Critical Review:
The Outcomes of Simulation-Based Learning Experiences for Speech-Language Pathology Students

Stella Doytchinova & Sarah Yellan
M.Cl.Sc SLP Candidates
University of Western Ontario: School of Communication Sciences and Disorders

This review examined evidence reporting on the outcomes of simulation-based learning experiences in graduate level speech-language pathology (SLP) students. A literature search using computerized databases and a search engine yielded nine articles that met the inclusion criteria. Articles reviewed include two randomized controlled studies, one mixed design study, three repeated measures cohort studies, two single group studies and one case series study. All literature was evaluated based on design, methodology, validity, reliability and clinical importance. The current state of the literature suggests that students value the contribution of simulations to their learning and perceive simulations as increasing their clinical skills, confidence and knowledge. However, further study is required to confirm the objective development of clinical competencies and the parameters that constitute an effective simulation.

Introduction

Simulation-based learning involves creating a high-fidelity imitation of clinical scenarios to provide a safe and supportive learning environment (Hewat et al. 2020). Students can benefit from simulations because they provide opportunities to practice and to learn technical skills in a wide range of clinical scenarios without any risk to clients. The introduction of simulations in healthcare has been shown to improve patient safety, enhance student competency, and positively impact student confidence and skills (Dudding and Nottingham, 2018). Currently, there is positive evidence for the use of simulations in the development of clinical knowledge and skills in medicine and nursing (Curl et al., 2016; Hayden et al., 2014; McGaghie et al., 2010). Additionally, there is emerging evidence for its use in allied health professions, such as physiotherapy, audiology and occupational therapy (Blackford et al., 2015; Dzulkarnain et al., 2015; Imms et al., 2018).

Clinical education is a core component of speech-language pathology (SLP) curriculum, providing students with the opportunity to translate knowledge learned in courses to workplace contexts and develop fundamental occupational and professional skills. Globally, SLP programs face challenges securing sufficient traditional clinical placements for students in all necessary clinical areas. These challenges are due to the growing number of programs and students, limited clinician availability and willingness to take on students, and insufficient funding for clinical education positions (Ward et al., 2015). Given the increasing demands on finite clinical placement opportunities, there is an increasing need to explore alternate clinical learning opportunities in speech-language pathology.

In response, there has been growing evidence exploring the use of simulation-based learning experiences in SLP. This evidence must be evaluated to reveal whether there is potential to implement simulations as a solution.

Objectives

The primary objective of this paper is to critically evaluate the existing literature reporting on the outcomes of simulations for graduate level speech-language pathology students.

Methods

Search Strategy

Google Scholar and databases including CINAHL, PsychINFO, PubMed were searched for the following using the following search strategy: [(student, speech language pathology) AND (simulation)]. Articles were also obtained through the reference lists from previously discovered articles.

Selection Criteria

Studies selected for inclusion in this review were required to measure or describe perceived or objective clinical competency outcomes following a simulation learning experience for graduate SLP students. The literature included in this critical review was limited to graduate SLP students because undergraduate SLP students differ from graduate students in knowledge and experience at baseline. This difference may impact students perceived or objective clinical competency development.

Data Collection

The results of the literature search yielded nine articles that met the selection criteria. Two of the articles were randomized controlled studies (Benadom and Potter, 2011; Hill et al., 2020), one was a mixed design study

(Carter, 2019), three articles were repeated measures cohort studies (Howells et al., 2019; Miles et al., 2015; Ward et al., 2015), two were single group studies (Hill et al., 2013; Miles et al., 2016) and one case series study (Stead et al., 2020) was also included.

