Ergonomic challenges of USA ground ambulances: An all hazards approach

Emergency Medical Services (EMS) Definition
- An EMS system is –
  - A coordinated arrangement of resources (including personnel, equipment, and facilities) which are organized to respond to medical emergencies, regardless of cause.
  - Detection and reporting of medical emergencies, initial care, transportation and care for patients in route to health care facilities, medical treatment for the acutely ill and severely injured within emergency departments, and the provision of linkages to continued care or rehabilitation services (EMS Research Agenda 2011)

History of EMS
- EMS is a relatively new industry
- An unusual history of beginnings within the mortician industry.
  - Early ambulances were hearses, once motorized usually a Cadillac, a vehicle in which an occupant could be transported in the recumbent position
  - Over the past 100 years, the sophistication of EMS medical care has advanced dramatically
- EMS communications and transportation technology have not kept up with that pace

USA EMS
- EMS Systems - >15,000
- Personnel - ~1 million (~30% F/T professional & 70% volunteer)
- Vehicles - ~50,000
  - (Type I, Type II, Type III, Freightliners, motorcycles)
- Transports - ~50 million
  - (to Emergency Depts ~ 50%, <1/3 emergent)
- Cost - ~$8 Billion annually
- Safety Oversight - ? Disparate

USA 1960’s
- EMS is... Emergency care, public health, public safety and patient transport
- Bridge between the community and the hospital
- Volunteer – professional
- Urban – rural
- Disaster response
- Majority of transports NOT critical or life threatening – less than 3%

1960 to 2007
- A passenger vehicle - sure
- A ‘laundry or mail truck’ - ??
- A passenger vehicle - sure

Ergonomics
- Understanding of interactions among humans and other elements of a system, and application of theory, principles, data and methods to design in order to optimize human well-being and overall system performance
  - (definition adopted by the International Ergonomics Association in 2000)
- Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people (IEA, 2000)

An important and unique system
- Public safety, public health and emergency service
- Is there to save lives
- A more recent service compared to Fire and Police
EMS - very much a human machine/systems interface

- The ergonomics approach — understanding tasks ... and the users

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
  - Captains chair
  - Standing or kneeling

The ‘workplace’ is also a crash scene

- An emergency medical care system conducted in a transportation environment
- EMS, public health and public safety
  - Three interrelated dimensions -
    - ergonomics of the work environment
    - acute healthcare delivery and patient transport
    - occupant, automotive and transportation safety
- Safety for three populations –
  - the patient
  - the provider
  - the public

Key issues

- An emergency medical care system conducted in a transportation environment
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and what is killing EMS?

EMS personnel fatalities*
- 12.7 fatalities/100,000 EMS workers
- 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


A tragic emergency health care intervention outcome

It does happen....

National EMS data

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

Some USA challenges

- No accepted national safety standards for -
  - EMS fleet management or safety practice
  - Ambulance vehicle rear compartment design and performance
  - Provider occupational injury protective equipment
- Yet convincing data for injury risk and hazard
- Need for patient, provider and public safety focus

* FARS/BTS 2005-6

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Ground Ambulance Transport Safety
IS Complex AND Multidisciplinary

Epidemiological Data Collection
Risk Management
Public Safety
Ergonomic Research
Transport Safety
Transport Technology
Safety Technology
Regulations and Standards
Fleet Safety Program

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

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

Problems
- No safety standards aside from biohazards
- Unique safety and hazard protection needs
- A number of less than appropriate products out there

Important...
- Ergonomics and automotive / transportation safety issues are interrelated in the safe delivery of emergency care and response

Objective
- To identify an all hazards approach to addressing ambulance transport safety bridging delivery of emergency medical care, transportation and occupant safety and crashworthiness and ergonomics and human factors.
Methodology

- Multidisciplinary team analyzed the diverse challenges to EMS transportation safety
  - EMS field personnel, EMS safety officer, emergency physician and public health researcher, and automotive safety and crashworthiness engineer

- Transport hazards were identified via
  - review of published literature in the fields of epidemiology, ergonomics, ambulance safety engineering
  - case studies to identify potentially hazardous practice.

Ambulance Safety Research: A New Field

EMS Safety
- 40 papers - on ambulance safety
- 2 papers - on ambulance ergonomics
- 1 paper - on stretcher ergonomics

Computer Workstations
- 30,000 papers – on ergonomics of computer work stations

EMS Ergonomics 2005, 2006

December 2007
Prof Issachar Gilad

Policy and practice ignorant of existing technical safety data

Ergonomics issues
Gilad 2007

“It seems that the interior design is based primarily on spatial utilization, with little concern for ergonomics. Based on the data and observations of how work is actually performed in the ambulance interior working cell by the variety of personnel who participated in this study, we suggest a few guidelines to enhance the interior design. We believe that these suggestions can reduce the uncomfortable and extreme postures indicated in this study.”
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

Technical automotive safety and biomechanics information

Human factors monitoring and feedback

Technical information available

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

NOT new technical data...

