USING MEDICAL MANNEQUINS TO TRAIN NURSES IN STROKE SWALLOWING SCREENING

A Thesis Presented

to the

Faculty of the Department of

Communication Sciences and Disorders

University of Houston

In Partial Fulfillment of the

Requirements for the

Degree of Master of Arts

By

Tonya Freeland

May 2015

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ABSTRACT

Screening patients admitted with stroke symptoms for risk of dysphagia is often the responsibility of registered nurses (RNs). Simulation technology has become a widely used evidence-based form of training for healthcare professionals. The purpose of this study was to determine if the use of medical simulation mannequins as a training component is feasible when training and evaluating nurses administering swallowing screenings to stroke patients. A total of 32 RNs were divided into one of two training groups: didactic training only or didactic training plus simulation. Acquisition of skills was assessed immediately post-training and compared between the groups revealing significant differences between simulation group and didactic-only group for interpretation ($p = 0.01$) and administration ($p = 0.05$) accuracies. Following training to 100% accuracy for baseline competency, maintenance of skills across participants was assessed three more times over six weeks with the third follow-up screening completed with a standardized patient (live patient actor). While interpretation performance at each subsequent trial never equaled the baseline 100% accuracy ($p = 0.000$), steady improvement in performance was observed with each follow-up assessment. For screening administration, no significant differences in skills were evident between baseline competency and the 6 week follow-up ($p = 0.269$) further confirming improvement in skills over time. Generalization of screening administration and interpretation skills to the standardized patient was evident. Findings indicate that simulation training using medical mannequins can be used to train and evaluate nurses for obtainment and maintenance of swallowing screening competency.

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Introduction

Dysphagia in Stroke

Dysphagia occurs when neurological or structural damage affects a person's ability to swallow. Depending on the method used to detect it, research reports that 37 to 78% of patients experience dysphagia after a stroke (Martino et al., 2005). Other conditions such as degenerative neurological disease or structural changes, e.g., head and neck cancer, can also affect the ability swallow.

The health effects associated with dysphagia includes aspiration of liquids or food matter into the lungs which increases the risk for pneumonia, possible dehydration, malnutrition, and increased length of hospitalization (Hinchey et al., 2005; Odderson, Keaton & McKenna, 1995). The implementation of a swallowing screening protocol is associated with a decrease in patient morbidity and mortality due to aspiration pneumonia and other associated conditions in stroke patients (Hinchey et al., 2005; Titsworth et al., 2013).

Swallowing Screening Following Stroke

Due to the consequences of dysphagia, provision of swallowing screening prior to any oral intake for individuals presenting to the hospital with stroke symptoms is a guideline of the American Heart Association/American Stroke Association (Jauch et al., 2013). A swallowing screening is defined by the American Speech Hearing Association as a minimally invasive means to quickly determine if there is risk of dysphagia present in a patient (American Speech and Hearing Association, 2009).

A symposium was held in 2012 to discuss patient care topics in order to improve care and increase interdisciplinary cooperation among relevant healthcare professionals

(Donovan et al., 2013). In an effort to improve and streamline patient care, there is a growing body of research to indicate that administration of swallowing screenings by nurses is clinically feasible (Cichero, Heaton & Bassett, 2009; Daniels, Anderson & Peterson, 2013; Donovan et al., 2013; Magnus, 2001). Nurses are among those professionals on the front lines of care for acute stroke patients. Their expertise and round-the-clock presence within the emergency department and hospital ward make them obvious candidates for administering swallowing screenings in the absence of speech-language pathologists (SLPs), who are generally regarded as the experts in oropharyngeal swallowing and disorders (American Speech and Hearing Association, 2002).

Training nurses to properly administer and score screenings is an integral part of implementing a swallowing screening protocol. A well-developed training model must take many factors into consideration. The work culture, or how nurses view themselves and how other professionals view nurses, the work place priorities and expectations that they encounter, and the timing of the trainings have all been shown to be associated with successful training programs (Miller & Krawczyk, 2001). Therefore, when designing a training program to implement swallowing screening protocols, stakeholders, SLPs and nurses, must take into account those factors and the practical demands on the nurses' time and skills. A successful training model should include the necessary practical knowledge, disseminate that knowledge efficiently and effectively, and ensure retention of that knowledge over time.

Currently, there are swallowing screening procedures documented within the literature that included training periods ranging from 10 minute in-service trainings (Edmiaston, Connor, Loehr & Nassief, 2010) to 4-hour comprehensive training sessions

(Martino et al., 2009). Training components included the use of videos (Edmiaston et al., 2010; Magnus, 2001), computer modules (Davis & Copeland, 2005), and hands-on supervised practice with a patient (Magnus, 2001; Martino et al., 2009). While these researchers have reported increased confidence and knowledge in skills after training, there is limited published research to indicate which components of the various training programs proved to be the most effective in long term retention of skills. Currently there is no consensus about the best methods for effectively training nurses to perform swallowing screenings.

Simulation Technology Use in Medical Training

One educational model that has been implemented in the health care industry to provide professionals with hands-on experiences while limiting the potential for patient harm as they learn is the use of simulation. A full spectrum of the various simulation typologies has now been described in the literature (Alinier, 2007; Decker, Sportsman, Puetz & Billings, 2008). This spectrum includes a range of technologies from the very low-fidelity written simulations (e.g., using case studies to teach patient management) to medium- and high-fidelity classifications which include realistic full body medical mannequins, live participation scenarios, computer simulations, and virtual reality.

