MEDICAL STUDENT SURGICAL SIMULATION WITH HIGH FIDELITY KNOWLEDGE DONOR MODEL

By

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ABSTRACT

Objectives: Medical students need to excel in basic clinical skills to become effective healthcare providers. Intentional skills training could lead to more improved patient outcomes in the hospital setting. In this pilot study, Knowledge Donors (high-fidelity whole-body donors treated with a novel preservation solution) are used for students to practice endotracheal intubation and foley bladder catheter placement, both of which are time-sensitive procedures in the emergency setting. It was hypothesized that intentional repetitive training on the Knowledge Donor platform would result in improved performance of these two procedures.

Methods: Students received visual guides and in-person demonstrations of foley catheter placement and endotracheal intubations on both manikins and Knowledge Donors prior to performing the procedures themselves. Each student completed three intubations and foley catheter placements on two female and one male donors. Students were measured on critical procedural steps and time to completion by an experienced proctor. Student confidence was self-reported.

Results: Nine students completed intubations with 13/27 reaching proficiency. 10 students completed foley catheter placements with 16/30 judged as proficient. Failure to verbalize steps and sterility contributed to most failures across both procedures. Mistakes were not repeated in 8/9 intubations and 6/8 foley catheter placements. Median times in minutes to completion decreased significantly over 3 repetitions for intubation (2.8, 2.2, 1.5; $P<0.001$) and foley catheter placement (8.2, 6.8, 6.0: $P<0.001$).

Conclusions: This pilot study demonstrated that utilizing the high-fidelity Knowledge Donor platform in medical student skills training contributed to reaching competency in intubation and

foley catheter placements after few repetitions. Notably, completion time significantly improved for each of these time-sensitive procedures.

INTRODUCTION

Medical students aim to excel in basic clinical skills as they study to become effective healthcare providers. Frequently, students learn and practice emergency care techniques including endotracheal intubation and foley catheter placements on manikins. They are expected to translate these skills directly to patients without having learned the intricacies of practicing on a living human. In the event that students are given the opportunity to study with a preserved body, their learning can be limited by the likeness to a patient, the preservation method, and condition of the specimens[1].

Endotracheal intubation is a time sensitive resuscitative procedure used in an emergency setting to secure a patient's airway while providing oxygen and ventilation[2]. As this procedure replaces a patient's need to breathe, failure to complete this procedure in a timely manner can result in extreme consequences - this is a common yet preventable cause of death in the emergency department setting[3]. In a study on delayed intubation times, a mortality rate of 11.8% was seen for trauma patients whose intubation was delayed versus a 1.8% mortality rate for patients who received early intubation[4]. Healthcare systems use the foley catheter to assist in urination and when monitoring urine output. Should a foley catheter be required, proper and sterile insertion are imperative as foley catheter-associated urinary infections are some of the most common infections a patient is at risk for while in a hospital[5]. Creating a controlled platform for inexperienced learners to intentionally perform time-sensitive emergency procedures while prioritizing patient safety and abiding by time pressures can be challenging.

This pilot study aims to utilize repetitive and intentional skills training on a new cadaveric model to develop the skills of medical students. The Knowledge Donor Model is a high-fidelity whole-body cadaver treated with a novel preservation solution. The solution used for this preservation is non-formaldehyde based and allows for the donor body to appear realistic internally and externally in coloring, appearance, and feel providing an accurate template for future emergency situations.

This study hypothesizes that exposing students to intentional repetitive training on the Knowledge Donor platform will result in improved performances of endotracheal intubation and foley catheter placements as well as increased self-reported confidence in the subsequent procedures.

METHODS

This study was performed at a university affiliated hospital with an accredited learning simulation center operating room where the training took place. Medical students attending the university volunteered to participate in this pilot study. Data was collected on a single day in June 2022. A team of trauma and general surgeons agreed upon a set list of critical procedural steps for both intubation and foley catheter placement prior to data collection. The proctors used these steps to evaluate the proficiency of the learners performing both procedures.

Study Components

Donors: One male and two female Knowledge Donors were ethically acquired from local or national body donations in June 2022. Time from death to use was dependent on availability of whole-body donors. The Knowledge Donors were preserved within a week of acquisition using a

non-formaldehyde preservation solution developed by Global Anatomix (GAX). The donor bodies were stored in the hospital morgue when not in use in the simulation center.

