Project Title: Rapid Cycle Deliberate Practice in Virtual Reality: Teaching Transvenous Pacemaker Insertion to Emergency Medicine Residents

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Project Rationale

Temporary transvenous pacemaker insertion is a critical life-saving procedure that requires a multitude of steps and proficiency in cognitive and technical skills. Traditional mannequin-based simulation is used to train residents in this infrequently performed procedure (Ahn et al., 2013). However, current training models may not be adequate. In one survey, 50% of 80 medical professionals were unsatisfied with their training in this procedure (Murphy, Frain, & Stephenson, 1995). Another study evaluating the number of attempts of deliberate practice to achieve competency in cardiac pacing (involving both transcutaneous and transvenous pacing) found that the total number of attempts to achieve competency in their deliberate practice based education was greater than that six required by Accreditation Council of Graduate Medical Education (ACGME) (Ahn et al., 2013). Inadequate training can lead to critical delays and complication rates being cited to up to 20% in cardiologists and emergency physicians (Birkhahn et al., 2004).

Ideal training in this procedure would involve Rapid Cycle Deliberate Practice (RCDP). In this approach, the learner receives a series of micro-debriefs facilitated by the instructor and are able to repeat part of the case after mastery of items addressed. RCDP instruction for procedures has been effectively demonstrated in the past (Tara et al, 2017). This technique has yet to be applied to pacemaker placement.

Virtual reality (VR) is the ideal medium for procedural learning and application of RCDP. VR training in laproscopic procedures for surgical residents has been shown to reduce error rates by three-fold during their first ten laproscopic procedures (Ahlberg et al., 2007). The benefit of VR involves the ability to perform repetitive practice with faster resets and objective, unbiased measures with preset checklists. In a competency-based teaching model where time is variable, VR is a potentially attractive modality that would reduce the amount of resources, such as faculty time and simulation center equipment cost, necessary to implement such a program for a multitude of learners.

We propose the novel development of a VR experience to teach transvenous pacemaker insertion for emergency medicine residents using the principles of RCDP. Our hypothesis is that VR will be a feasible modality for teaching temporary transvenous pacemaker insertion to emergency medicine residents. We also hypothesize that there will be no difference in competency-based training acquired through traditional RCDP with facilitated micro-debriefs versus non-facilitated checklist-based feedback. Lastly, we expect that there will be no difference in retention of skills between the two groups.

Specific Educational Aims and Approach

Specific Aim #1: *To evaluate the feasibility of using VR to teach transvenous pacemaker insertion using rigorous approaches to innovation*. We will be using SimX, a local VR company whose product was previously purchased by the Center for Simulation Immersive Learning (CISL). We will design the experience based off a previously validated procedure-based checklist published in the literature and reference texts. After programming the scenario, we will have a minimum of two faculty with greater than three performances of this procedure to provide feedback and make adjustments accordingly. All facilitators participating in the next phase of the study will be trained on the use of the VR system.

Specific Aim #2: *To demonstrate that RCDP is just as effective when performed with a facilitator as without a facilitator in the virtual environment*. Facilitators will be familiarized with the checklist and equipment beforehand. All facilitators will be trained in RCDP. Voluntary participants will include emergency medicine residents. They will be assessed with the checklist on their baseline ability to perform the procedure on a mannequin. They will also be provided with a pre-questionnaire assessing their previous experience with the procedure, current comfort level, and previous use of VR. They will be randomly assorted into either group: with traditional RCDP or with non-traditional RCDP. The traditional RCDP group will have facilitator-assisted micro-debriefs. The non-traditional RCDP group will have

checklist-based feedback with no facilitator interruptions. After the experience, a post-questionnaire will be performed assessing their comfort level. Immediately following the exercise, another mannequin-based assessment will be performed. This will be the baseline for the retention study.

Specific Aim #3: *To demonstrate retention of these procedural skills to be equal in both variations*. A retention study will be performed in 1, 2, and 3 months after completion of the exercise on the mannequin. This will be compared to their performance on the post-VR mannequin-based assessment.