In the 1960s, the first medical mannequins were developed for the purposes of teaching mouth to mouth resuscitation (Cooper & Taqueti, 2004; Rosen, 2008). The Resusci®-Anne mannequins are highly recognizable by most people as the cardiopulmonary resuscitation (CPR) dummies used in the training of CPR skills to both medical and non-medical personnel. It was not until the early 1990s that the next generation of medical simulation mannequins was conceived, taking advantage of

advances in computer technology. The latest generation of high-fidelity medical mannequins provides a full-body, anatomically shaped patient simulators with programmable features to provide realistic reactions to stimuli.

Anesthesiologists were reportedly among the first to train their professionals using medical mannequins and high fidelity simulation (Cates, 2011; Gabba, 1999; Gaba et al., 2001). They used the medical simulators to train residents in procedures that were high risk to patients, such as airway management. As technology has continued to advance and cost-effectiveness with the equipment has improved, simulation mannequins are now being used in a variety of disciplines for training and assessing specific skills as well as promoting multidisciplinary teamwork.

To justify their use, researchers across disciplines have begun to investigate the acquisition and retention of specific skills by medical students using high-fidelity simulations and mannequins. It is reported that specifically trained skills may be retained anywhere from 6 to 11 weeks post-training (Bonrath et al., 2012; Fraser et al., 2009), 6 to 8 months post-training (Kuduvalli, 2008), and even up to 1 year post-training (Boet et al., 2011) depending on the complexity of the skills being taught. Although some data suggest that very specifically trained skills are not necessarily transferred to new and different scenarios (Fraser et al., 2009), the data support the use of simulation as a means for medical students to successfully acquire and retain specifically targeted knowledge and skills.

Simulation Training in Education

There are advantages to utilizing simulated environments to teach students in the medical field. The use of simulated scenarios with medical mannequins provides an

opportunity for safe, practical application and repetition of theoretical knowledge in a risk-free, controlled environment (Decker et al., 2008; Okuda et al., 2009). Students can practice difficult skills multiple times without compromising patient comfort and safety. Groups of students can be provided with controlled, uniform practice conditions to ensure the equal dissemination of knowledge.

When thoughtfully integrated into curriculum, simulation technology could be a useful strategy for helping learners gain critical thinking skills. Alinier (2007) proposed the idea of what he termed a "pattern of acquisition" related to the use of simulation technologies to enhance overall student success. He suggested that the student should first build theoretical foundations (knowledge) and competence. Next, the student could demonstrate theoretical knowledge in the presence of the instructor. Finally, the student takes action and performs the required tasks in the full-scale simulated environment.

With this in mind, it falls to the educators to design a successful program for their students. Researchers have begun to compile educational frameworks and guidelines to aid in the designing of future training programs based on their own experiences (Alinier, 2007; Jeffries, 2008; Henneman & Cunningham, 2005). These include suggestions such as clearly defining learning objectives, adhering to time limits, clearly defining roles of students and instructors, maximal numbers of participants, and strategies for incorporating a debriefing and feedback session to maximize learning.

Additionally, a simulated environment was deemed more realistic if no one was directly observing the students within the training room (Alinier, 2007; Jeffries, 2008). The idea was that this promoted problem solving and group communication by the participants. A large part of a successful learning experience using simulated

environments also included feedback to the learner in the form of debriefing after the simulation experience (Alinier, 2004, 2007; McGahie, Issenberg, Petrusa & Scalese, 2010). This debriefing session gave the learners a chance to express thoughts and feelings in a non-threatening, non-judgmental environment and to further incorporate the new knowledge.

Simulation Training in Nursing

Research indicates that there is evidence to support the use of this technology for training nursing students in a variety of disciplines (Decker, Sportsman, Puetz & Billings, 2008). Simulation technology has presented a unique approach to education to ensure that students acquire and practice necessary skills in a safe, controlled environment.

Simulation training has the potential to narrow the gap between classroom theory and workplace reality while helping to limit the risks to patients (Henneman & Cunningham, 2005). In two separate studies, researchers investigated the use of simulation technology in training undergraduate nursing students and found in both cases that student performance and confidence increased after the experience (Alinier, Hunt & Gordon, 2004; Alinier, Hunt, Gordon & Harwood, 2006).

Many of the research findings provided qualitative information about simulated learning experiences and inter-professional cooperation (Reising, Carr, Shea & King, 2011; Willhaus, 2010) and post-training confidence levels (Bambini, Washburn & Perkins, 2009; Henneman et al., 2005; Norman, 2012). In most instances learning outcomes and measurements of skills acquired by participants were not reported. Within the current body of research available, there is a lack of quantitative evidence to indicate

how the simulated skills transfer to clinical real-life applications (Alinier, et al., 2004; Norman, 2012; Fraser et al.2009).

Simulation Training in Speech-Language Pathology

Simulation training using a medical mannequin has rarely been used in the field of speech-language pathology, yet because of the nature of dysphagia it could be a viable training component in this particular area of the profession. To date, only one study has reported the use of medical simulation mannequins as a component specifically for training in the clinical evaluation of dysphagia.

