from 20% of the nation in 10 years

Total Fatalities Per 10 Million Population
1999-2006
Fatalities among EMTs and paramedics, 2003-2008:

- Aircraft incidents: 34%
- Other transportation: 6%
- Struck by vehicle: 6%
- Highway incidents: 8%
- Assaults and violence: 8%
- Other: 36%

Cases with days away from work among EMTs and paramedics, private sector, 2007:

- Other transportation incidents: 13.5%
- Contacts with objects or equipment: 13.5%
- Transportation incidents: 9.2%
- Falls on same level: 9.2%
- Other: 34%

October 28th Workshop Agenda:

13:00 - 13:05 Workshop Introduction: Nadine Levick MD, MPH
13:05 - 15:00 Session A: Vehicles
   i. Gene Lukianov – Vehicle and occupant systems safety
   ii. Jeff Welch – Occupant protection strategies
   iii. Walther Bloch – Vehicle operational and design safety
   iv. John Killen – Vehicle Visibility and Conspicuity
15:00 - 15:30 Afternoon Tea Break
15:30 - 15:45 Session B: An International Approach
   i. Perspective from Norway
15:45 - 17:30 Session C: Stretchers
   i. Chris Fitzgerald
     a. Overview of stretcher features
     b. Design influence and impact on stretcher operational costs

Workshop Outline:

- Ambulance vehicle occupant protection
- Ergonomics as it applies to EMS
- What are the principles
- How do the different challenges of ergonomics and automotive safety systems integrate
- What technologies are there to assist in getting the best outcome

Automotive engineers addressing EMS Safety Foundation Workshop

VEHICLE DESIGN and SAFETY

Extensive Passenger Car and Light Truck Vehicle Safety Standards apply to vehicles below 10,000 Gross Vehicle Weight (GVW)

VEHICLES over 10,000 GVW have a reduced set of Federal Safety Standards

VEHICLE SELECTION IS CRITICAL

ESC: ELECTRONIC STABILITY CONTROL

- Electronic stability control systems are second only to seat belt in terms of preventing fatal injury
- ESC systems are not yet as common as seat belts

Statement by Nicole Nason, Administrator, National Highway Traffic Safety Administration, On the Adoption of Electronic Stability Control as a Global Technical Regulation
**VEHICLE DESIGN and SAFETY**

- ESC ELECTRONIC STABILITY CONTROL

**AMBULANCE ACCIDENT REDUCTION OPPORTUNITIES**

- AVOID ACCIDENTS
  - Driver Training and Responsibility
  - Operating Rules
  - Improved Ambulance Conspicuity
- Choose Vehicles with Advanced Safety Technology
- Engineer Rear Compartment Interior to be IMPACT FRIENDLY
- Constrain Attendants SAFELY
- Constrain Patients SAFELY
- SECURE all Equipment reliably

**Seat Structure and Seat Belts**

- Seat structure can be used to maintain occupant position as well as contribute to intrusion resistance in side impacts
- Seat belts are known to be effective in passenger vehicle rollover ejection mitigation as well as preventing excessive interior impacts
- For large compartments, these features can be used to improve occupant protection and have fewer concerns than active airbag systems

**Seat Structure**

- A main feature in a front-end crash is the "disconnectable" front axle, which releases additional deformation zones in the longitudinal frame member when a particular force level is reached.
- On a frontal crash, transmission and engine will be pushed underneath front occupants.

**Sprinter Features Summary**

**Market Exclusives**

- Available left side sliding door
- Premium CD turbo Diesel engine with SCR technology to meet the EPA / CARB 2010 emission standards.
- Best in class cargo capacity
- Best in class wall-to-wall turning diameter
- Best in class available payload capability
- Superior safety standard with ABS, ASR, BAS, ESP and 3-point seat belts on all passenger seats
- Most versatile commercial van on the market

**Load adaptive Electronic Stability Program (ESP)**

**Details and Technology (cont.)**

- PSM is a “Gateway” for vehicle information
- Control of vehicle functions
- Engine-functions
  - Fixed rpm specification
  - Variable rpm control
- Logical Functions (AND, NAND, OR, NOR, XOR etc)
- Counter blocks, flip-flops, timer stages etc.
- Defined interface, easy access, short set-up times

**MY 2010 Emissions Features**

- DEF tank location on Sprinter Cargo & Bus
  - Tank location under the floor 8th side behind B-pillar
  - Tank volume 6.6gal. = 25L
  - Tank features drain plug
Muskoka EMS Canada

- Waistline height reflectivity
- Muskoka chose solid yellow for rear
- Blue lettering is key-lined to increase reflectivity
- Different brands of material used to achieve the result
- Consultation was entirely virtual over the internet with a successful result

Principles when purchasing ambulances

- Must fulfill all laws and regulations
- EN 1789 standard as a minimum
- Special requirements from our service:
  - Better internal lights (White halogen)
  - Reduced noise level (65dB A at 60 km/h and 70dB A at 120 km/h)
  - Focus on securing people and equipment
  - Focus on hygiene / easy to keep clean
- The attendant should reach all basic equipment, communication, light and climate controls without releasing the safety belt.

