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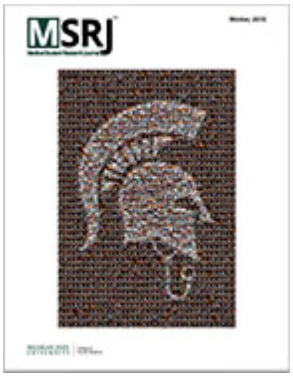

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Just like the simulations: Improving medical student confidence with simulated emergency medicine scenarios

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ABSTRACT

Background: Incoming emergency medicine residents may feel unsure of their ability to handle common emergency department scenarios, even if they are well educated on the proper steps to take in those scenarios. This may not stem from a lack of skill so much as a lack of confidence in their ability to perform with skills they have. **Objective**: We look to establish a link between completion of simulation-based training in common emergency medicine scenarios and learner self-reported confidence in their ability to perform competently in those scenarios. **Methods**: Fourth-year medical students who matched into an emergency medicine residency program participated in a Transitional Educational Program (TEP) at the Interprofessional Immersive Simulation Center at the University of Toledo in April 2021. Simulations of 16 procedural skills and clinical judgement cases were carried out using high-fidelity mannequins and real medical equipment in a hospital-based setting. Subjects were given pre- and post-TEP survey questionnaires assessing their self-reported confidence to competently perform in common emergency medicine clinical scenarios, using a 5-grade Likert scale. Data was analyzed using a one-tailed Wilcoxon signed-rank matched-pairs test. **Results**: Of 19 participating subjects, 16 (84.2%) consented and responded to the pre-survey. Of those 16 subjects, 10 (62.5%) completed the surveys at the correct time and order. The pre- and post- surveys consisted of the same 14 questions. In 11 of 14 survey questions, there was a significant increase in subject self-reported confidence ($p<.05$) between pre- and post-survey. **Conclusions**: Simulation-based training in the setting of high-fidelity equipment and faculty guidance improved the self-reported confidence of incoming emergency medicine residents to perform in common emergency medicine scenarios.

Introduction:

Real-world clinical situations can be daunting for both medical students and residents. While clinical experience is a vital part of medical school and residency curricula, beginning learners of both levels may not feel confident in their ability to manage the clinical scenarios that they will face on these rotations.[1] Most medical students entering clinical education will have just completed several years of preclinical work, in which they learned about the foundations of medicine mostly through reading and attending lectures. Though incoming first-year residents have completed their medical school clinical rotations, they are quickly transitioning from those curated, supervised clinical experiences to real-world clinical scenarios in which they will be the primary decision makers in patients' medical care. While the preclinical and pre-residency education undertaken by these learners provides the groundwork for clinical competency, it does not always directly translate to clinical ability. For example, even though a first-year resident might know the proper steps for many various procedures or exams indicated in a trauma patient, they may lack confidence in their ability to adequately perform these steps in a real clinical setting, and thus can still "freeze up" and find themselves unable to perform when needed. One way that medical education has evolved to help learners better navigate the transition to real-world clinical practice is through the use of simulations.

Several studies cited below have shown proof of concept for the ability of simulation-based educational programs to increase the self-reported confidence of medical students and incoming residents in their ability to perform emergency medicine procedures and make clinical decisions. However, available literature did not provide a standardized version of simulation-based education; variations in simulation programs include the use of mannequins, standardized patients, computer-based scenarios, replica equipment, and more. Several studies identified advantages to using the most lifelike equipment available, while also eliminating any risk to real or standardized patients as learners complete the simulated procedures.[2–4] Therefore, our investigation explores specifically the use of a transitional education program (TEP) consisting of high-fidelity mannequin human patient simulators and real clinical

equipment, taking place in a hospital-based simulation setting. The TEP was led by faculty in the Department of Emergency Medicine at the University of Toledo College of Medicine and Life Sciences, and was aided by other trained medical staff employed by the university. As the focus of this study is emergency medicine procedures, we restricted our subject population to graduating fourth-year medical students who had matched into an emergency medicine residency program that same year.

Our study investigates the use of simulation-based education for fourth-year medical students and assesses their self-reported confidence levels through scaled surveys both before and after they perform in the role of a first-year emergency medicine resident in several simulated clinical scenarios. Our primary outcome measure is the change in self-reported confidence measured by the Likert scale described below, with higher scores indicating higher confidence in each respective clinical scenario. We hypothesize that the use of simulation-based training will have a positive effect on self-reported confidence levels in this cohort's ability to perform the simulated procedures in real-world clinical practice. We hope to add to the available body of literature regarding simulation use in medical education, with an emphasis on self-reported confidence levels as an important factor alongside competence in evaluating medical learners' ability to perform in clinical scenarios.