Materials: The endotracheal intubation materials included a stylet, endotracheal tube, and scope. The foley catheter materials came in a prepackaged, sterile tray kit ready for use. This kit included sterile gloves, a foley catheter, lubrication gel, an iodine packet with swabs for application, a syringe, hand sanitizing gel, etc. All students and participating personnel were required to wear full personal protective equipment (PPE) including sterile gloves, gown, and mask with plastic eye shield.

Proctors: Coordinators and interns assisted the lab directors in ensuring procedural safety and donor respect as well as timing all procedures. Attending trauma surgeons proctored the medical students and evaluated them using a list of predefined critical steps. Procedural criteria for endotracheal intubation included verbalization of steps, appropriate technique, proper placement of the intubation tube, and securing the tube to the patient. Foley catheter placement critical steps included proper patient positioning, maintaining PPE throughout, equipment set-up - connecting syringe, deploying lubricant, placing foley catheter into lubricant, opening iodine pack and coating swabs - applying appropriate countertraction, reducing foreskin if applicable, ensuring catheter is in place, and verbally confirming urine prior to balloon inflation. Should students abide by all criteria they would receive a passing grade.

Medical Students Participants

Students had no prior experience intubating or inserting a foley catheter on a Knowledge Donor. They received visual guides and in-person demonstrations of foley catheter placement and endotracheal intubations on both manikins and Knowledge Donors prior to performing the

procedures themselves. The live training instruction provided by medical professionals denoted step by step techniques for proper patient placement, appropriate technique for foley catheter and endotracheal tube placement, verbalization of all steps, maintaining PPE. Students were made aware of and measured on said critical procedural steps and time to completion by an experienced proctor. Failure to properly complete any procedural step (Figure 1) resulted in a failing grade. Nine students completed endotracheal intubations and ten students completed catheter placements. Each student completed three intubations and catheter placements on one male and two female donors. Students received a survey to report their confidence levels in each procedure following completion of all three series on each donor.

RESULTS

Medical students participated in this study in June of 2022. Nine students completed three intubations each with 13/27 reaching proficiency. Ten students each completed three foley catheter placements with 16/30 having a passing grade. Failure to verbalize steps and improper placement of the endotracheal tube contributed to all intubation failures and breaking sterilization was the most significant reason for failures during the foley catheter procedures (Figure 1). Of failed procedure attempts, mistakes were not repeated in 8/9 intubations and 6/8 foley catheter placements. Median intubation times measured in minutes decreased from 2.8, 2.2, 1.5 over 3 rounds with the largest decline in time between rounds 2 and 3. Similarly, time to completion in. minutes for the foley catheter placement decreased from 8.2, 6.8, 6.0 minutes across 3 repetitions. Median times to completion for both procedures are indicated in Figure 2. Proctor comments regarding intubation failures include not inserting the endotracheal tube past the vocal cords and failure to vocalize steps. Proctors' comments regarding foley catheter placement most notably

commented on failure to maintain sterile PPE – contamination of foley catheter kit and gloves, not maintaining a sterile field, and returning used items into sterile field breaking. Other proctor comments on foley catheter failures included inappropriate patient positioning, rough insertion, and improper countertraction. Students self-reported increased confidence levels in procedural competency following both the endotracheal intubation and foley catheter placement simulation with Knowledge Donors.

FIGURES

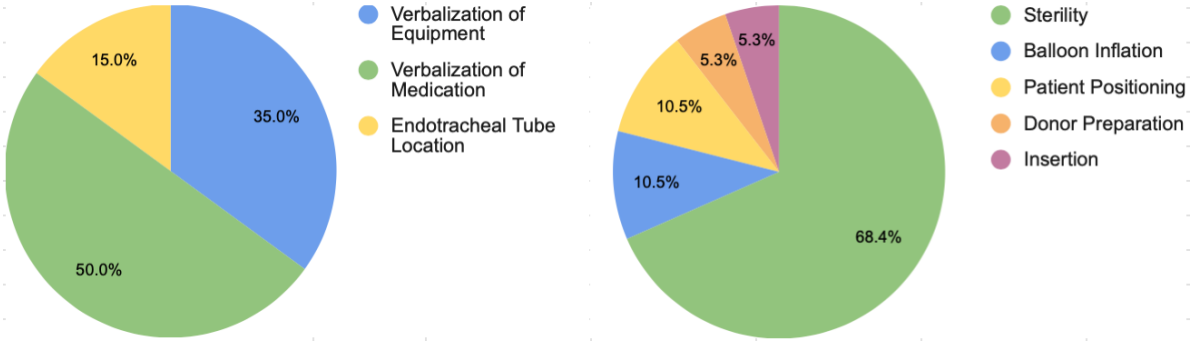

Figure 1. Failure descriptions for the 13 failed endotracheal intubation procedures on left. Reasons for failure for the 14 failed foley catheter procedures on right.