Teams of speech language pathology students were trained to administer a clinical swallowing examination (CSE) (Potter & Allen, 2013). The mannequin was set up to simulate a tracheostomized patient in respiratory distress. The speech language pathology students completed a CSE, including a water swallow test, which is frequently part of the protocol for a swallowing screening. Nursing students provided suctioning as warranted. The aim of the study was to provide an inter-professional experience between the nurses and the students during which they would learn to rely on each other and work together. Outcomes of the training and retention of knowledge by the nurse and students were not reported.

There is a paucity of research describing the use of medical simulation mannequins within the field of speech-language pathology in general. It was reported that of Australia's ten accredited speech-language pathology programs, only four were using contemporary simulated environments (MacBean, Theodoros, Davidson & Hill, 2013). The university programs reported using standardized patients, part task trainers, low fidelity mannequins and environmental simulations to target different areas of practice

including adult voice, adult swallowing, foundational clinical skills and more. The lack of utilization of the technology by more speech-language pathology programs was attributed to many factors, including costs associated with the equipment, space requirements for housing the equipment and lack of expertise.

The use of a non-realistic training method versus a simulated training method for teaching speech-language pathology students to perform transnasal endoscopy was compared (Benadom & Potter, 2011). Students were randomly assigned to one of two training groups. Non-realistic simulation included the use of a tissue box with target lines drawn across to indicate where the students needed to aim for placement of the endoscope. The realistic simulation included the use of a non-lifelike medical mannequin in the form of a stationary dummy head and neck. The training included practicing seven passes of the nasal endoscope which was determined to be the standard number of practices necessary for the skills to be successfully acquired. Following training, the students completed the procedure on healthy volunteers.

Success was measured by the time it took to complete the procedure of passing the scope into the oropharynx. In this scenario the student was given a maximum of three minutes before they were disqualified. Results revealed no significant difference between the groups and their performance. Findings were attributed to the small number of participants as well as the fact that the medical mannequin was not much more lifelike than the tissue box.

Potential of Simulation Training for Swallowing Screenings

With regards to swallowing screenings and the role that nurses must assume in this endeavor, the use of a medical mannequin would allow nurses to practice

administering unfamiliar swallowing screening procedures and develop interpretation skills, particularly auditory perceptual accuracy for items such as dysarthria (i.e., slurred speech). The mannequins could allow the trainees to be repeatedly exposed to the auditory elements that distinguish patients with dysphagia, such as dysarthria or the quality of a cough. The nurses would also have the opportunity to practice administration of the water swallow protocols. This component is included in many validated swallowing screening tools (Edmiaston et al., 2013; Martino et al., 2009; Trapl, et al., 2007) and appears to be a key component of swallowing screening in stroke (Daniels, Anderson, & Willson, 2012), yet it is the one component that exposes the patient to risk due to the potential for aspiration. Thus administration and interpretation of this item is especially critical to patient safety.

The training of these components could be repeated indefinitely under the same conditions each time, ensuring a uniform experience for all trainees. The programmable mannequin also allows for the nurses to experience a range in degrees of severity of vocal responses in a controlled manner. This would quickly give them a familiarity with a range of responses that they may not likely experience otherwise until presented with actual patients, further supporting patient safety.

SLPs are specifically trained to recognize these auditory signs; however, nurses and other medical personnel qualified to administer screenings may get no training or opportunity to practice these skills in the workplace. Simulation could provide a controlled, uniform and replicable element to a training program that would that could contribute to effectively measuring learning outcomes as well.

Purpose and Hypotheses

Medical mannequins have not yet been studied as a component for training nurses to administer swallowing screenings. Because the time and skills of nurses are in such high demand, training should be efficient and effective to provide them with the necessary clinical skills to complete their duties with minimal retraining necessary. Since simulation mannequins can be used for practice, the nurses can gain experience without practicing new skills on actual patients, limiting patient risks and increasing patient comfort and safety.

The purpose of this study was to determine if high-fidelity medical simulation mannequins could be used successfully to teach and evaluate the administration of swallowing screening items to patients with strokes compared to a standard in-service style training. The following research questions were addressed:

1) Which training method is the most efficient for initial acquisition of skills needed to accurately administer and interpret swallowing screenings?
2) Is the accuracy in administration and interpretation of swallowing screenings maintained over time?
3) Do skills learned with the medical mannequin transfer to human patients?

It was hypothesized that: 1) simulation training would result in quicker obtainment of accurate interpretation and administration of screening items compared to the standard in-service training, 2) nurses would maintain screening accuracy over time, and 3) skills learned on the medical mannequin would transfer to a human patients.

Methodology

Participants

Registered nurses (RNs) from the Michael E. DeBakey VA Medical Center (MEDVAMC) in Houston, TX were recruited for participation. The inclusion criterion was no prior training in stroke swallowing screening. Nurses were recruited via flyer solicitation and informational sessions held on each hospital ward. A convenience sample of 35 RNs were recruited and consented to participate. Due to scheduling conflicts, three RNs did not participate in the study, yielding a total of 32 participants. RNs were assigned to either a control group (n = 16) or simulation group (n = 16) using a counter-balancing assignment method as they consented to participate to ensure that group sizes remained similar. Demographic data for the groups are provided in Table 1.