Methods

Settings and Participants: The Transitional Educational Program (TEP) was held in April 2021 at the Interprofessional Immersive Simulation Center, a state-of-the-art facility at the University of Toledo Health Science Campus with capabilities including high-fidelity mannequins, advanced clinical simulations, virtual reality, and anatomy/surgical skills training. The TEP was designed by teaching and clinical faculty of both the Department of Graduate Medical Education and the Department of Emergency Medicine at the University of Toledo College of Medicine and Life Sciences. All designing and participating faculty had at least 5 years of experience, with most eclipsing 10 years. Participants in the TEP consisted of 19 fourth year medical students (M4s) who matched into an emergency medicine (EM) residency program and planned to enroll as a first-year resident upon graduation from medical school. The subjects volunteered to participate in the TEP by responding to an email sent to the several weeks prior to the event. The faculty and staff that conducted the TEP were all involved with the Department of Emergency Medicine or the Department of Graduate Medical Education at The University of Toledo College of Medicine and Life Sciences (UTCOMLS). Each subject received the intervention (attended the TEP) and self-reported confidence in ability to perform each procedure was assessed before and after the intervention.

Interventions: To better prepare graduating medical students for their intern year in the emergency medicine setting, the TEP was designed with 10 simulations of common emergency medicine skills, six simulations of common patient cases requiring rapid clinical judgement, and several structured and unstructured discussions with EM faculty and residents (**Figure 1**) (**Appendix A)**. The schedule of events was assembled after discussions with many medical students, residents, and faculty at UTCOMLS, who collectively identified the listed topics as areas in which first-year residents had a high potential to feel underprepared or unsure of their abilities.

Before the program started at 8:00am, subjects were asked to complete the pre-survey individually. Subjects were then put into small groups of two to four and were randomly placed into one of the six morning session activities (three skill simulations and three case simulations). Subject groups spent 30 minutes at each station, including a briefing and debriefing before and after each simulation. After the station time had elapsed, subject groups rotated to the next station. This process repeated until all morning session stations were completed. There was a 1-hour lunch break between the morning sessions and the afternoon sessions. The afternoon session was completed in the same manner as the morning session. After the TEP was finished, students who completed the pre-survey were asked to complete the post-survey.

Morning Sessions (8 AM - 12 PM)	Afternoon Sessions (1 PM - 5 PM)
Cases: Cardiac Pacing Airway: CHF or Asthma Trauma: ACLS	**Cases:** GI Bleed AMS: Hypoglycemia Stroke: Hemorrhagic vs. Ischemic
Skills: Placement: IO Splint Chest Tube Pigtail Suturing Lumbar Puncture	**Skills:** Urgent Airway: Intubation Emergent Airway: Cricothyroidotomy Sick vs. Non-sick: Identification Picking the Right Medication
3rd Year Clinical Horror Stories	**Q&A with Residents & Faculty**

Figure 1: TEP Schedule

Outcomes measured: To assess the impact of the TEP on M4 self-reported confidence in the EM setting, this study used a descriptive pre/post survey design, with the pre-survey given immediately prior to the simulations program and the post-survey given immediately after the program was completed. The study survey consisted of 14 statements asserting confidence in various EM procedures (all of which would later be topics covered in a simulation during the TEP), and subjects were asked to indicate their level of agreement with each statement on a standard 5-grade Likert scale (1= strongly disagree, 2= disagree, 3=

undecided, 4= agree, 5= strongly agree) **(Appendix B)**. These survey questions were designed according to guidelines proposed by Nemoto and Beglar (2013).[5] The pre-survey included the informed consent agreement, three demographic questions, the study survey, and a field for the entry of a unique 4-digit PIN that would be used to link pre- and post-survey responses to an individual without the need to collect any other identifiers. The post-survey included the PIN field, the study survey, and another 8-item survey (the secondary survey). The secondary survey asked the subjects to indicate their level of agreement, on the same 5-grade Likert scale used in the primary survey, with statements about the usefulness of simulations as an education tool, their perception of how closely the simulations matched real clinical scenarios that they had experienced, and their satisfaction with the TEP.

The pre-survey was made available at 9:30pm the night before the start of the TEP, and submissions were accepted until the program started at 8:05am. The post-survey was made available at completion of the TEP, and submissions were accepted for 10 days; this longer window was used to allow subjects adequate time for survey completion during a very busy time at the end of their medical school careers. Both surveys were administered with Microsoft Office Forms and sent to the subjects' personal email addresses. Likert score data from each survey was exported from Office Forms, linked by PIN, and analyzed using Microsoft Excel. Data was only accepted for analysis if: (1) the pre-survey was completed before the start of the TEP (8:05am on 4/6/2021), and (2) there was both a pre- and post- survey linked to the same PIN.

The primary outcome of this study is the measured change in self-reported confidence in subjects' ability to adequately perform in each situation that was covered in the TEP simulations, with a secondary outcome of the measure of participants' opinions on the effectiveness of simulations in medical education.

Analysis of Outcomes: Pre-TEP and post-TEP survey responses (n=10) were analyzed using a one-tailed Wilcoxon signed-rank matched-pairs test.[6] Statistical significance was determined with a p-value of 0.05

and a critical value of 10, as per the critical value table computed by McCornack (1965).[7] The secondary survey regarding simulation effectiveness in medical education was assessed for general positive or negative responses to each question by assigning numerical values to the Likert scale responses (-2= strongly disagree, -1= disagree, 0= undecided, 1= agree, 2= strongly agree) and calculating average values for each question and each subject response.