Timeline and Plan for Implementation

	Oct-Nov 2019	Nov-Dec 2019	Dec-Jan 2020	Jan-Feb 2020	Feb-Mar 2020	Mar-Apr 2020	Apr-May 2020	May-June 2020	June-July 2020
Case Development	x	x							
Expert validation		x	x						
Data Acquisition				x	x	x	x		
Retention Analysis					x	x	x	x	x
Composite Data Analysis									x

Anticipated Work Product

The anticipated product is a VR experience to teach temporary transvenous pacemaker insertion using RCDP that may be disseminated to outside emergency medicine residencies and cardiology fellowships. This pilot study also has the potential to revolutionize the current way of performing RCDP. With the checklist-based feedback, the faculty involvement would be more limited. The result would be an innovative method to achieve asynchronous competency-based learning of procedures.

The skill of central line insertion is also embedded into this product as it is a pre-requisite to pacemaker placement. Subsequent projects will involve the effectiveness of teaching central line insertion using RCDP in VR. The scope of this study will be inter-disciplinary and involve emergency medicine, internal medicine, general surgery, and anesthesia residents.

Evaluation Plan

The success of our project will depend on the data analysis phase of our study. Statistical analysis will be performed on the following items: 1) comparison of 5-point Likert scale in pre and post questionnaire of comfort level with procedure, 2) comparison of pre and post-mannequin assessment performance based on previous experience, 3) comparison of post-mannequin assessment performance between the traditional and non-traditional RCDP groups and faculty time involved in both groups, and 4) regression analysis of retention in 1, 2, and 3 months.

In addition, we will do an item analysis to identify checklist steps that learners struggled with mastering. This will help other residencies do targeted teaching for this procedure. In addition, we will provide a resource and cost analysis including cost for VR equipment and case, faculty time, simulation center time, simulation center equipment, learner time, etc.

Dissemination of Results

We will submit our findings to medical education journals and repositories such as MedEdPortal, Journal of Graduate Medical Education, or Academic Medicine. Future presentations will be within Stanford and will extend to emergency medicine conferences: Council of Residency Directors in Emergency Medicine, American College of Emergency Physicians, Society of Academic Emergency Medicine. Dissemination in simulation focused conferences such as the annual International Meeting on Simulation in Healthcare (IMSH) hosted by the Society for Simulation in Healthcare will also be targeted.

APPENDIX:

References

Ahlberg, G., Enochsson, L., Gallagher, A. G., Hedman, L., Hogman, C., McClusky, D. A., … Arvidsson, D. (2007). Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies. *American Journal of Surgery*, *193*(6), 797–804. https://doi.org/10.1016/j.amjsurg.2006.06.050

Ahn, J., Kharasch, M., Aronwald, R., Menon, S., Du, H., Calabrese, N., … Wang, E. (2013). Assessing the Accreditation Council for Graduate Medical Education Requirement for Temporary Cardiac Pacing Procedural Competency Through Simulation. *Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare*, *8*(2), 78–83. https://doi.org/10.1097/SIH.0b013e3182822336

Birkhahn, R. H., Gaeta, T. J., Tloczkowski, J., Mundy, T., Sharma, M., Bove, J., & Briggs, W. M. (2004). Emergency medicine–trained physicians are proficient in the insertion of transvenous pacemakers. *Annals of Emergency Medicine*, *43*(4), 469–474. https://doi.org/10.1016/j.annemergmed.2003.09.019

Murphy, J. J., Frain, J. P., & Stephenson, C. J. (1995). Training and supervision of temporary transvenous pacemaker insertion. *The British Journal of Clinical Practice*, *49*(3), 126–128.

Taras, J., & Everett, T. (2017). Rapid Cycle Deliberate Practice in Medical Education - a Systematic Review. *Cureus*, *9*(4), e1180. https://doi.org/10.7759/cureus.1180