This study was approved by the Committee for the Protection of Human Subjects at the University of Houston and the Institutional Review Board at Baylor College of Medicine and the MEDVAMC. All subjects provided written consent before participation.

Table 1. *Demographic Characteristics of Subjects*

Variable	Control n = 16, 14 female	Simulation n = 16, 14 female	P-value
Age, mean (SD) Range	48.25 (9.81) 26-62	44.40 (10.20) 24-59	0.347
Experience (years), mean (SD) Range	14.64 (11.96) 0.25-38	16.53 (9.08) 1-30	0.618
Education (years), mean (SD) Range	4.0 (1.03) 2-6	4.13 (0.89) 2-6	0.716

Simulation Equipment and Environment

The study was conducted at the Simulation, Training Assessment and Research (STAR) Lab located at MEDVAMC. The STAR Lab provided an authentic simulated environment that included a patient's hospital room complete with working medical equipment and accessories that RNs encounter in everyday practice. For this study, the control equipment was placed in an adjoining room with viewing glass to allow researchers to leave the room and allow the participants to complete the screenings with more autonomy. Cameras were present to help the researchers capture procedures such as measurement of water in the syringe. If the RN consented, the screening process was recorded.

The Laerdal SimMan® 3G was used in this study to deliver the patient scenarios to the participants. The mannequin was controlled via Laerdal LLEAP instructor software for PC operated simulators. Delivery of the audio file responses (e.g. sustained "ah", coughs, throat clears) were controlled by the researchers in response to the participant's actions during his/her screening demonstration. This method allowed the researchers to maintain realism by timing responses appropriately, and selecting appropriate responses when participants deviated from the expected pattern. For example, during the non-swallow portion of the screening a participant might have unexpectedly changed the order of items by asking the patient to cough first and then engaging the patient in conversation. The researchers would then change the order of response to fit the order of questioning.

Swallowing Screening Form and Components

The swallowing screening tool was comprised of items from the MEDVAMC stroke swallowing screening tool which is currently under development and research to validate its use in clinical practice by nurses in the VAMC (Daniels et al., 2012). It consisted of three non-swallowing items and water swallowing components (Appendix A). Non-swallowing items included the identification of dysarthria, wet vocal quality, and abnormal cough on command. The water swallowing items consisted of administration of two 5ml water swallow trials and 90ml of water. Cough after swallow, throat clear after swallow, wet vocal quality was assessed after each trial, and inability to continuously drink 90ml was also assessed.

Interpretation of each item was recorded by individual participants using the swallowing screening form during his/her demonstration of skills with the mannequin. Participants were scored for accurate administration (Appendix B) and interpretation for each item by the researchers using a pass/fail scoring system. Six procedural skills were selected in which to assess the RNs as they were critical for patient safety and considered most important. These included completion of non-swallowing items before administration of water, elevating patient's head before offering water, presentation of water in a cup, completion of at least one water swallow before stopping the screening, completion of the water swallow trials in order by starting with the 5ml volume and administering twice before proceeding to the 90ml volume, and stopping the screening when a positive clinical sign was evident with a water swallow trial (e.g., throat clear after swallow).

Due to limitations of the simulation equipment, participants could not actually administer water to the mannequin. The participants were trained to measure each portion

of water accurately, place the water in a cup, and offer the cup to the mannequin as they would with a patient. They were instructed not to pour any water from the cup into the mannequin. Following each "simulated" administration of a water bolus, the RN asked the patient to say "AHHH" and listen for signs for potential aspiration (cough, throat clear, wet voice). Additionally, the patient's ability to continuously swallow 90 mls of water could not be assessed on the mannequin. These limitations were addressed in the six-week final follow up by providing a standardized patient simulation which is defined as an actor who is trained to play the role of a patient.

Designing Simulated Patient Scenarios

Multiple patient case scenarios were designed to provide controlled responses to each of these screening components. All participants were presented with the same case scenarios, in the same order, to preserve continuity across the groups. A total of 13 patient scenarios were created. Patient scenarios included auditory responses to each of the items included on the screening form (e. g., discourse sample to determine presence or absence of dysarthria, volitional cough to determine if weak or normal). Audio files were processed and manipulated for distortion, volume levels, timing and appropriateness using Adobe Audition and Premiere® program, and then compiled to create patient case scenarios.

Written patient profiles were created to complement each of these scenarios and were presented to the participants at the start of each training and/or screening session. These patient profiles contained information such as age, presentation of medical symptoms and potential diagnosis to provide more authentic experiences.

The audio files associated with the case scenarios were loaded on the Laerdal LLEAP computer software platform and played aloud using the Laerdal SimMan 3G® mannequin. A panel of seven experts which included the researchers, SLPs, and RNs who had two years of experience administering a similar version of this screening to patients with stroke was employed to score the audio clips for the absence or presence of each characteristic (dysarthria, wet voice, abnormal volitional cough, and throat clear, cough, and wet voice after swallowing) for each scenario. A minimum agreement level by five out of the seven experts was required for use of the individual audio clip within the scenario. Once finalized, these completed patient scenarios were loaded onto the Laerdal LLEAP computer software platform for use in the study.

