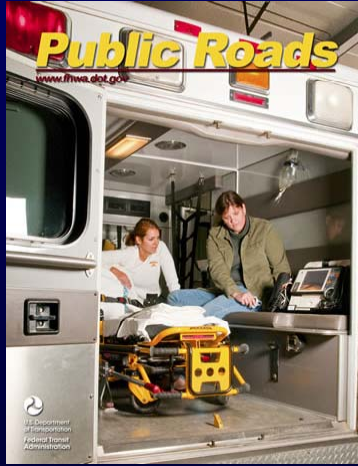


# Naturalistic safety evaluation of a medic's work environment during rural emergency response



## Primary Investigator

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## External Project

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## Project Objectives

### *Biomechanical/Ergonomic Assessment*

Increase medic and public safety through collection and analysis of data associated with emergency medical care providers during transport, specifically:

1. Determine the rate of restraint use by EMS workers.
2. Determine significant causes leading to medics being unrestrained.
3. Identify medic activities and physical hardships imposed by their equipment or procedures.
4. Determine biomechanical forces experienced by medics during patient transport.
5. Identify factors which influence ambulance travel in emergency mode.



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# Data Collection



Video of rear patient compartment while in motion:

- Medic posture
- Reach analysis
- Medic position
- Restraint behaviors
- Patient care patterns



Example Vehicle Data:

- Velocity
- GPS position
- G-force

Other data:

- EMS call logs
- EMS patient care records
- Focus groups

• Accelerometer data:

- Peak forces
- RMS acceleration
- Crest factors



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# Preliminary Results


- Restraint usage: average of 2.6% time restrained per trip.
  - Self-reported restraint rates: a median of 10% restraint rates in the rear, median of 100% restraint usage in the front.
- Reach analysis: 20 unique reaches identified - reaches were from bench seat to: the electrical panel (23% of reaches), shelving on opposite wall (20%), pass through window to driver (10%), and linen/blankets storage (9%)
  - Longest repeated reach was toward the pass-through window to communicate with driver (18.7s average).
- Vibration Exposure: Does not violate ISO STD 2361 health guidance caution thresholds.
  - Comfort is in the “fairly uncomfortable” range, which can affect efficacy of patient care in procedures requiring fine motor control (intubation, IV sticks)



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**Rural EMS Worker Restraint Usage and Feasibility in Emergency Response Vehicles**

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**Background**

Emergency medical service (EMS) workers have a fatality rate of 12.7 per 100,000<sup>1</sup>. Of these fatalities, 74% of them are transportation related<sup>2</sup>.



The primary cause of transportation related deaths is the lack of restraint use in the patient compartment of the ambulance. A recent survey of working medics showed that only 3% of medics report actually wearing their seatbelts all the time<sup>3</sup>.

**Reported Restraint Usage in Patient Compartment<sup>3</sup>**

Restraint Usage	Percentage
Always wear seatbelt	3%
Only wear on inter-venue trips	10%
Never wear seatbelt	87%
Wear seatbelt but not when performing procedures	0%

**So why are medics riding unrestrained during emergency transport situations?**

Medics report the inability to access patient and provide proper care as the primary reason<sup>3</sup>. In this way it is the procedures that are required of the EMS workers may cause them to ride unrestrained.

**Objective**

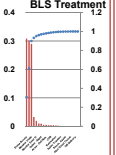
This study observed EMS worker restraint usage feasibility while performing the most common procedures.

**Methods**

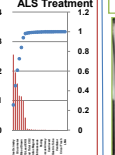
**Pareto Analysis**

A Pareto analysis is a statistical technique of selecting significant factors in a system. This method was used to determine common procedures during transport.

**BLS Treatment**



**ALS Treatment**

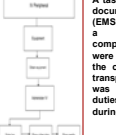


**Mock Up Presentations**

Mock up presentations performed by two experienced EMS workers (male - paramedic, 32 years old with 11 years experience; male - EMT-Basic, 60 years old with 35 years experience) were filmed to further understand procedures outlined in Pareto analysis. Analysis was conducted inside a Ford F-150 model ambulance.

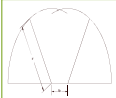
**Task Analysis**

A task analysis is method of documenting how a user (EMS worker) moves through a system (procedural completion). Task analyses were conducted for each of the common procedures in transport situations. This was used to understand duties and body postures during these procedures.




**Reach Envelope Analysis**

A reach envelope is the area in which the performance of manual tasks can be completed conveniently, or at all, by a seated, restrained medic.

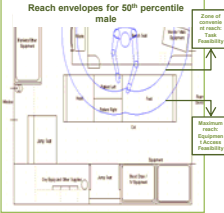


Envelopes were created from the diagram at left where b is the biacromial breadth and r is the radius of reach.



Overhead ambulance layout was created from measurements of in use ambulance. The envelopes were then laid over the overhead drawing of the ambulance to assess restraint feasibility.

**Reach envelopes for 50th percentile male**



Reach envelopes were created for three population percentiles (5th percentile female, 50th percentile male, and 95th percentile male) and computer aided drawings were created to assess the reach feasibility of seated and restrained medics.


**Results**

**Reach Feasibility**

Category	Percentage
Percentage of Feasible Equipment Access	42%
Percentage of Time Feasibly Restrained	59%

■ 5th %ile Female

Feasibility varies by population percentile. However, on average restraint usage is feasible 42% of the time the patient is being treated.



**Conclusions**

Restraint use is feasible for an average of 42% of the time the patient is being treated. With simple design modifications (e.g. relocation of IV bag hook, placement of medication admin equipment) this can be increased to 50% of the patient treatment time. These improvements would increase safety of medics riding in the rear of the ambulance.

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# Current Work

- Publications to follow
- Redesign and Policy Recommendations
- Industrial Engineering Graduate Students Competition

“Improving restraint feasibility through ambulance layout redesign”

**Student Safety Technology Design Competition 2011**  
 22nd International Technical Conference on the Enhanced Safety of Vehicles  
 June 13th-16th, 2011, Washington, DC



**NHTSA**  
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