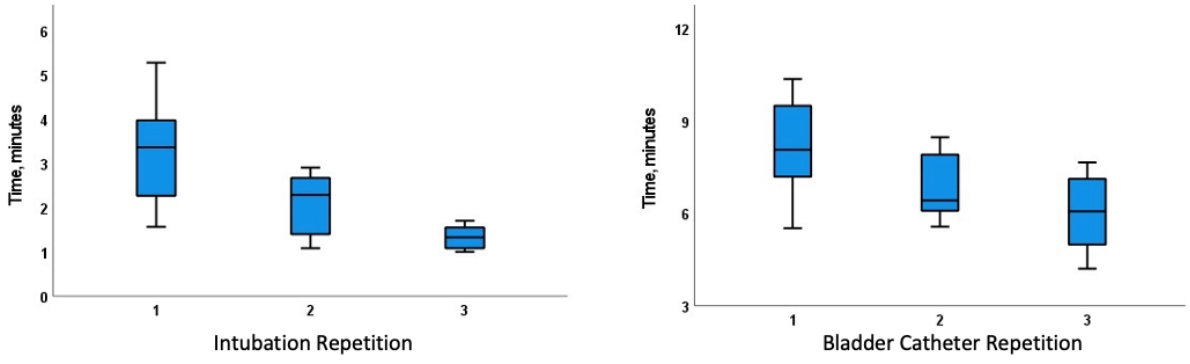

Figure 2. Time in minutes to complete endotracheal intubation (left) and bladder catheter placement (right).

DISCUSSION/CONCLUSION

This pilot study demonstrated that utilizing the high-fidelity Knowledge Donor platform in medical student skills training contributed to reaching high competency levels in intubation and foley catheter placements after few repetitions. Notably, time to completion significantly decreased for each of these time-sensitive procedures.

After visual demonstration and three repetitions per procedure, students showed a remarkable increase in performance and decrease in time to completion for never before having performed said procedures on a Knowledge Donor. These findings are consistent with other studies[6,7] evaluating the benefits of simulation training and their capacity to influence a trainee's confidence. This study is unique in that the emphasis lies in intentional and repetitive training in a simulation environment. It was important that repetitive training for students was at the forefront of this study as most learners typically get limited opportunities for repetition of any given procedure. Considering the simulation environment this study took place, students were provided an environment made to look identical to an actual operating room. It is possible that the fidelity of the room generated positive stresses necessary to perform a time-sensitive procedure accurately and efficiently. In a real-world trauma bay setting, the stresses of performing time-sensitive procedures on an array of patients would add to the stress of being an inexperienced learner.

This study has several limitations. The small sample size should be considered when analyzing these findings. The minimum number of repetitions for each procedure was three; however, some participants repeated the procedures several more times. Only the first three repetitions were used

when recording the data for this study although students showed further improvement with each additional performance.

There are broader implications with this study regarding the development of student training in general. The use of Knowledge Donors allows for simulation with high fidelity tissues affording an accurate real-life environment. In the context of an endotracheal tube placement, the accuracy needed to correctly place the tube into the airway while lifting the patient's head to gain access is afforded via the Knowledge Donor platform. In both male and female donors, this platform ensures that the foley catheter must be placed correctly; students will be met with resistance should they place the foley catheter incorrectly, the balloon will not hold if improperly inflated, and the proper counter-traction must be attained for smooth insertion. While the studies being conducted using Knowledge Donors have a small sample size, the positive implications of this platform can prove valuable on a broader scale for step retention and skill improvement through repetitive training. Further studies on the benefits of repetitive training on a Knowledge Donor could include retesting the original study participants to determine if their overall skill retention is significant and if they perform at the same average level after time away. Outside possibilities to consider include whether the student has had additional practice through continued medical schooling or further training.

In conclusion, this study demonstrates the viability of intentional repetitive training of time-sensitive procedures using the high-fidelity Knowledge Donor simulation model showing a correlation between repetition number and improvement in time to completion.

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