Safety Ambulance

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Abstract: ***The goal of this IQP project was to understand ambulance services, reliability problems and potential technologies that can be used to advance patient-centered care. The IQP team conducted interviews, polling, and participated in data collection. Through these methods it was discovered that the main problems in ambulance services were associated with the road vibrations that were transmitted into the patient compartment. These vibrations were known to decrease the ability of paramedics to perform the tests and treatments needed while simultaneously increasing the stress experienced by patients. Potential technologies to improve ambulance services and suppress vibration were also investigated.***

1. Introduction

When a life threatening accident requires an ambulance everyone wants the best care and the highest chance of survival on their journey to receiving advanced medical care. While proper training of ambulance workers can increase the success rate of trips, advancing the technologies that allow them to work safer and more efficiently provides a foundation for the advancement of the ambulance ride. Improving ambulance patient safety while simultaneously increasing the en route capability of the ambulance through technological advancement allows engineers a unique opportunity to increase the life saving capabilities of ambulances worldwide. The most important part of an ambulance ride is the safety of the crew and patients with a focus on delivering the patient to the professional care they require. While ambulances are designed to make this as easy as possible there is room for improvement in certain areas of their performance. Improvements could increase the ability of the ambulance crew to provide a high level of care and perform all the necessary treatments to insure that the patient arrive at advanced treatment facilities. Once these areas in need of improvement have been identified, potential design flaws are attributed to the poor performance characteristics of the ambulance so that an engineering solution may be applied.

2. Problems Identified with Ambulance Transportation

When on a call ambulance teams have two separate and equally important goals. In the back, patients must be treated with the optimal level of care so they arrive to their final destination in the best condition possible, while in the front the navigator and driver must insure that the ambulance gets there as quickly as possible in a safe manner. When polling the paramedics online and at local dispatch facilities it was clear that certain factors greatly decrease both the patients comfort level and the ability of the paramedics to provide care en route. Road induced vibrations can be felt inside the patient compartment making it difficult to diagnose and treat patients. These vibrations can also cause pain and discomfort to patients being transported, especially those with spinal or neck injury and broken bones. Noise pollution hinders patient comfort level and the ability of the paramedics to communicate. In the front ambulance drivers have a completely different set of issues. Often driving through traffic at high rates of speed these drivers need every bit of support they can get to make their intense job as easy as possible. Without up to date road construction information and GPS mapping support the drivers are not moving as efficiently as possible. Drivers must also know how the ambulance handles to drive as efficiently and safely as possible. Due to drivers changing vehicles and new drivers entering the field they don‟t always know how the vehicle handle, especially at the high rates of speed ambulances are known for. After polling ambulance workers through multiple sources, it was obvious that the reduction in vibrations would greatly increase patient comfort level and their ability to provide 11 care. In light of this information our IQP team decided to research possible solutions to improve the shock absorbing capabilities provided to the patient compartment. Also a suite of programs is suggested for Ambulance Fleet systems to implement which would improve their current response time, ambulance routing capabilities, and decrease the amount of accidents caused by overdriving due to the driver being unfamiliar with the ambulances handling capabilities.

3. Quantifying Road Surface Induced Vibrations

It has been well established that an ambulance ride has the potential to be a very traumatic and stressful experience for both the patient and the paramedic. Ambulances in the United States are typically built on Ford chassis (Appendix B) relying solely on the vehicles stock suspension to isolate the patient compartment from road surface induced vibrations, but the suspension does not succeed at complete vibration isolation. Ambulance manufacturers do nothing to decrease the vibrations induced upon patients by road surface conditions in addition to the stock suspension of the chassis they purchased. Figure 1 Ambulance Patient Compartment in Use 13 Road Surface induced vibrations impact the patients care on two levels; it decreases the ability of paramedics to diagnose and treat. Additionally it has the potential to affect the body’s vital functions, which may already be compromised. Specifically the cardiovascular system, skeleton, central nervous system, and respiratory system are all affected by road induced vibrations. The accuracy of EKG signals and blood pressure readings along with the ability to perform tests and treatments decrease as road vibrations increase.

