Reimagining Procedural Competency and Prevention of Skill Decay Using Virtual Reality and Mastery Learning

I. Specific educational aims:

We propose the creation of a virtual reality (VR) experience capable of delivering asynchronous, simulation-based mastery learning training sessions for physicians to prevent procedural skill decay. This will allow for inexpensive, wide scale dissemination of simulation-based mastery learning to unlimited learners. An experience of this sort is not currently available.

The first aim of this project is to develop the VR learning experience. The procedure we will use is pericardiocentesis, a high-stakes intervention to relieve severe cardiac tamponade. We will work with software consultants at a VR healthcare simulation company to develop a learning experience that provides rapid cycle deliberate practice with automated expert feedback. The software program will detect whether a step in the procedure was completed based on motion of the VR handsets. If a step was incorrectly performed, the platform will trigger a demonstration of the appropriate step and associated technique and rationale. The participant will then repeat the step and continue this process until all steps are completed. The second aim of this study is to evaluate if this VR experience is a reasonably effective method of procedural practice as compared to traditional mastery learning.

This project supports various funding priorities: *collaboration* as we will be developing the mastery learning checklist with input from cardiology and critical care colleagues, *rigorous approaches to scholarship or innovation* through a structured approach to development of the virtual reality experience and efficacy testing, and *impact and sustainability* because the software can be used in specialties other than emergency medicine like cardiology and critical care. The work product of this project can be distributed widely and utilized by any institution that has access to an Oculus headset.

II. Project rationale:

Physicians currently lack an efficient method of maintaining procedural competency after initial training. Academic physicians are especially susceptible to decline in procedural proficiency, likely due to insufficient volume of procedures as well as scholarly and institutional demands.[1] Time from residency completion has been associated with a decrease in baseline procedural proficiency for emergency procedures such as cricothyrotomy and trauma-specific competencies.[2,3] A means of asynchronous routine retraining is needed to prevent the threats to safety and education that skills decay poses.

Simulation-based mastery learning has been shown to be a superior approach of skills acquisition when compared to non-mastery instruction.[5] Rapid cycle deliberate practice involves learners alternating between directed feedback and deliberate practice until mastery is achieved and has been shown to be an effective tool in teaching procedural skills like pediatric intubation.[6,7] Despite these benefits, mastery learning has been criticized for its high cost; instruction by this method includes deliberate practice with expert feedback, which is time variable and involves greater human capital and equipment resources.

VR offers a promising solution to the obstacles of expert faculty time and limited-use task trainers. Previous research has shown virtual reality-based simulation to be an effective modality in improving technical skills.[8,9] Software can provide computer-mentored rapid cycle deliberate practice by recognizing if the appropriate psychomotor elements of a procedure have been performed by using hand sensors. Learners may complete training asynchronously, and data may be collected which can inform future learning activities. VR based deliberate practice with automated instruction has been used to train civilian personnel in mass casualty triage procedures and showed similar learning gains to live-action instruction.[10] However, examples of virtual reality simulation with individualized, automated feedback for procedural training are not prevalent. Our project will address this gap in the existing literature with the development and use of VR rapid cycle deliberate practice with adaptive instruction for mastery learning of pericardiocentesis. Our hypothesis is that physicians who go through the virtual reality learning activity will have similar skill retention as those who go through traditional mastery learning skill training; in other words, the virtual reality learning experience will be non-inferior to the traditional mastery learning experience, which is much more time intensive and cannot be done asynchronously.

III. Approach:

The development of the VR experience will necessitate the creation of a mastery learning checklist for the procedure, as a validated mastery learning checklist for pericardiocentesis does not currently exist in the literature. This checklist will undergo expert consensus for feedback and improvement. Once it is finalized, an instructional script accompanying each step will be created, which will also undergo expert consensus and feedback. Then, we will collaborate with our software consultants to develop the virtual reality experience. It will be tested on a faculty focus group who will provide feedback for improvement. These improvements will be incorporated, and the experience will be tested again on a focus group. This process will continue until there is consensus within the focus group that an acceptable standard was met, to ensure maximal usability before deployment.

Emergency medicine residents will be invited for voluntary participation and randomized into control and intervention groups. Baseline skills will be assessed on a task trainer and scored by blinded raters. The control group will undergo traditional mastery learning instruction. The intervention group will undergo the VR learning experience. Both groups will then be re-tested on a task trainer two months after the initial testing to assess for differences between the groups. The outcome will be the number of steps completed according to the mastery learning checklist, as well as a global competency rating.

IV. Timeline and plan for implementation:

Aug-Sept: mastery learning checklist creation, automated instruction script creation
Oct-Nov: virtual reality experience development, focus group testing, participant recruitment
Dec-Jan: initial skills testing and implementation
Feb- Mar: follow up skills testing
Apr-June: Data analysis, abstract preparation, manuscript preparation

V. Anticipated work product:

The anticipated work product is a VR learning experience which allows for mastery learning of pericardiocentesis with automated adaptive instruction. This is a software product which can be utilized by anyone with an Oculus headset.

VI. Evaluation plan:

After creation of the VR experience, participants will be randomized to the intervention or control group. All participants will undergo baseline skills assessment on a task trainer. The outcome measure will be number of observable actions from the mastery learning checklist completed. Assessment will consist of videotaping the learner performing the procedure on a task trainer, with only the participant's gloved hands visible. Participants will all wear procedure gowns to cover wrists and arms to further assist with blinding. These videos will be scored by blinded faculty raters, who will assess the number of steps completed according to a mastery learning checklist specific to the procedure. Physicians in the intervention group will then undergo the virtual reality deliberate practice experience. Physicians in the control group will undergo traditional a mastery learning experience. Follow-up testing will occur two months from initial testing and will be performed on all participants using the same videotaping method. These videos will be scored in a similar, blinded fashion. We will know our project is successful if follow up skills testing is not statistically different between the two groups.

VII. Dissemination of results:

We plan to present our work product and findings at a TMA lecture and as part of the CTSS honors scholars presentations. We will also submit our findings to publications related to medical education journals such as *Academic Emergency Medicine: Education and Training*, *JET EM*, and *Academic Medicine*, as well as a simulation focused journal, *Simulation in Healthcare*. Our plans for presentation include emergency medicine focused conferences including the Council of Residency Directors in Emergency Medicine Annual Meeting and the Society for Academic Emergency Medicine Scientific Assembly.

APPENDIX

References

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