Results

Randomized Controlled Studies

Benadom and Potter (2011) investigated the acquisition of transnasal endoscopy skills using a lifelike human patient simulator (HPS) and non-lifelike simulator (a box with a drawn narrow path). Transnasal endoscopy skills were measured by the duration of the fiberoptic endoscopic evaluation of swallowing (FEES) procedure and student clinician's confidence ratings. Eighteen students were randomly assigned to perform seven training passes on the HPS or non-lifelike simulator and then one transnasal endoscopy pass on two different randomly assigned volunteers. Following each pass on a volunteer, surveys were administered to evaluate students' self-assessment of confidence and competence and volunteers' perceptions of the student's confidence and competence. Appropriate statistical analyses revealed no significant difference in pass times between student clinicians trained using the lifelike simulator and non-lifelike simulator. However, both training groups were significantly faster and more confident on the second endoscope pass on a volunteer.

A strength of this study is the detailed description of the instrumentation and outcome measures, such that the methodology was well understood, and the study could be replicated. Inclusion of objective pass time and subjective reflections of improvement as outcome measures provides further credibility to the results. As well, comprehensive randomization was implemented by randomly assigning students to groups, students to volunteers, and the order of transnasal endoscopy conducted on a volunteer, which minimized confounding variables related to procedure.

One limitation of this study is that participant demographics and relevant variables were neither described nor assessed to establish equivalence between the training groups. The study also had a small sample size, which limited the statistical power of the results for each training group individually. Consequently, the authors made post-hoc statistical analyses with both groups combined and this revealed the statistically significant results reported in the study. The interpretation of the findings was further limited by the lack of a control group without simulation to compare the benefits of simulations to traditional clinical opportunities.

This study is suggestive that simulations can support the development of necessary competencies for transnasal endoscopy due to the appropriateness of the study design and outcome measures. The level of evidence is limited by post-hoc statistical analyses and small sample size.

Hill et al. (2020) aimed to determine if students from six universities achieved statistically equivalent levels of competency when a portion of traditional placement time was replaced with simulation as compared to traditional placement only. Students from each university were stratified and paired based on grade point average and each student in the pair was randomized to the simulation + traditional group or traditional only group. Students in the traditional only group attended their placements and students in the simulation + traditional group completed a standardized simulation placement prior to completing their traditional placement. At the conclusion of the traditional placement, each student's competency was evaluated by their clinical supervisor using a validated assessment tool (COMPASS®). Appropriate statistical analysis of student competency revealed that students in the simulation + traditional group achieved statistically equivalent competency scores as students in the traditional only group.

The study had strengths related to the appropriateness of the design and the rigorous methodology used to address the clinical question. Participant selection criteria was broad and included: students enrolled in a university SLP program, in the middle of their program and allocated to a 16–30-day placement working with adults with communication and swallowing disorders. The criteria allowed for a large and diverse sample, which facilitated adequate statistical power and generalizability of the findings. Although prior experience was not controlled, cohort effects were controlled through stratified randomization at the student level. The simulation was also designed according to best practice principles, checked for fidelity, and the outcome measure is a validated tool, which bolsters the validity and reliability of the results.

One limitation of the study is that clinical educators evaluating the students could not be blinded to the student's group, but the authors attempted to offset this by providing limited information about the study purpose. Students in the middle of their program have already begun developing professional competencies through previous clinical placements, but the authors

did not analyze previous clinical experience in the targeted clinical area. Therefore, students' developing skills or previous clinical experiences may have influenced the group effect.

This study offers compelling evidence that students can learn clinical competencies through simulations due to its thorough methodology, use of a standardized outcome tool, and appropriately employed statistical analysis.

Mixed Design Study

Carter (2019) investigated student learning outcomes from a computer-based simulated learning experience. Four consecutive student cohorts were randomly assigned to either a traditional learning experience or a computer-based simulation experience for a mandatory course. Appropriate statistical analyses of pre-experimental and post-experimental measures revealed that the students in the simulation group demonstrated greater improvements in various clinical skills than the traditional learning experience group.

A strength of this study is that traditional cohorts and simulation cohorts were highly equivalent at baseline. Equivalence was determined based on statistical analysis of undergraduate GPA and entrance exam scores, which are appropriate predictors for potential performance in the course. One way ANOVA of the pre-experimental measure further corroborated equivalence between the groups. Therefore, significant group effects are less likely to be attributed to participant factors. The learning conditions were also equivalent in topic, structure and depth, but the extra time devoted outside of class in the traditional condition may account for the results.