To study the effects of road induced vibrations on the human body the expected vibrations experienced in an ambulance must first be determined. Road surfaces are typically categorized into four categories; dirt roads, rural paved roads, paved city streets, and paved multi-lane highways.

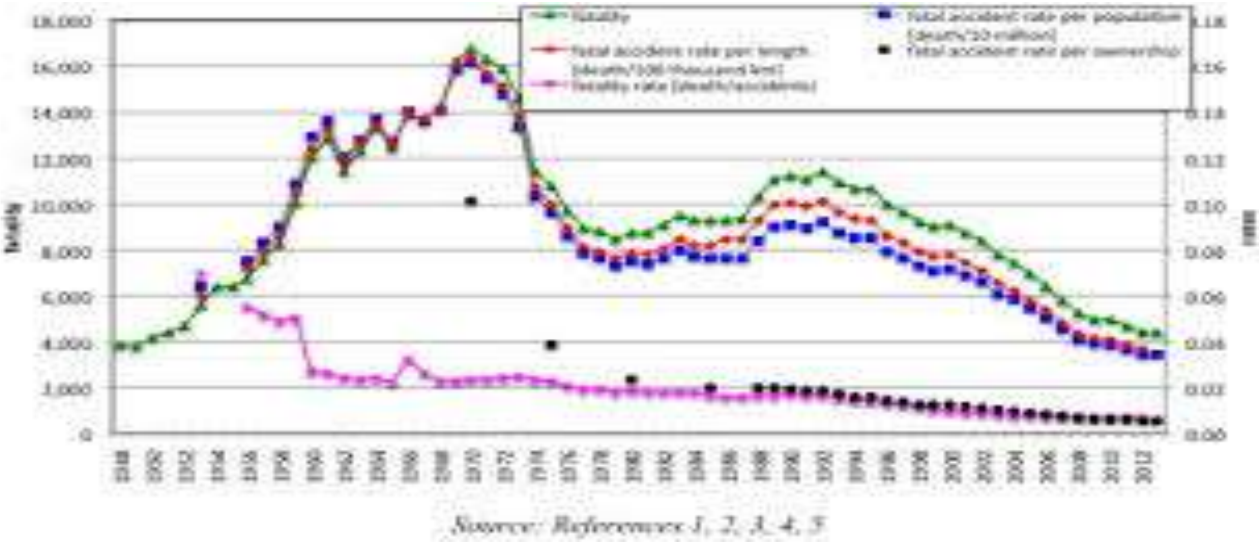
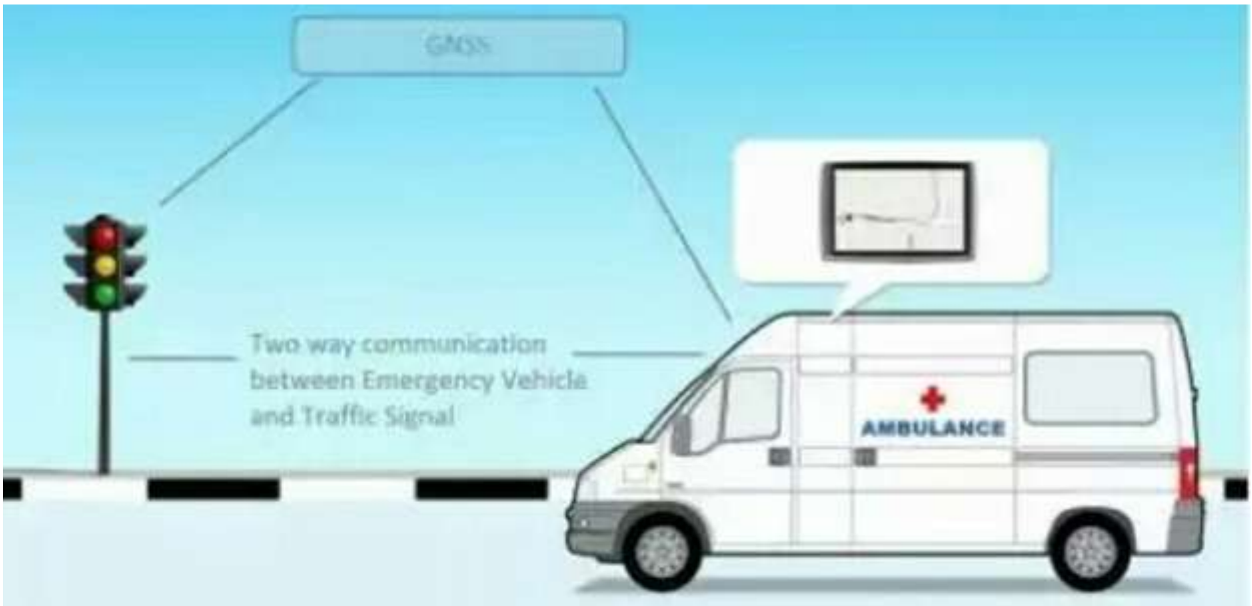


