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Using the Simulation Environment to Test a Theory-Based Intervention to Improve Healthcare Safety
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BACKGROUND: Clinical simulation is considered a link between the theory of clinical practice and actual clinical practice. However, there has been limited research in simulation to evaluate the impact in producing patient safety best practices. Simulation offers an ideal setting to test theory-based interventions aimed at the reduction of medical errors in the actual clinical environment. This research tested an innovative, theory-based positive power action and communication intervention strategy (PACIS) to improve consistent execution of hand hygiene (HH).

METHODS: The study occurred during 13, four-hour multi-patient care clinical simulation experiences, each randomized to treatment or control, with 60 senior II level baccalaureate-nursing students. Seven clinical simulation faculty members were trained interveners. The treatment group received a manualized three-minute interaction with the faculty on HH and then ten minutes of direct observation by the faculty member in the clinical simulation laboratory. The control groups received a standard educational approach. The measurement instruments included demographics, faculty leadership support for patient safety, intervention acceptability, HH observation, faculty leader presence and intervention fidelity assessment. The dependent HH variable data collection forms were completed real-time at each measurement opportunity for HH using an electronic data collection form. The full scoring methodology was described in the intervention manual. HH observation inter-rater reliability was established at three points in the data collection period. A generalized estimating equations (GEE) model was used to test the null hypotheses: (a) there is no difference of HH overall adherence; (b) there is no difference of HH adherence before or after an opportunity; and (c) there is no relationship of nursing unit faculty leader time in the simulation area and HH adherence between intervention and control. The t-test was used to test the hypothesis of no difference between treatment and control in the theoretically mediating variable perceived leadership support.

RESULTS: The final student participant sample consisted of 54 baccalaureate senior II nursing students. There were no significant differences between intervention (n=25) and control (n=29) groups in demographics. There were a total of 370 HH observations, using the World Health Organization 5 Moments in Time definitions. In the base model, the estimated marginal mean probability for the control group adherence was .22 and the estimated marginal mean probability for the treatment group adherence was .69. The lift rate is consistent with prior HH education and observation intervention studies. The odds of an individual in the intervention group adhering to HH performance guidelines are six times larger (95% CI: 3.0 to 12.1 times) than those in the control group. The odds of an individual in the intervention group adhering before when indicated according to guidelines are four times larger (95% CI: 2.0 to 9.4 times) than those in the control group. The odds of an individual in the intervention group adhering after when indicated according to guidelines are six times larger (95% CI: 3.5 to 12.8 times) than those in the control group. The odds of HH adherence almost doubles [1.078] @ 1.97 for every nine minute increase in faculty time in simulation. There was no difference between groups of perceived faculty leadership for patient safety.

CONCLUSION: There was a significant difference in HH performance between the control and PACIS groups. HH in these clinical simulation groups could still be greatly improved. Although the study failed to produce a significant relationship between faculty leadership support for patient safety and HH adherence, the characteristics of faculty leadership support for patient safety may remain a significant factor in the integration of patient safety performance into student practice. Further research is needed in the areas of patient safety and teaching methods in simulation.

DISCLOSURES: None

REFERENCES
VENTRICULOLOGY PRACTICE ON A LIBRARY OF VIRTUAL BRAINS USING A VR/HAPTIC SIMULATOR IMPROVES SIMULATOR AND SURGICAL OUTCOMES

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BACKGROUND: Ventriculostomy, insertion of a catheter into a fluid-filled ventricle deep in the brain, is a closed-head procedure providing therapeutic cerebrospinal fluid drainage in situations such as traumatic brain injury and tumors. Ventriculostomy is often performed by beginning neurosurgery residents; several passes through the brain may be required for a successful cannulation. Feedback on the final location of the catheter tip is unavailable until the post-procedure CT scan, making it difficult for residents to relate their technique to the final outcome and improve their aim. To help residents improve their ability to correctly insert the catheter we developed a library of fifteen virtual brains for the Immersive Touch® workstation, a head- and hand-track augmented virtual reality and haptics simulator. The library, representing a range of normal and abnormal anatomies including normal, shifted and slit ventricles, allows neurosurgery residents to practice with multiple anatomies and obtain immediate feedback of the location of the catheter in the brain (figure 1). Research question: would practice on the library of virtual brains result in improved performance; 1) on a novel virtual brain; and 2) in actual surgical procedures?

METHODS: Neurosurgery residents participated in two hours of individual simulator practice on the virtual brains, including visualizing the 3-D location of the catheter within the brain immediately after each insertion. The performance of each participant was assessed on a novel normal, shifted and slit ventricle on the simulator before, immediately after, and one month after the intervention. Live surgery outcomes were assessed for three to six months before and one month after simulator practice, including whether cannulation was successful, whether intervention succeeded on the first attempt or not, entry into the lateral (first or third) or other ventricle space (catheter location in the lateral ventricle decreases complications requiring a repeated procedure), and hemorrhage. A series of generalized linear mixed models (GLMM) were fitted to the data using SAS 9.2 PROC GLIMMIX, with full maximum likelihood estimation (METHOD=QUAD) and either logistic or normal distributions, depending on the nature of the outcome. In each model, random intercepts were fitted for residents using an unstructured covariance matrix, to account for clustering of responses within resident.

RESULTS: Sixteen (16) residents generated a total of 397 simulated ventriculostomy attempts, with three attempts per resident per brain type per time. Relative to pre-intervention performance, residents were more successful immediately post-intervention (OR=3.43, 95% CI=[1.74, 6.77], P=0.001) as well as at follow-up (OR=2.59, 95% CI=[1.24, 5.41], P=0.011), but performance at follow-up was significantly worse than immediately post-intervention (P=0.001). Twenty-three residents provided live surgical data, generating a total of 176 ventriculostomy data points (not all participated in simulator training). Cannulation was successful in all but three of these surgeries, and thus success of cannulation could not be modeled. Cannulation succeeded on the first attempt in 152 surgeries (96%). There was no effect of training on likelihood of succeeding on first attempt (72% pre-training vs. 91% post-training, OR=3.76, 95% CI=[0.86, 16.4], P=0.08). After training the catheter was significantly more likely to have entered the lateral ventricle as opposed to other spaces (OR=2.51, 95% CI=[1.19, 5.28], P=0.02). Hemorrhages occurred in 16 surgeries (9%), and were not predicted by training or ventricle type.

CONCLUSION: Practice on a VR/haptics simulator with a library of virtual brains produces improved performance in neurosurgery residents, as measured by simulator outcomes and catheter location in live surgery. Simulator practice, especially by novice residents, may accelerate learning and shorten the learning curve for this common procedure, and thereby decrease morbidity and complications due to inexact technique. This work was supported in part by AHRQ grant # 1R18HS017361-01 from Dr. Tuchkowsky.

DISCLOSURES: Fady Charbel is a consultant for Immersive Touch.