The pre-experimental and post-experimental measures are unstandardized measures, which limits the confidence that improvements are associated with empirical measures of clinical improvement. Another limitation is that the author taught the course and could not be blinded to each cohort's group assignment, which introduces potential bias. To minimize the influence of these limitations, blind raters with high inter-rater reliability and parallel forms of the pre-experimental and post-experimental measures were employed.

Although the study used non-standardized measures that reduce the clinical validity of the study, it offers suggestive evidence for the benefit of simulations due to the comprehensive methodology.

Repeated Measures Cohort Studies

Howells et al. (2019) investigated student's perceptions of confidence, preparedness to work with adults requiring alternative and augmentative communication (AAC) devices, and views on the use of telepractice and simulation before and after working with simulated patients. Two consecutive student cohorts worked with simulated patients who portrayed an adult with complex communication needs requiring an AAC device via videoconferencing. Appropriate statistical analyses revealed that student confidence significantly increased, they felt better prepared to work with this population, but had unfavorable views of telepractice. Additionally, students reported an overall positive experience and felt the simulation benefitted their clinical competence.

Strengths of this study include the use of validated and reliable tools to assess outcomes. However, measures included in this study are perception-based and consequently, offer no assessment of student skill attainment. As such, student perceptions of improvement cannot indicate an actual change in competency. Furthermore, no follow-up measures were performed to confirm if skills acquired during simulation translated to real-life clinical scenarios. The authors also neglected to investigate students' perceptions of telepractice and evaluate possible sociodemographic implications in relation to telepractice. Additionally, data was collected from a small sample of students at one academic institution, limiting the statistical power of the findings.

Overall, this study provides suggestive evidence for the use of simulation and telepractice to develop clinical skills in AAC. However, the aforementioned weakness in methodology limits the interpretation of the results.

Miles et al. (2015) explored students' perceptions of confidence, hospital readiness, and knowledge before and after participating in simulation-based training on dysphagia management. Students' perception of the simulation and post-training skill retention was investigated as well. Students participated in part-task skill learning and immersive simulated scenarios. Prior to and immediately following the simulation, students completed a questionnaire to evaluate their confidence, knowledge, preparedness to work in a hospital environment, and their perception of simulations in developing skills required for working in hospital settings. Following the training day, the participants attended a focus group to discuss their perspectives of the simulation and its efficacy. Additionally, students who had hospital clinical placements within one month and three months following training participated in an early placement feedback group and a delayed

placement feedback group respectively. Appropriate statistical analyses revealed students' self-ratings of confidence, preparedness and knowledge had significantly increased. Students attributed these improvements to the training day up to three months post-simulation.

The pre-training and post-training questionnaire and focus group questions used in the study are unstandardized and unvalidated, therefore, reducing the impact of the findings. The surveys measured students' self-reported perceptions of improvement but did not evaluate clinical reasoning or skill acquisition. As such, the study could be improved through validation and reliability of survey measures, as well as inclusion of assessment of clinical competencies pre- and post-simulation.

This study offers highly suggestive evidence of a long-lasting benefit and/or retention of clinical skills and confidence obtained through simulation training. However, the findings of this study must be interpreted with caution due to methodological limitations relating to equivocal validity and reliability.

Ward et al. (2015) examined if participating in a human patient simulation (HPS) tutorial was associated with improvements in anxiety, confidence, clinical skills and clinical readiness compared to only academic curriculum. First-year SLP students completed academic lectures in their mandatory dysphagia course and then participated in two HPS tutorials related to pediatric dysphagia management. Students' perceptions of their knowledge, skills, confidence, and levels of anxiety were assessed using a survey pre-lectures, post-lectures, but pre-HPS and post-HPS. Eight months later, students completed a survey about the usefulness of the simulation. Appropriate statistical analyses revealed that students reported significant enhancements in their knowledge, skills and confidence in pediatric dysphagia management and significant reductions in anxiety working with this patient population. Students continued to value the HPS and felt it positively contributed to their preparation for clinical practice.

