DESIGN OF AN ELBOW JOINT REDUCTION TRAINER FOR DISLOCATION MANAGEMENT

JOINT DISLOCATION MANAGEMENT: PROMOTING INCLUSIVITY TO ENHANCE MEDICAL TRAINING DEVICES

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SOCIOTECHNICAL SYNTHESIS

The U.S. has the highest number of hospitalizations from preventable causes, contributing to disparities across joint dislocation treatment that negatively affect rural and low-income groups. A medical professional's first time performing the joint dislocation treatment is on patients, increasing the likelihood of complications. The technical project involves the development of an elbow joint reduction trainer (JRT) that mimics a human elbow joint to provide medical professionals a resource to realistically learn and practice reduction technique. The STS research seeks to characterize the nature of the JRT's development, particularly concerning newly qualified athletic trainers and rural and low-income groups, through the lens of the Social Construction of Technology (SCOT) framework, by Trevor Pinch and Wiebe Bijker. SCOT reveals social patterns involved within the device's development in order reflect unique needs among groups, which is essential as a majority of the design and evaluation of the JRT is based on feedback. It will provide potential focuses for future development of orthopedic training technology, while demanding further concrete implementation to promote inclusivity and avoid an creating an inaccurate model that poses harmful consequences.

There is a need to address improper joint reduction treatment, in which eight percent of reductions result in complications, with standard education only requiring professionals to learn from books and practice the motion on a non-dislocated joint, contributing to hesitancy and error during prompt reduction. The JRT was developed with the goal of biomechanically imitating the forces and tension elements of realistic a posterior elbow joint dislocation and reduction to provide hands-on experience. The foundation of the project was based on feedback, in which interviews determined parameters such as what type of trainer was preferred and the features of the trainer. The model was designed with Solidworks CAD, 3D printed, and springs were hooked

onto screws to create the joint mechanism. For evaluation, orthopedic surgeons and an athletic trainer were asked to rate the force simulation, anatomical landmarks, form simulation, and usability of JRT presented on a scale of 1-5, with average scores of 4.3, 4, 4, 4.1, respectively for six experts. Overall, the scores were high for force simulation and usability for professionals to practice in skills labs and emergency rooms. The suggestions for improvement involve the addition of skin material around the joint and a medial rotation for complexity, as well as make the foam bicep smaller and stiffer. These changes will be incorporated with continued evaluation, and eventually will be mounted on Luna Lab's Shoulder Reduction trainer to create a model with more training capabilities.

Rural and low-income groups experience healthcare disparities, such as financial challenges, scarcity of services, a lack of trained physicians, and insufficient public transport, where prompt examination for a dislocation is difficult to achieve. Athletic trainers have become recently qualified to perform the reduction procedure on-site, providing a better way to treat dislocations, but this raises a concern. The SCOT framework recognizes the visualization of critical negotiations and social patterns that exist in the trainer's development, emphasizes interpretive flexibility, and opens up possibilities of change. This STS research will analyze the stakeholders, while focusing on the inclusion of athletic trainers and rural and low-income groups. Athletic trainers have the capability to decrease complications, costs from hospitalization, and psychological trauma from treating the dislocation on-site, having the potential to provide needed relief, especially among rural and low-income communities. The framework also addresses the inclusion of generalized doctors in rural and low-income areas, costs, and the potential relief of programs through regulators. It is proposed to incorporate design thinking into the design process, augmenting human factor engineering, guidelines and

requirements for human centered design passed by the FDA. Design thinking provides a similar focus as SCOT, keeping a clear user focus throughout development, the inclusion of multi-disciplinary teams, and the principle of failing fast and often, which would enforce more inclusive concrete implementation.

It is important to ensure the properties of the JRT are humanly sound, as there could be differences in feedback regarding techniques, patient injuries, and the overall feel of the functionality of the elbow joint reduction trainer. Design thinking provides a potential regulatory avenue that can improve the usability, enhancing the trainer, but further research through the lens of SCOT is needed help fully determine differences between groups. Medical training devices that are heavily impacted by professional feedback need to be regulated to promote optimal patient care and ensure healthcare disparities are suppressed and not exacerbated.

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