Gauging the Effectiveness of Brain-Based Learning and Simulation Instruction in an Airway Management Course for Emergency Medicine Residents

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Abstract: Airway management is a critical skill that emergency medicine (EM) residents must develop. Brain-based learning is a form of instruction that creates the best conditions for learning and retention. Used in conjunction with simulation-based instruction, the potential exists for reaching more learners. The purpose of this study was to assess the basic airway management skills of postgraduate year-one (PGY-1) EM residents before and after receiving training through a three-hour brain-based learning and simulation course in order to gauge the effectiveness of this teaching method. EM residents who completed a brain-based learning and simulation course in airway management in 2010 were evaluated before and immediately after the course by using a multiple-choice quiz to assess knowledge and a standardized checklist to assess practical airway skills. Pretest and posttest assessments were identical and subjects were blinded to the practical assessment criteria. Mean pretest scores on the quizzes and practical skills assessments were calculated and compared with mean posttest scores using two-tailed paired t-tests. A total of 71 new EM residents participated in this study. Improvements were observed in each practical airway management skill; mean total pretest score increased from 22.82/30 to a mean posttest score of 26.98/30 (p = 0.03). Improvements were also observed in knowledge assessments, from a mean pretest score of 5.97/10 to mean posttest score of 8.90/10 (p = 0.00). In conclusion, a three-hour brain-based learning and simulation course was effective at improving new EM residents’ knowledge and practical skills in basic airway management.

Keywords: brain-based learning, simulation, airway management, medical education

Airway management is a fundamental skill in emergency medicine (EM).¹ EM residents typically develop proficiency in airway management during residency through the apprenticeship model of learning, which assumes that residents will encounter a variety of clinical situations during their residency that will allow them to develop the skills necessary to handle future clinical encounters. However, some residents may not have the opportunity to experience uncommon clinical situations with sufficient frequency to develop the skills needed to handle certain situations.² Additionally, the apprenticeship model requires inexperienced residents to perform clinical procedures on patients in the clinical setting.³ This model does not ensure that residents develop proficiency in practical skills and places patients at risk for complications.⁴

Some high-risk, low-frequency clinical presentations require successful airway management as part of its management.⁵ Because of the relative infrequency of patients requiring airway management in the emergency department, it is difficult to adequately teach EM residents airway manage-
ment skills through apprenticeship alone. One study found that the first time intubation success rate is 72% among first year residents,¹ which demonstrates the misunderstandings, difficulties, and variance in technique associated with airway management. Numerous studies have reported that many clinicians are unable to state and apply the correct amount of cricoid pressure,⁶,⁷ and many clinicians confuse cricoid pressure, the BURP (Backward, Upward, Rightward Pressure) maneuver, and external laryngeal manipulation.⁸ Carelessness and limited experience in laryngoscopy for intubation and airway management can lead to permanent injuries or death.⁹,¹⁰ Therefore, additional education and training is necessary to enhance clinicians’ knowledge and skills in airway management.

Simulation offers the potential to teach airway management skills in a realistic and safe environment with ample opportunities for practice. Direct instruction, especially an over-reliance on didactic lectures, may not meet the learning style preferences of many residents as they attempt to understand the reasons for the use of particular airway skills. Further, an instructor who relies on direct instruction alone may have difficulty assessing learners’ understanding throughout the instructional process. Lesson planning should coincide with the way the brain acquires and processes information into long-term memory.¹¹ A four-phase lesson plan that combines brain-based learning and differentiated instruction has been proposed, utilizing the four phases: inquire, gather, process, and apply.¹¹ This four-phase lesson plan was modified for clinicians by one of the authors (T.C.C.) because the design is compatible with the Accreditation Council for Graduate Medical Education’s (ACGME) six general competencies that are important to the practice of medicine: 1) patient care, 2) medical knowledge, 3) interpersonal and communication skills, 4) professionalism, 5) practice-based learning and improvement, and 6) systems-based practice. The ACGME promotes the integration of a variety of learning and teaching approaches focused on improving patient care outcomes.¹²

While the effectiveness of brain-based, differentiated instruction on various academic subjects has been examined, we have not found studies that assessed the effectiveness of brain-based simulation instruction on airway management knowledge and skills. The purpose of this study was to assess the airway management skills of new EM residents after receiving brain-based simulation instruction in order to gauge the effectiveness of this teaching method. We hypothesized that residents’ airway management skills will improve after receiving brain-based simulation instruction.

