Thesis Project Portfolio

Design of a Sensor-Enabled Testing Device for the TrueClot® Tourniquet Application Trainer

(Technical Report)

Relationships Between Emergency Medical Services and Marginalized Communities: Disparities Across High- and Low-Income Areas in the United States

(STS Research Paper)

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Molly Luckinbill

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Department of Biomedical Engineering

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The need for effective and efficient emergency medical care is ever-present as mass-injury events such as school shootings and the Boston Marathon bombing remain prevalent. Society needs to be able to rely on emergency medical services (EMS) to be competent and responsive. Therefore, this portfolio explores two different facets of EMS: the training and the response. The technical research topic covers the training aspect; the final product is a device that examines the effectiveness of a bleeding control training product: the TrueClot® Tourniquet Application Trainer, designed by Luna Labs USA, LLC. The EMS response, on the other hand, is addressed by the STS research topic, for which the final deliverable is a paper that analyzes the variables that affect the answer to an overarching research question: what is the sociotechnical relationship between marginalized communities and emergency medical services in the United States? The combination of these two topics provides a broad view of the processes surrounding EMS and any disparities that need to be addressed.

The technical portion of this portfolio examines the clinical relevance of the TrueClot® Tourniquet Application Trainer (TAT) through the design of a sensor-enabled testing device. The TAT is a heavily-padded cuff that can be secured around the wearer's left shoulder and upper arm, and it contains a synthetic wound and blood vessel. The synthetic blood vessel is constructed with flexible tubing, representing the brachial artery, and it ends at a silicone wound at the base of the cuff. In order to use this product during tourniquet application training, an individual wears the TAT while synthetic blood is pumped through the tubing and out of the wound via a plastic squeeze bottle. The trainee then applies a tourniquet over the TAT and tightens the tourniquet until they observe the stoppage of synthetic blood flow out of the wound. Luna Labs requested the formulation of a validation project that will assess whether the tubing within the trainer occludes within the same pressure range as the brachial artery in an arm.

Therefore, the sensor-enabled testing device will be implemented between the tubing and the foam padding within the TAT, and it will measure the pressure applied to the tubing by a variety of tourniquets. The results of the tests performed with the device will inform Luna Labs of the clinical relevance of their device and whether changes need to be made to the design of the TAT.

The STS portion of this portfolio investigates EMS response, as the amount of time it takes EMS to respond to a distress call can be the difference between life and death. Unfortunately, evidence shows that low-income communities experience slower emergency response times than high-income communities, and that the amount of time it takes EMS to respond to a distress call impacts the severity of health complications that patients experience. Therefore, there are disparities in the overall health of high- versus low-income communities. The final research paper aims to determine what factors are involved in creating these disparities through the analysis of the main research question: what is the sociotechnical relationship between marginalized communities and emergency medical services in the United States? The factors and how they interact with one another are determined through the use of the STS framework actor-network theory. This analysis provides insight into how the resources that are available to different communities are influenced by the wealth of each respective community. The results of the research are expected to show that the EMS response system is largely influenced by money (e.g., hospital availability and private ambulance companies), and thus, people who belong to lower-income neighborhoods do not receive the highest level of care because they pay lower taxes or are less able to afford the cost of healthcare.

As previously stated, the combination of the two research projects within this portfolio provides a broad overview of the processes and problems within emergency medical services. Although the technical topic focuses only on one aspect of EMS training, the simultaneous STS

research allows for a deeper understanding of the necessity of proper training of EMS employees. Proper training not only applies to tourniquet application, but it also involves reducing bias regarding marginalized communities, which is not something that is well managed across the United States. It is important to ensure that all communities receive the same level of emergency medical care, and the research shows that medical training scenarios are not necessarily enough to accomplish that goal. Thorough training, including scenarios involving social factors, such as race and household income, would increase the efficiency and competency of EMS.