The authors provided a thorough rationale for the study and clearly described the methodology and outcome measures for future replications. No inclusion criteria were included, but the results for the students with previous experience with simulation, children or pediatric management were examined separately and did not differ from the other participants. As well, no control group was included, which limits the interpretation that students' positive perceptions arose from the HPS alone. The first three surveys have the same core questions, which supports comparison of change over time. However, the survey questions and statements were positively worded, which may have artificially inflated the students' agreement with the statements. As well, the study measured student perception, which does not indicate actual clinical competency attainment.

Due to limitations, such as lack of a control group and leading questions, this study offers suggestive support for the benefits of simulations perceived by SLP students.

Single Group Studies

Hill et al. (2013) examined undergraduate and graduate students' perceptions related to their skills, confidence and anxiety before and after participating in a simulation program and the usefulness of the program. Given the scope of this review, only graduate student results will be discussed, but this does not pose an issue to the quality of the review as the authors reported and interpreted the results for the populations separately. Graduate students attended six sessions to practice various clinical skills with a simulated patient and completed a pre-clinic survey and post-clinic survey. Appropriate descriptive statistics revealed that graduate students' confidence significantly increased, their anxiety decreased, but not significantly and students evaluated the simulation program positively.

Pre-clinic and post-clinic surveys were based on an unvalidated survey from previous research, which limits the ability to interpret and generalize the study findings. Furthermore, the surveys did not use the same core questions, which would have allowed for more accurate comparison of perceptions over time. Positive responses may be overestimated in the results because the post-clinic questions were phrased positively and both surveys lacked a neutral option in the ordinal scale. The surveys measured students' self-reported improvement, but this does not equate to an objective improvement in competency. Moreover, a control group doing traditional learning was not included to establish the contribution of the simulation to developing clinical skills.

This study offers equivocal validity and reliability due to methodological limitations, which undermines its clinical importance.

Miles et al. (2016) investigated SLP and dietetics students' perceptions of hospital preparedness, and interprofessional clinical reasoning, before and after participating in dysphagia simulation-based training. Students' perception of the simulation and clinical

knowledge following training was investigated as well. Students participated in two-half day training simulations, which included part-task skill learning and immersive simulated scenarios. Prior to and immediately following the simulation, students completed a 10-point Likert scale survey exploring perceived confidence, knowledge, and hospital readiness. Additionally, students completed three 15-minute written clinical vignettes to evaluate interprofessional competencies one month prior to the simulation, the day before the simulation training, and immediately following the second day of training. Appropriate statistical analysis revealed students' self-ratings of confidence, preparedness, and knowledge had significantly increased. Overall scores on clinical vignettes across the three time points also significantly increased, with no statistical difference in performance between SLP and dietetics students.

Strengths of this study include the use of expert practitioners to develop an appropriate interprofessional education marking rubric and their use of blind raters to score written clinical vignettes. Additionally, inter-rater reliability across experts was considerable (intraclass correlation coefficient .67), thereby increasing the validity of the findings. However, neither the marking rubric, nor the pre- and post-training questionnaire were standardized or validated. Therefore, reducing the impact of the study's conclusions. Another limitation of the study is its lack of investigation into interprofessional clinical competency. Despite the use of written vignettes to assess clinical knowledge in this study, there was no assessment of clinical interprofessional competency pre- or post-simulation training.

Overall, this study offers suggestive evidence for the benefit of interprofessional simulation-based training in developing clinical reasoning skills and improved hospital readiness in allied health graduate students.