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

June 17th, 2008

a paramedic and a patient killed

In this vehicle...

USA Ambulances: Safety performance standards failure - FMVSS Exempt

AMD - Propaganda that kills...

KKK certified and FMVSS exempt...?
Occitant protection....??
July 2007

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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

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KKK/AMD – ‘safety testing’

- Ignorant of automotive safety principles – and specifies that a ‘successful test’ is -
- 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.

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

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No ‘a’... then NO ‘F’ !!!!!

- $F = ma$
  - where $F$ – force
  - $m$ – mass
  - $a$ – acceleration

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Results Summary

- There are clearly outlined major ergonomic and transportation hazards during ambulance transport for the patient, the provider and the general public which were identified as fundamental by the literature search and case studies, relating to the following areas -

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Areas of Hazard

- Three areas -
  - Delivery of emergency medical care
  - Transportation, vehicle operations
  - Occupant safety and crashworthiness
  - Ergonomics and human factors
- Three target populations -
  - Patient
  - Provider
  - Public

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Delivery of Emergency Care

- Priority dispatch
- Scope of medical practice
- Medical policies and procedures
- Patient outcomes of priorities
- Public safety focus of policies and operations

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Transportation, occupant safety and crashworthiness

- Vehicle operations
  - Dispatch policies
  - Driver training, monitoring and distraction
  - Intersection Policies
  - Emergency response mode policies
- Automotive safety and occupant protection
  - Design standards exemptions
  - Payload and vehicle capacity limitations
  - Restraint systems for all occupants
  - Protection from interior hazards
  - Vehicle automotive design and crashworthiness
Ergonomics and human factors
- Communication
  - With patient, coworkers/providers and base and hospital
- In vehicle
  - Access to medical equipment and patient
  - Evaluation of patient
  - Patient and provider safety and comfort
  - Ability to perform medical interventions in a mobile environment
  - Ability to perceive displays and alarms of medical equipment
  - Protection from interior hazards
  - Access to entrance and egress of vehicle
- Patient Handling
  - Loading/unloading the patient
  - Transport of patient to and from ambulance
- Biohazards
  - Visibility and conspicuity
  - Safety on the road and roadside access

Discussion
- Limited overlap in the published literature in the realms of ergonomics, automotive occupant protection priorities and clinical care issues.
- Furthermore it appeared that many recent developments in ambulance design had proceeded with no input from the technical experts in either field in any fashion.

Given the combination of an automotive environment and an operational workplace
- The design of the system is required to provide both -
  - a safe automotive occupant protection and transport environment
  - as well as a functional physical ergonomic environment, and adequate attention to perception and human factors for patient monitoring and communication - to allow essential patient care to occur effectively.

Failure to utilize available technical information
- Integration of technological expertise and practice has not been current practice in EMS design
- Of greater concern is in a setting where the technical principles, knowledge and data to address the safety and optimization of this environment has been in the public domain for in excess of 20 years.

Safety design directions
- Ambulance design compatible with principles of ergonomics, occupant safety, automotive and transport safety and biohazards
  - A compact environment with clear proximity to access to the upper body of the patient and to support patient care of medical personnel, toward a more ergonomic conduct of the ambulance environment, and an integrated communications system that does not require the provider to leave the seat
- Automotive grade provider seating and restraint
  - Autonomous restraint and provider seating -
    - Provider
      - A restraint and seating system that keeps the provider in the seat and that does not cause potential for neck injury on side facing seating and anchored to meet automotive crash forces
    - Provides both -
      - A restraint and seating system that keeps the provider in the seat and that does not cause potential for neck injury on side facing seating and anchored to meet automotive crash forces
      - A compact environment with close proximity to access to the upper body of the patient and to support patient care of medical personnel, toward a more ergonomic conduct of the ambulance environment, and an integrated communications system that does not require the provider to leave the seat
- Patient handling transport equipment
  - Essential Medical Equipment/supplies -
  - Monitoring Equipment -
  - Automotive grade provider seating and restraints -
  - Ambulance design compatible with principles of ergonomics, occupant safety, automotive and transport safety and biohazards

Conclusion
- Based on existing injury and fatality data, and basic ergonomic and transport safety principles and technology - current USA ambulances have serious deficiencies in the ergonomics of their design and have demonstrated major automotive crashworthiness and occupant protection failures.

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- as well as a functional physical ergonomic environment, and adequate attention to perception and human factors for patient monitoring and communication - to allow essential patient care to occur effectively.

Conclusion
- The goal is to design the EMS environment -
  - To minimize predictable hazards, both ergonomic & automotive
  - To enhance safety for the patient, the provider and the public
- Designing solutions for this environment requires an integrated approach between clinical care providers and operational expertise, automotive and transportation safety technical expertise and ergonomists and human factor expertise.
- This current disconnect, between EMS practice and ergonomic and transportation technical input, is unacceptable.

Thank you! Any Questions??

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