Perspective from Norway

Ronald Rolfsen
Assistant
Oslo university hospital - Pre-hospital division / Ambulance department

Geir Vidhammer Engly
Asst. Section leader/Paramedic
Oslo university hospital - Pre-hospital division / Ambulance department

Liv Bråmark
Coordinator, Ambulance group
Stein Erichsrud
Senior Engineer
Norwegian Public Roads Administration Motor Vehicle and Driving License Inspectorate:

Summary

- Safety of the patient and the crew are an important issue
- The use of shoulder straps on a stretcher are mandatory (unless a medical reason)
- The national analysis group can implement reactions against employees and suppliers.
- Can we be better? Absolutely!

“Together for your safety”

Ombulance investigation

- Accidents involving an ambulance with injury or death
- Accidents involving an ambulance with major damage to property
- Accidents where equipment inside the ambulance cause injury / danger of injury

Ergonomist Chris Fitzgerald

addressing the Workshop
EMS Safety Foundation
Ambulance Transport Innovation Workshop
Design and operational aspects of X Frame Stretchers
Chris Fitzgerald - Ergonomist

October 28th, 2009

Stretcher lifting & loading

Solutions
Reduce levels of force exertion via,
- Greater recruitment strategies for lifting, lowering, loading & unloading
- Mechanisation / Design based
  • Use lower ambulance floors
  • Use other stretcher systems such as those with independent front & rear leg system – these collapse as they are loaded
Safety in the Back? Safety in the Back?
Ergonomic and Automotive Safety Challenges
What are the practices, technologies and challenges of ambulance safety design – in a spectrum of countries, a real world perspective

- Introduction:
  - Mr. Darren Walter FRCS(Ed) FCEM – Emergency Medicine Physician, South Manchester, UK
- A Systems and Interdisciplinary Perspective:
- Automotive Safety and Engineering Challenges:
  - Gene Lukasen, Automotive Safety Engineer, Michigan Detroit, USA
- Operational Ergonomics – Key Issues:
  - Chris Fitzgerald CPE, EMS Ergonomist, Risk and Injury Management Services, Melbourne, Australia
- Overview - Q & A

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

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

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

And very Predictable...
- Intersections are lethal environments

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

- Stopping distance: Perception time + Reaction time + Vehicle braking time
  - varies with age, skill, alertness, vehicle type, the presence, road etc.)
Testing the real world

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

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

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

Dynamic Sled Testing of Ambulance Pediatric Restraints
If we know this – and it’s published…


Why do we do this?

Pre crash sled test configuration
(view of captain’s chair and patient area)

Pre crash sled test configuration
(view of squad bench)

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

Post impact (from rear door)

What is actually happening during an ambulance crash
Pre-impact CTD positioning

Preparation of test vehicles

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

Impact residue

CTD dynamics

During impact

Post impact

In the absence of standards or automotive peer review
And now for some **MYTH BUSTING**

‘Safety’ approaches being driven by manufacturers claims and sales rather than by science and data

A few key words about restraint systems…

PPE from the stationary environment can be highly hazardous in the automotive setting

NOT new technical data…

NOT new technical data…

USA 2004, NIOSH Head strike zone hazards

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

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....

Yes, the ride of your life....

Sure... these vehicles all parade around the EMS and Fire shows... BUT... NOT ONE of these vehicles has been to the automotive safety shows or scrutinized by the automotive safety industry...

'Safety' approaches being driven by manufacturers claims and sales rather than by science and data

Systems safety failure AND dangerous

Overwhelming existing evidence these practices are HIGHLY dangerous
NO evidence whatsoever that these practices are NOT dangerous let alone safe

“Our design features are focused on improving the safety of the patient compartment, and side re- protection in Horton ambulances helps reduce the threat of a fatal injury if a rollover occurs.”

Airbags ....??
Absent safety testing standards, any meaningful crash or injury mechanism data or effective occupant positioning – rear compartment airbags are likely to be hazardous

Bigger is not necessarily better......
Increasing awareness ...

**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??

---

**Immobilization board**

- Foldable
Choose the Best Option

Innovation

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

What about changing driver behavior in the real world??

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

How the Device Works
> Computerized monitoring device installed on each vehicle to measure parameters
> Each driver has individual key “fob”
> Data collected every second
  > including: vehicle speed and performance, driver behaviors, and emergency mode
> Auditory feedback of warning ‘growls’, and penalty tones
> Data downloaded automatically every day

Demonstrated Effectiveness

A key to safe ambulance transport
**Extensive Indirect cost savings**
- Fewer out of service vehicles
- Improved transport times
- Decreased administrative lost in managing unsafe behaviors
- Decreased legal burden
- Automatic system wide data
- Insurance benefits

**Other monitoring devices**
- 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

**You want a system that works!!**
- Does the system really work
- Is it going to be a major burden on your staff to implement
- What are the real costs
- Are you going to have video of your company vehicle on you tube??