Table 1: Results of Road Surface Induced Vibration Analysis (Paddan& Griffin, 2002)

Typical frequency-weighted vibration magnitudes measured on various vehicles using both BS 6841 and ISO 2631 methods	BS 6841 (1987)		ISO 2631 (1997)
	Equivalent r.m.s. accel. (m s	2 r.m.s.) Seat vertical accel. (m s	2 r.m.s) Most severe axis accel. (m s
Car	**0.75**	**0.61**	**0.75**
Truck (Lorry)	**1.25**	**1.03**	**1.28**
Van	**0.61**	**0.53**	**0.57**
Armored Vehicle	**1.66**	**1.85**	**1.52**

- Problem likes time consumption, Death of patients in Ambulance by the timing, Traffic Problem, etc. In this project automatically control all the Ambulance activities.
- In many urban cities near Traffic Signal Ambulance have many problems like pass from one Hospital to another Hospital to require more time this time automatically cover in this project.



4. Module Control System through GPS

Problem like near Traffic Signal pass Ambulance to consume more time and by the emergency condition patient dead some time. Through this project to save life of patients by the saving times.

The results of the test that are tabulated in Table 1 show that with an increase in weight (i.e. trucks and armored vehicles) the route mean square (RMS) acceleration is much larger than that of a typical car with an increase of up to 60% shown. This means that the induced vibrations are harder to dampen due to the increase in weight. This shows that a secondary suspension of a much lighter platform within the patient compartment could greatly reduce the vibrations felt by patients. Paddan and Griffen also conducted another test where the induced road excitations were recorded for several axis in 25 different cars. Two vibration standards were recorded during the test for a comparison. The methods for these vibration tests are outlined in the International Organization for Standardization 1997 ISO 2631-1 and the British Standards Institution 1987 BS 6841. A description of these basic standards may be seen in Appendix C and D respectively, explaining the goal of each standard in regards to whole body vibration experimentation and quantification. "Both standards require the vibration amplitude data to be calculated using a vibration dose value (VbV) which accounts for the frequency, the amplitude and the length of exposure to the vibration under investigation."

We recorded the vibrations caused by various road conditions at three different speed levels. The data was collected in 30 second intervals for each road condition at three separate speed ranges. The speeds ranged from 25 mph to 70 mph. collecting the data was a sophisticated black box specifically designed to measure vibrations in three axes. A picture of the equipment used is seen above in Figure 6. After reviewing the data the ambulance ride was a success. It was evident that at high speeds similar to the speeds a patient would experience riding in an ambulance, considerable vibrations had occurred. We placed the data in the computer program in order to graph the measurements. The graphs prove that road induced vibrations on an ambulance are frequent and at times considerable. Personally experiencing the ride it's easy to see how vibrations can have a negative impact on the patient care. It was difficult enough to sit still at times making it seem almost impossible to treat a dying patient. Physically experiencing the vibrations in an ambulance gave us a better understanding of the problem and the need for an alternative support system. A possible solution can be a force feedback system in which a force plate specially engineered to be retrofitted under the cab would suppress the vibrations. Although the Force Feedback system 19 seems like a reasonable solution the reality is finding a way in order to design the system without having to build an entirely new ambulance. The cost of such a system comes into effect. Tests have to show the money being put into the construction of a feedback system would be greatly beneficial to the EMT"s and patients.

References

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