Patient scenarios were designed to provide participants with a range of exposures from absent, to mild, to severe patient responses to mimic what nurses might encounter in daily practice. Audio files used were unique to each patient scenario to control for potential memorization or recognition of patient voices and responses across sessions. Participants were presented with the same patient scenarios during each scheduled session.

Didactic Training

The RNs in the control group were provided didactic training on swallowing screening in patients with stroke symptoms in a traditional in-service format. The RNs in the simulation group were given the same didactic training, but they were provided an additional hands-on simulated group practice session with the medical simulation mannequin prior to demonstrating skills learned. Both groups were offered the same information in the didactic training sessions to ensure that all participants were given the

opportunity to acquire equal knowledge and skills. All training was provided by a speech-language pathology graduate student closely supervised by a certified SLP. The size of each training session ranged from one to three participants.

The didactic training was delivered via a PowerPoint presentation on a laptop computer. This training consisted of a 20-minute presentation that included information about incidence of dysphagia and stroke, distinction between screening and swallowing assessment, and a review of screening items for which the participants were expected to demonstrate later. The discussion of the screening items included operational definitions of each item, demonstration of administration and interpretation of each item, and audiovisual examples of individuals with stroke participating in the screening. The examples included a variety of patients to demonstrate the presence and absence and various severity levels of item characteristics on the screening form (e.g. wet voice, dysarthria, abnormal volitional cough, throat clear or cough after swallowing). Handouts of the PowerPoint presentation and screening form were made available to all participants.

Simulation Training Component

Following didactic training, RNs in the simulation group received hands-on demonstration of screening procedures and practice using the medical simulation mannequin. These RNs were exposed to auditory examples of volitional coughing, voice quality, dysarthric speech, and response to water swallows of varying severities and types via the mannequin as an additional training component. Three training case scenarios were designed specifically for the simulation group.

The first training scenario was completed with the instructor present. The instructor helped familiarize the participants with the simulation environment by demonstrating procedures and talking through interpretation of patient characteristics.

Prior to the start of the second training scenario, the instructor left the simulation environment so the RNs could practice independently. Participants completed the second and third training scenarios as a group. The RNs were encouraged to take their time and talk through the procedures and interpretation as a team while scoring their patient on the screening form. After each case scenario a group debriefing session was provided to allow the participants an opportunity to discuss questions and concerns with the instructor and with each other. Procedural and interpretation errors were discussed and corrected, and the group was retrained specifically to those errors. The retraining included demonstration and/or instruction of procedural errors, and replay and/or discussion of sound clips for interpretation errors.

Testing for Acquisition of Skills

Immediately following training for the respective groups, each RN individually demonstrated his/her ability to administer and interpret the screening items using the medical mannequin as a simulated patient. After each case scenario was completed and testing concluded, a debriefing session was held with the participant. During this debriefing, errors in procedures or interpretation were identified and corrected allowing the RN to be retrained specifically for those items. The retraining included demonstration and/or instruction of procedural errors, and replay and/or discussion of sound clips for interpretation errors. The RN was given opportunity to ask questions and discuss concerns with the instructors during this debriefing process.

The testing process was repeated until each RN achieved 100% accuracy in administration and interpretation of the screening items on at least one patient scenario. If the RN achieved the accuracy goal in the initial attempt, the second screening scenario was always completed to ensure that the participant was given the opportunity to learn to discriminate between the absence and presence of each screening item characteristic.

Maintenance of Skills Over Time

Following obtainment of 100% accuracy during the initial testing period, maintenance of the learned skills was evaluated. Participants were scheduled to return at two weeks and four weeks post training to the STAR Lab to complete swallowing screening using the mannequin as a simulated patient.

The same case scenario and mannequin response was provided to each RN during the follow-up testing session. If the RN made errors in interpretation or administration, the errors were verbally acknowledged once the screening was completed; however, no additional training before, during, or after the screening during the follow-up sessions was provided.

Six Week Follow-up Testing: Transfer of Skills

The final testing session was conducted using one of two standardized patients to evaluate retention and transfer of skills to a live person. The standardized patients were trained SLPs with 30 years of experience working with individuals with stroke-related dysphagia. Each maintained pre-determined responses to each screening item to provide continuity across all participants being tested.

As with the previous follow up visits, the participants received no additional training and no debriefing following the screening administration, but errors in procedure

or interpretation were revealed to them verbally after completion of the screening. Unlike prior evaluations with the mannequin, the participants had to demonstrate actual administration of the water to the standardized patient and to evaluate continuous swallowing during the 90mL water swallow trial, both of which were reviewed and demonstrated during the initial didactic training session.

Analyses

Due to the small sample size and unequal distributions, nonparametric analyses were used to reveal differences between groups for initial obtainment of screening skills and maintenance of skills over time. Mann Whitney tests were used to determine group differences between initial obtainment of skills. The Friedman test was conducted to evaluate maintenance of skills across participants by analyzing differences between scores from the initial baseline evaluation and each of the three follow up evaluations. A series of post-hoc Wilcoxon Signed-Rank Tests was completed to further evaluate differences between screening interpretation scores over time. SPSS 22.0 was used with a significance level set at $p < 0.05$ for all tests except the Wilcoxon Signed Rank Test in which Bonferroni correction was applied to handle the multiple comparisons resulting in an adjusted alpha value of ($p = 0.0125$).