**The jury is out on**
- Opticon
- Simulators

**Resource availability and allocation technologies**
- VSSM (Visual System Status Management) provides a geographic view of call demand through the application of varying colors of density

**Visibility and lighting issues**

**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???

It isn’t like this outside of the USA

News we don’t want to see

Worker viability Act: November 24th 2008

Day visibility

Night visibility

Here’s the real world at 6 ft...

Here’s the real world at 6 ft...

August 2009 – Visibility review
First step toward developing informed guidelines
A generalised report with an underlying awareness of numerous political & multi-agency sensitivities
Embraces operational diversity (Fire, Police, EMS)
Recognises US & selected international research

Succeeds in focusing the future direction of conspicuity research and practice for all US states + other countries

Key Findings:
1. Importance of contour markings – especially the difference between research in USA & Canada + benefits of solid colors
2. Battenburg and chevrons – effectiveness is unproved due to lack of research and possible cross-cultural misinterpretation
3. Need for national standardisation of colors for rear chevrons
4. A balanced approach in the use of fluorescent and retro-reflective markings + the possibility of visual overload

Policy and practice ignorant of existing technical safety data

This addresses some very real risks, very creatively – and currently ONLY available in London Ontario!

Color-blindness affects 10% of the population

Emergency Vehicles – Viewer Awareness

For a timely, appropriate and safe response
- Location
- Size
- Shape
- Speed
- Intended path
Having access to that technical knowledge supports changes to improve safety practice.

**Summit County EMS - Colorado**
- Old vehicle
- New yellow vehicle markings
- Staff use lime-green vests & jackets

**Muskoka EMS - Canada**
- Old design
- New design

**Muskoka EMS - Canada**
- Old design
- New design

**Hmmm.. and what is this – a fighter plane, a billboard…??**

**But whatever color …. If you run a red light someone will be killed**

**International approaches**
- The state of the art non-USA vehicles have NO squad bench nor the after market structural vehicle modifications that can potentially decrease crashworthiness integrity that were seen in study vehicles.

**EMS Safety Foundation Delegation bringing Rettmobil to you**
Wayne Zygowicz, Advisory Board, Littleton Fire/EMS, Colorado & JEMS
http://connect.jems.com/profiles/blog/list?user=2odthpncsm46j

Vehicle Occupant Safety design
- European design
- Safety technology is a key focus

Safe and Ergonomic design

Patient Transferring Slides

Ergonomic layout and equipment

Flexibility to manage two patients
High speed crash, rolled and the occupants (patient and medics) had only minor scratches

Sprinter v Ford Transit crash test

Ergonomic layout and equipment

Awkward tasks? Develop solutions!

this vehicle is safety crash tested by automotive experts

Unlike this vehicle

Sprinter v Transit Crash Test

Operating in an environment where many aspects of safety are still devoid of safety standards – requires technical knowledge and understanding

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?
Were we safer in the Cadillac???

Fleet Mix?

R & D
“Ripoff and Duplicate”

Avoid reinventing the wheel at all costs

Where are the best practices that we need to transfer knowledge from

Mark Kessler - CareFlite

EMS Safety Foundation Update
CareFlite's New Safety Science Based Ambulance Design

Prototype vehicle pictures

Careflite's prototype vehicle
Tips for Emergency Vehicle Operations

USFA Emergency Vehicle Safety Initiative

Traffic Incident Management Systems (TIMS)
- Released April 2008
- FEMA, USFA, IFSTA
- Covers setting up safe roadway incident work areas and using unified command at these incidents

National Academies TRB Ambulance Transport Safety Summit October 29, 2009

Risk/Hazards
- Predictable risks
- Predictable fatal injuries
- Serious occupational hazard
- Public safety hazards

What do we know works...
- Vehicle Operations Safety Policies
- Squad bench lap seat belts
- Patient over the shoulder belts
- Securing equipment
- Forward and rear facing seating
- Some electronic technical devices
- Safety awareness
- Cultural change
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

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

Predictable, Preventable, and NO ACCIDENT

Be ready for...

- New Infrastructure
- New information
- New collaborations
- New events
- Innovation in safety technologies, strategies and policy
- Knowledge transfer
- Unacceptable mythology
- Challenges to advancing EMS transport safety

Conclusion

- EMS transport has serious hazards and safety issues
- Major advances in EMS safety research, infrastructure and practice over the past 5 years
- New technologies for vehicle design, occupant PPE and equipment restraint and driver performance are now available
- Development of substantive EMS safety standards is a necessity and a reality
- Failure to transfer knowledge from transportation and automotive safety is unacceptable and dangerous
- EMS is still way behind the state of the art in vehicle safety and occupant protection

And...

- It is no longer acceptable for EMS to be functioning outside of automotive safety and PPE safety standards for prevention of and protection of EMS providers and the public from injury and death

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