Case Series Study

Stead et al. (2020) explored student perceptions of the benefits provided by four different simulated learning experiences in medical SLP curriculum. The first two simulations utilized task trainer simulations with mannequins to develop procedural skills in first year graduate students. The final two simulations employed simulated patients to develop clinical critical thinking and adaptability in second year graduate students. The outcomes evaluated in each simulation varied slightly, but each case assessed students' perceptions of confidence, knowledge and/or skills using an optional survey and predetermined learning objectives. Appropriate statistical measures and analyses were employed. Overall, students reported improvements in confidence, knowledge and skill development.

A strength of this study is the comprehensive description of the procedures, learning objectives, and outcome measures of each case study, such that the methodology was well understood and could be replicated. However, the small sample size and limited number of students who completed post-training surveys limits the statistical power of the study. Furthermore, the study was conducted at one university reducing the generalizability of the findings.

This study provides compelling evidence for the integration of simulations in medical SLP curriculum, as supported by student's perceptions of improved clinical competency, confidence, and skill development.

Discussion

Collectively, these studies suggest that graduate SLP students perceive simulations to increase their confidence, knowledge and skills in various populations and areas of practice. Moreover, they value the contribution of simulations to enhance their learning. The majority of the studies in this review focused on SLP students' perceptions and reflections following simulation experiences, which is valuable as it can better inform curriculum development and refine learning opportunities. However, it is equally important for evidence about simulations to demonstrate objective enhancements of the clinical skills that students perceive as improving through simulations. Perceptions of increased confidence can help students become more self-sufficient and prepared in clinical contexts, but overinflated perceptions of technical knowledge and skills that are not equivalent to substantiated improvements can negatively affect client outcomes.

Additional limitations pervasive throughout the literature are primarily related to methodology. For one, many studies have small sample sizes consisting of a student cohort from one university, which limits the generalizability of the results. The ability to generalize the results is further challenged by limited information regarding participant demographics and the use of unstandardized measures that are not validated. Beyond the research, there are also barriers to integrating simulations into clinical education from an institutional standpoint. These barriers include limited availability of resources and educators' limited knowledge and skills in facilitating simulations. Limited resources include funding for development of simulations, equipment, and personnel, as well as time for personnel training. For simulations to support clinical competency development, educators require education and training

to become proficient and effective facilitators (Dudding and Nottingham, 2018; MacBean et al., 2013).

Although the challenges to integration require consideration by stakeholders, the literature in this area is progressing through ongoing quality improvement. The most recent literature evaluated in this critical review accounts for many of the limitations previously mentioned. For instance, the studies by Hill et al. (2020) and Stead et al. (2020) use rigorous methodology that takes many of the aforementioned limitations into consideration. Moreover, both demonstrate compelling evidence for developing clinical competencies in a simulation, compared to traditional clinical experiences.

Future Research

It is recommended that further research be conducted to strengthen the evidence for use of simulations as means for students to learn and develop clinical competencies for entry to practice. To this end, the following recommendations may be considered:

a) Conduct studies with a control group to compare student outcomes with simulation and traditional placement only.
b) Use standardized tools that are validated and reliable to measure outcomes and support comparisons across time and groups.
c) Evaluate acquisition of clinical competencies using standardized behavioural or technical criteria.
d) Use probability sampling methods to minimize bias and improve generalizability of results.
e) Investigate the processes and parameters that constitute a successful simulation (e.g. timing, sequence, duration, etc.) to develop a framework for implementing simulations.
f) Explore the effectiveness of the types of simulations in various clinical areas and populations to establish the most effective simulation for a particular disorder area or population.

Clinical Implications

Clinical education is essential to the training of SLPs, but there are growing challenges to acquire sufficient traditional placements. The literature examined in this critical review does not provide sufficient evidence that simulations objectively improve SLP student clinical competency in order to recommend integration of simulation-based learning yet. However, the evidence indicates that simulations are a promising clinical teaching model to support the development of clinical competencies and may be used to supplement time in traditional placements. Additionally, the results help inform the direction for future research in order to elucidate the true benefits and best practices for simulation-based learning.

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