Material and Methods

Study Design

This was a pre- and post-educational intervention assessment of starting postgraduate year one (PGY-1) EM residents from four EM residency programs affiliated with the New York City Health and Hospitals Corporation. Institutional review board approval was obtained prior to conducting this study. All residents were informed about the goals, risks, and benefits of participating in the study, and written informed consent was obtained.

Study Setting and Population

This study was conducted at four New York City Health and Hospitals Corporation hospitals, each of which is an urban tertiary care center affiliated with a medical school and separate university hospital. On average, each hospital cares for approximately 110,000 patients annually (range 75,000-135,000). All starting PGY-1 residents from the EM residency programs at the four hospitals were trained in airway management through a brain-based learning and simulation course. All residents in the course were eligible to participate in the study.

Study Protocol

In July 2010, 73 starting PGY-1 EM residents attended a single three-hour basic airway management skills course with brain-based learning and simulation. Prior to the start of the course, study investigators (N.S.T. and/or T.L.) provided an overview of the study, informed residents about the voluntary nature of the study, and invited residents to participate in the study. Written informed consent was obtained from the 71 residents who chose to participate in the study. All subjects underwent pretesting before the start of the course. Subjects’ airway management skills and knowledge were evaluated individually using two methods of assessment: 1) a written quiz on knowledge of airway management and 2) a practical assessment of airway management skills.

The written quiz consisted of ten multiple-choice questions on airway management. Topics included: patient positioning, laryngoscopy technique and complications, cricoid pressure, laryngeal manipulation, and bag-mask-ventilation (BMV). One point was awarded for each question answered correctly, for a maximum score of 10.

The practical skills assessment required subjects to demonstrate oropharyngeal airway (OPA), nasopharyngeal airway (NPA), and BMV techniques, and perform endotracheal intubation on a simulated airway (AirSim Bronchi Trainer, Belfast, UK). Subjects’ performance was evaluated by a study investigator using a checklist (T.L., N.S.T., or Y.O.). One point was awarded for each criterion that was performed.
correctly without assistance. Subjects were blinded to the testing criteria. The maximum score for the OPA skill was 6, NPA 4, BMV 6, and intubation 14. The checklist was developed based on guidelines from the New York State Department of Health, Bureau of Emergency Medical Services, as well as a consensus discussion between study investigators.

As shown in Figure 1, the brain-based simulation instruction, designed and facilitated by one of the study investigators (T.C.C.), commenced after pretesting was completed. The course included assessment of residents’ knowledge, cooperative learning session of evidence-based topic reviews, airway skills demonstration, technique practice time, and group-based simulated airway management cases on a medium-fidelity mannequin (ALS Simulator, Laerdal Medical Corporation, Wappingers Falls, NY). Immediately after the course, subjects were administered the posttest, which consisted of the same two methods of assessment as the pretest: written quiz and practical skills assessment. The primary outcome measure of this study is the difference in scores between the pretests and posttests.

Figure 1. Structure of the Course and Research Design

Data Analysis

Pretest and posttest scores from the written quizzes and practical skills assessments were computed and entered into Predictive Analytics Software (PASW) for analysis; missing data were imputed with mean values. Mean scores from the pretests were compared with mean scores from the posttests using two-tailed paired t-tests. The two-tailed paired t-test was selected because it allows us to determine whether the means of the pretests and posttests differ significantly from each other. A p-value of < 0.05 was considered statistically significant.