Results

Initial Accuracy and Acquisition of Baseline Competency

Group differences in the accuracy of screening administration and interpretation for the initial evaluation following training were assessed. Significant differences were observed between the simulation training group (M = 0.92) and the didactic training group (M = 0.79), $U = 64.0$, $p = 0.01$ for interpretation accuracy and for administration

accuracy, simulation training group (M = 0.95), didactic training group (M = 0.84), U = 80.5, p = 0.05.

Immediately following the initial evaluation, participants repeated screening trials until baseline competency of 100% accuracy was achieved for interpretation and administration of screening items. No significant differences were observed between the simulation training group (M = 2.00) and the didactic training group (M = 2.69), U = 81.0, p = 0.06 for the number of trials required to reach baseline competency for interpretation of screening items. All participants achieved this baseline within 5 trials. Significant differences, however, were observed between the simulation training group (M = 1.38) and the didactic training group (M = 2.06) U = 79.5, p = 0.04, to obtain baseline competency for administration of the screening items. The simulation group required one fewer screens to obtain administration competency.

Maintenance of Skills Over Time

Slight attrition was evident over the subsequent screening trials: 2 weeks (n = 32), 4 weeks (n = 31), and 6 weeks (n = 29). Analysis between baseline competency score of 100% and the three follow-up evaluations revealed significant differences over time in interpretation scores, $\chi^2(3) = 47.36$, $p = 0.000$ and administration scores $\chi^2(3) = 9.03$, p = 0.03.

Post-hoc analyses of interpretation scores (Table 2) revealed significant differences between baseline and each subsequent trial (p = 0.000), between 2 and 4 weeks (p = 0.013), but not between 4 and 6 weeks (p = 0.269).

Table 2. *Wilcoxon Signed Rank Results for Differences in Interpretation Scores Across Participants*

	Baseline &			Between	Between
	2 weeks	4 weeks	6 weeks	2 & 4 weeks	4 & 6 weeks
Mean Score	.685	.785	.840	---	---
Z	-4.722	-4.498	-4.310	-2.480	-1.105
P-value	0.000*	0.000*	0.000*	0.013*	0.269

*Significant p-values after Bonferroni correction

Post-hoc analyses of administration scores (Table 3) identified significant differences between baseline and the 2 week follow-up ($p = 0.000$) and for the 4 week ($p = 0.003$) but not for the 6 week ($p = 0.038$) follow-ups. No significant differences were observed between the 2 week, 4 week and 6 week screening sessions

Table 3. *Wilcoxon Signed Rank Results for Differences in Administration Scores Across Participants*

	Baseline &			Between	Between
	2 weeks	4 weeks	6 weeks	2 & 4 weeks	4 & 6 weeks
Mean Score	.910	.910	.954	---	---
Z	-3.69	-2.970	-2.070	-2.14	-0.577
P value	0.000*	0.003*	0.038	0.831	0.564

*Significant p-values after Bonferroni correction

Discussion

The aim of this study was to determine if the use of a medical simulation mannequin is feasible for training and evaluating nurses administering swallowing screenings to stroke patients. It was hypothesized that: 1) simulation training would result in quicker obtainment of accurate interpretation and administration of screening items compared to the standard in-service training, 2) nurses would maintain screening

accuracy over time, and 3) skills learned on the medical mannequin would transfer to a human patients. The results of this pilot study supported these hypotheses.

Simulation training using the medical mannequins as a component is a feasible method to train and evaluate nurses for swallowing screening. The initial testing scores achieved for the trial conducted immediately post-training indicated that the simulation group had better immediate recall of skills learned compared to the didactic training group. The structure of the simulation experience which allowed for the nurses to receive uniform training experiences also provided for uniform evaluation of the participants. The mannequin component was likely more successful initially for gaining skills simply because of the hands-on nature of that training which aids in learning. The mannequin simulation portion provided an opportunity to practice the procedures taught didactically, and to do so multiple times and in a way that immediately targeted weaknesses. The nurses and trainers could effectively identify and target the weakest skills through evaluation of performances during the practice administrations and could do so multiple times as needed until skills were mastered.

The controlled simulation environment provides a means to comfortably and privately practice the new skills without the judgment of supervisors or peers allowing the nurses to focus solely on the skills being taught. Practicing those skills on the mannequin rather than an actual patient also allows for the nurses to gain confidence in their new skills, which in turn increases patient comfort and safety.

This type of repeated practice appears to be critical to the development of the auditory perceptual skills necessary for interpreting the screening items. The nurses in this study demonstrated an initial decrease from the baseline accuracy; however, scores

increased with each subsequent trial even without additional training, just acknowledgement of results. Practice alone was enough to help solidify the new knowledge and skills over time. An ongoing, directed practice with a dysphagia expert is not necessarily a clinically feasible option due to time constraints of the typical workplace. This study provides a basis that the creation of practice modules for independent practice in the simulation lab could be a feasible training model following the initial didactic training from the expert. Scenarios, once created, can be used multiple times by multiple trainees at the convenience of the nurses' schedules. The repeated practice of skills will conceivably help develop reliable and accurate skills for both administration and interpretation of screening items. Evaluation of those skills may be conducted by trainers, but this model also lends itself to self-evaluation by expert nurses as well.

The medical simulation mannequin, however, has some practical limitations. For example, the mannequin equipment cannot accept liquids. This limited the nurses' abilities to fully practice the water swallow portions of the screening during this study, especially continuous swallowing evaluation. This limitation was compensated for by instructing nurses to complete all portions of the process up to the point of administering water with the mannequin then eventually introducing the nurses to a live standardized patient scenario. Within this study, these limitations with the equipment did not hinder the nurses' abilities to learn the skills properly, as evidenced by their successes with administration of the screening to a live standardized patient.

The use of a standardized patient is recommended as a means to ensure the skills transfer to live patients and to continue simulated practice to solidify skills learned. While

the increase in scores for participants of this study between the four week trial and six week standardized patient trial was not significant, the trend toward increased accuracy indicated that the participants could successfully transfer screening skills from the mannequin to a live patient actor and suggest further transfer of skills to actual patient. The introduction of a standardized patient provided a continued safe environment to practice in areas that the medical mannequin did not support, such as actual administration of water and judging continuous swallowing ability of the patient. The inclusion of this component, or even a supervised practice with real patients, is strongly recommended to bridge the gap between the simulation and clinical practice.

Limitations

Some limitations of this study should be noted. The sample size was small. The study was limited nurses who had no previous experience with swallowing screening. Further, nurses had to fit the research requirements into their busy schedule which may have limited participation. The participants were all self-selected so were likely to have been highly motivated to learn the new skills compared to the general population of nurses. A larger, more generalized sample of nurses not composed of a convenience sample could provide more information about the true effectiveness of this training model over all.

While this was a longitudinal study, the skills were only tested at two week intervals for a total of six weeks post-training. The accuracy of screening ability trended toward increasing levels, and a more extensive longitudinal study (i.e. six months) could have provided even more information about how the nurses learned and retained skills. Research involving the use of medical mannequins in other areas of medical practice

indicated retention of skills up to 6 months (Kuduvalli, 2008) and even one year (Boet et al., 2011) post-training. This study was not extensive enough to provide data to determine how many training sessions and/or practices are needed to reach and sustain acceptable reliability levels, nor how long skills would be retained past six weeks post-training. This would be useful knowledge when building an effective and efficient simulation based training model for swallowing screenings in the future.

Lastly, all participants were highly familiarized with the medical simulation equipment as they attended regular monthly trainings in the STAR Lab as part of their jobs. Familiarity with the simulation environment and pre-existing etiquette with the medical mannequin allowed nurses to concentrate more fully on the skills being learned, lending to better outcomes. The same results may not be achieved if this study was replicated with participants who were learning both the swallowing screening skills and the simulation environment etiquette.

Future Research

This study introduces the use of technologically advanced simulation equipment to teach swallowing screenings for stroke patients and as a means to evaluate skills learned. This technology could allow learners to train with instructors once, and then practice multiple times at their own pace until the learner feels confident to utilize his/her new skills with actual patients. While the technology of the simulation mannequins has advanced to a point where SLPs can now utilize it as a tool for this purpose, the limitations of this technology dictate that a comprehensive training approach (such as inclusion of a standardized patient once certain training criteria have been met) would likely be most successful. Further research, with larger groups over longer periods of

time could help develop this new training model and learn more about how the skills learned from simulation training might transfer to actual patients.

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Appendix A

Swallowing Screening Items

Instructions: *First complete the Non-Swallowing Section. Read each section before beginning. Assess all items in this section. Score each item as either yes/no (present/absent). After completion, move to the Swallowing Section.* ***Position patient upright in bed before beginning.***

Non-Swallowing Section

1. Dysarthria (Slurred Speech) **Yes** **No** **No/Limited Response**

Ask patient open ended question, e.g., "**Tell me, what happened to bring you here**?" Prompt patient for more verbal output if needed. Listen to the quality of speech. Do NOT pay attention to the content. *If speech is slurred or not precise, score as YES. If speech is clear and precise (regardless of content), score as NO.*

**If the person makes no verbal response or response is too limited to judge, score as NO/LIMITED RESPONSE.*

2. Wet Voice **Yes** **No** **No Response**

Instruct patient to say **"AHHHHHHHHH."** Listen to voice quality. *If the voice is wet or gurgly sounding during "AHHHHHH" or anytime during the non-swallowing section, score as YES. If voice quality is not wet or gurgly, score as NO. Instruct patient to repeat task if proper score cannot be determined.*

3. Abnormal Cough on Command **Yes** **No** **No Response**

Instruct patient to **"Cough as strongly as you can, like this**…" Demonstrate an example of a strong, forceful cough to the patient. If cough is breathy, weak or patient does not respond correctly, repeat instructions and demonstration. Score second attempt. *Score as YES if the cough is NOT strong and forceful or if the patient produces a throat clear or some other vocal response that is not a cough. Score as NO if the person produces a STRONG, FORCEFUL cough.*

** Score as NO RESPONSE if the person makes no response.*

Swallowing Section

Items: 2 cups-1 filled with water, 10 ml and 60 ml syringes, straw if needed

1. 5 ml (or cc). Measure out 5 ml of water with the small syringe and place it in a cup. Tell the patient "**You are going to drink a small amount of water. Drink this entire amount in 1 swallow."** You can help the patient hold the cup or have him drink from a straw.