Results

A total of 71 residents participated in this study; 11 subjects did not complete the practical skills assessment. As shown in Table 1, the mean knowledge assessment score increased from 6.0 to 8.9 after the course (p=0.00), and the practical skills scores increased from 22.8 to 27.0 (p=0.03).

Discussion

Airway management is an important, fundamental skill for EM physicians. The life-threatening and infrequent nature of patient encounters requiring airway management makes brain-based learning and simulation potentially invaluable educational tools for teaching airway skills. In this study, we demonstrated that PGY-1 EM residents significantly improved their airway management knowledge and skills after a three-hour brain-based learning and simulation instruction course.

This course incorporated the four-phase lesson plan, combining brain-based learning and differentiated learning. In each of the four phases, the learners were engaged in active learning activities and a reflection-in-action process that assist learners with moving through the transformative learning process. Cooperative learning techniques are an important part of the brain-based lesson plan. They are used to assist learners with the declarative knowledge needed to understand the procedural knowledge that follows. More than what some might refer to as group work, cooperative-based learning techniques consist of groups of learners analyzing and constructing knowledge with the assistance of the course facilitator and other learners. Learners generally construct knowledge both individually and with the help of others as they internalize new information or information that is different from their existing understanding.

In addition, cooperative learning techniques allow for movement and active participation that is important for learning through a person’s preferred learning styles. Multiple meta-analyses have demonstrated the effectiveness of instructional techniques when the learning style needs of learners are met. The cooperative learning is followed by demonstrations of the skills on partial-task simulators, which progress to practice, scaffolding, and positive feedback from the facilitators. Following a reflection of learning, the learners are placed in clinical simulation where they apply the skills and...
knowledge acquired from the course. The debriefing, or reflection-on-action process that follows the simulation experience assists the learners with assessing how well they applied the skills and how they will use them in the clinical setting. To maximize the brain-based learning experience, it is important to maintain positive emotions throughout the entire learning process. This is accomplished by maintaining a learning environment that is not threatening to the learner.\textsuperscript{13}

We also utilized two different airway models in this course – the AirSim Bronchi Trainer and the Laerdal ALS Simulator – on which the residents were assessed, instructed, given guided and independent practice time, and re-assessed. Whereas real-world clinical education on actual patients offers limited opportunities to practice individual airway skills, including NPA and OPA placement, BMV, and laryngoscopy and intubation, this simulated environment offers a safe environment where students can practice and hone their airway skills. The improvement from pre- to post-course assessment indicates that students were able to hone their skills, without placing patients at risk. Moreover, all participants had Basic Life Support and Advanced Cardiac Life Support training, which includes airway management training, yet demonstrated statistically significant improvement in both skill and knowledge as a result of this brain-based learning and simulation instruction course.

This study has several limitations. As the primary assessments were pre- and post-course student assessments, we were not able to blind the evaluators. In addition, although the practical skills assessment checklists were reviewed by several emergency medicine clinicians, the checklists were created by the study investigators as, to our knowledge, there are no rigorously validated airway assessment instruments. Further, although the assessment criteria were designed to be as objective as possible, there is also potential for inter-rater variability.

This study evaluates the immediate improvement in airway management skills, and does not assess long-term retention. There was also no control group and therefore, our results cannot be compared to other educational methods. Also, as with any study of simulation, there may be limitations to real-world clinical applications of the skills involved. While it seems intuitive that clinical skills developed in a simulated environment can be extrapolated to real patient encounters, there is certainly a debate about the extent or limitations of simulation education. Finally, although this study involved residents from multiple sites, the sample size makes it difficult to generalize to the general population.

Conclusion

A three-hour brain-based simulation instruction course was effective at improving the basic airway management knowledge and skills of PGY-1 EM residents in a simulated environment. Future studies are needed to assess the retention of skills and residents’ airway management skills in clinical encounters.

References