After the patient has swallowed, have patient say **"AHHHHHHHHH"**. *Listen for presence of WET GURGLY VOICE when saying AHHHH, or COUGH or AUDIBLE THROAT CLEAR. Score as YES if any are present following swallow or ANY TIME before next section.*

A.	Cough after Swallow	Yes	No	
B.	Audible Throat Clear after Swallow	Yes	No	
C.	Wet, Gurgly Voice with AHHHHH	Yes	No	No Response

If any item is YES, STOP screening. DO NOT administer any more water.

2. 5 ml (or cc). If none are YES on the first swallow, measure out 5 ml of water with the small syringe and place it in a cup. Tell the patient "**You are going to drink a small amount of water. Drink this entire amount in 1 swallow."** You can help the patient hold the cup or have him drink from a straw.

After the patient has swallowed, have patient say **"AHHHHHHHHH"**. *Listen for presence of WET GURGLY VOICE when saying AHHHH, or COUGH or AUDIBLE THROAT CLEAR. Score as YES if any are present following swallow or ANY TIME before next section.*

A.	Cough after Swallow	Yes	No	
B.	Audible Throat Clear after Swallow	Yes	No	
C.	Wet, Gurgly Voice with AHHHHH	Yes	No	No Response

If any item is YES, STOP screening. DO NOT administer any more water.

3. 90 ml (or cc). If none are YES, measure out 90 ml of water with the large syringe and place it in a cup. Tell the patient **"Drink this entire amount of water without stopping, Keep the cup up to your lips and keep drinking, swallow after swallow, until the water is gone or I tell you to stop."** You can help the patient hold the cup or have him drink from a straw.
If the patient demonstrates COUGH, AUDIBLE THROAT CLEAR, or WET GURGLY VOICE during drinking, STOP THE PATIENT FROM DRINKING; REMOVE THE CUP OF WATER.

After the patient finishes drinking, have patient say **"AHHHHHHHHH"**. *Listen for presence of WET GURGLY VOICE when saying AHHHH, or COUGH or THROAT CLEAR. Score as YES if any are present during or following the swallow or ANY TIME within the 1-minute wait period. If the patient cannot continuously drink the water, even with encouragement, score as YES.*

A.	Cough after Swallow	Yes	No	
B.	Audible Throat Clear after Swallow	Yes	No	
C.	Wet, Gurgly Voice after Swallow	Yes	No	No Response
D.	Unable to Continuously Swallow	Yes	No	

Appendix B

ADMINISTRATION SCORING SHEET

	NON-SWALLOWING SECTION				
		TASK PERFORMED? Y=Yes/N=No/UN=Unnecessary			IF "NO", STATE REASON: OM=Omitted Item/ OO=Out of Order/IE=Inaccurate Execution
1	**START TIME:**				
A	Positioned the patient upright in bed	Y	N	UN	OM OO IE
2	**DYSARTHRIA**				
A	Asked patient to "Tell me what happened to bring you here?"	Y	N	--	OM OO IE
B	Prompted patient for more verbal output if limited attempt	Y	N	UN	OM OO IE
3	**WET VOICE**				
A	Asked patient to say "AHHHHHHHH"	Y		--	OM OO IE
B	Assisted patient in starting task if patient unresponsive or encountered difficulty	Y	N	UN	OM OO IE
4	**ABNORMAL VOLITIONAL COUGH**				
A	Asked patient to "Take a deep breath and cough as strongly as you can"	Y	N	--	OM OO IE
B	Demonstrated a strong, forceful cough as an example	Y	N	--	OM OO IE
C	Repeated instructions/demonstration a 2nd time if inadequate response	Y	N	UN	OM OO IE
	SWALLOWING SECTION				
5	**5 mL SWALLOWING (Part A)**				
A	Measured out 5 ml of water correctly	Y	N	--	OM OO IE
B	Asked patient to "Drink entire amount in one swallow"	Y	N	--	OM OO IE
C	Asked patient to say "AHHHHHHHHHH"	Y	N	--	OM OO IE
D	Stopped administering water if **circled YES** for any item (coughing, throat clearing, wet/gurgly voice)	Y	N	UN	OM OO IE
	Proceed if circled no, STOP if circled yes				
6	**5 mL SWALLOWING (Part B)**				
A	Measured out 5 ml of water correctly	Y	N	--	OM OO IE
B	Asked patient to "Drink entire amount in one swallow"	Y	N	--	OM OO IE
C	Asked patient to say "AHHHHHHHHHH"	Y	N	--	OM OO IE
D	Stopped administering water if **circled YES** for any item (coughing, throat clearing, wet/gurgly voice)	Y	N	UN	OM OO IE
	Proceed if circled no, STOP if circled yes				
8	**90 mL SWALLOWING**				
A	Measured out 90 ml of water correctly	Y	N	--	OM OO IE

B	Asked patient to "Drink entire amount of water without stopping…"	Y	N	--	OM OO IE
C	Stopped patient from drinking and removed cup if patient demonstrated cough, throat clear, or wet/gurgly voice during drinking	Y	N	UN	OM OO IE
D	Asked patient to say "AHHHHHHHH"	Y	N	--	OM OO IE
	STOP TIMING				
	TIME TO ADMINISTER SCREENING: **ADDITIONAL COMMENTS:**				