IRB Statement: This study was approved as an IRB-exempt study by the University of Toledo Institutional Review Board.

Results

The study population was composed of fourth-year medical students at the University of Toledo who had matched into an EM residency program beginning after graduation. The TEP was advertised to all EM residency-matched students via email, and 19 signed up to attend the program. Of these 19 participants, 16 responded to the pre-survey and informed consent (84.2%). Of those 16 consenting subjects, 10 (62.5%) completed surveys at the correct times and used a PIN that linked a pre-survey response to a post-survey response, for a final study sample of 52.6% (10/19) of the available population. These 10 primary survey pairs comprised the analyzed data set (**Table 1, Table 2**).

Demographics					
What is your level of training?	M4 (10)	Other (0)			
What gender do you identify with?	Man (6)	Woman (4)	Other (0)		
What is your age?	21-25 (3)	26-30 (6)	31-35 (0)	36-40 (0)	40+ (1)

Table 1. Demographic questions and responses given by the 10 study subjects.

Survey Question	Q#	Survey	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I feel confident in my ability to manage an emergent airway, e.g. performing a cricothyrotomy	Q1	Pre	1	4	3	2	0
		Post	0	1	0	7	2
I feel confident in my ability to manage a urgent airway, e.g. intubation	Q2	Pre	0	2	1	7	0
		Post	0	1	0	3	6
I feel confident in my ability to provide ACLS care	Q3	Pre	0	1	2	7	0
		Post	0	1	0	4	5
I feel confident in my ability to place a splint	Q4	Pre	0	4	3	3	0
		Post	0	2	1	7	0
I feel confident in my ability to place an intraosseus line	Q5	Pre	0	3	3	3	1
		Post	0	1	1	6	2
I feel confident in my ability to effectively manage patient situations involving opioids	Q6	Pre	0	5	3	2	0
		Post	0	1	2	7	0
I feel confident in my ability to place a chest tube	Q7	Pre	2	5	3	0	0
		Post	0	1	1	7	1
I feel confident in my ability to place a pigtail catheter	Q8	Pre	1	6	3	0	0
		Post	0	1	4	5	0
I feel confident in my ability to suture a wound	Q9	Pre	0	1	1	6	2
		Post	0	1	0	2	7
I feel confident in my ability to perform a lumbar puncture	Q10	Pre	1	8	1	0	0
		Post	0	1	2	7	0
I feel confident in my ability to effectively manage a patient with an altered mental status	Q11	Pre	0	2	6	2	0
		Post	0	1	0	7	2
I feel confident in my ability to effectively manage a patient with a GI bleed	Q12	Pre	1	1	5	3	0
		Post	0	2	0	8	0
I feel confident in my ability to manage a stroke patient	Q13	Pre	1	1	4	4	0
		Post	0	2	0	7	1
I feel confident in my ability to identify patients that are truly sick in the ED setting	Q14	Pre	1	1	4	3	1
		Post	0	2	0	5	3

Table 2. Primary survey questions and responses, grouped by question and timing (whether pre- or post-survey). *GI: gastrointestinal; ED: emergency department.*

Secondary Survey Question	Q#	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Simulations are an effective method of training in general	1	0	0	1	2	10
Simulations are a productive way of learning how to respond to common patient presentations in emergency medicine	2	0	0	1	3	9
I was able to work with colleagues successfully during the simulations	3	0	0	1	1	11
I was able to practice the technique of each skill during the simulations	4	0	1	1	5	6
In my experience, these simulations were similar to responding to these patient presentations in a clinical setting	5	0	0	3	8	2
I was given ample opportunity for questions during the simulations	6	0	0	1	3	9
I felt that feedback given during the simulations was constructive and meaningful	7	0	0	1	3	9
Overall, I personally feel more confident in my ability to respond to these patient presentations after simulation training	8	0	0	1	2	10

Table 3. Secondary survey questions and responses, grouped by question.

Of the 14 questions on the primary survey, 11 showed a significant increase in subject self-reported confidence after the TEP (**Figure 2**). Notably, the pre-survey had 4 total "Strongly Agree" responses, and the post-survey had 29, an increase of over 7-fold. Similarly, the pre-survey had 8 total "Strongly Disagree" responses, where the post-survey did not have any.

The secondary survey yielded generally positive subject responses for each question (range 0.92-1.76) as well as generally positive responses by each subject across the survey (range 0-2), indicating the subjects generally supported the effectiveness of simulations as an educational tool (average overall score 1.52) (**Table 3).** Secondary survey responses for all 13 subjects that completed the post-survey were included, regardless of pre-survey completion status or PIN linking the post-survey to a completed pre-survey, because the secondary survey was only present on the post-survey and thus did not require comparison to pre-survey responses.

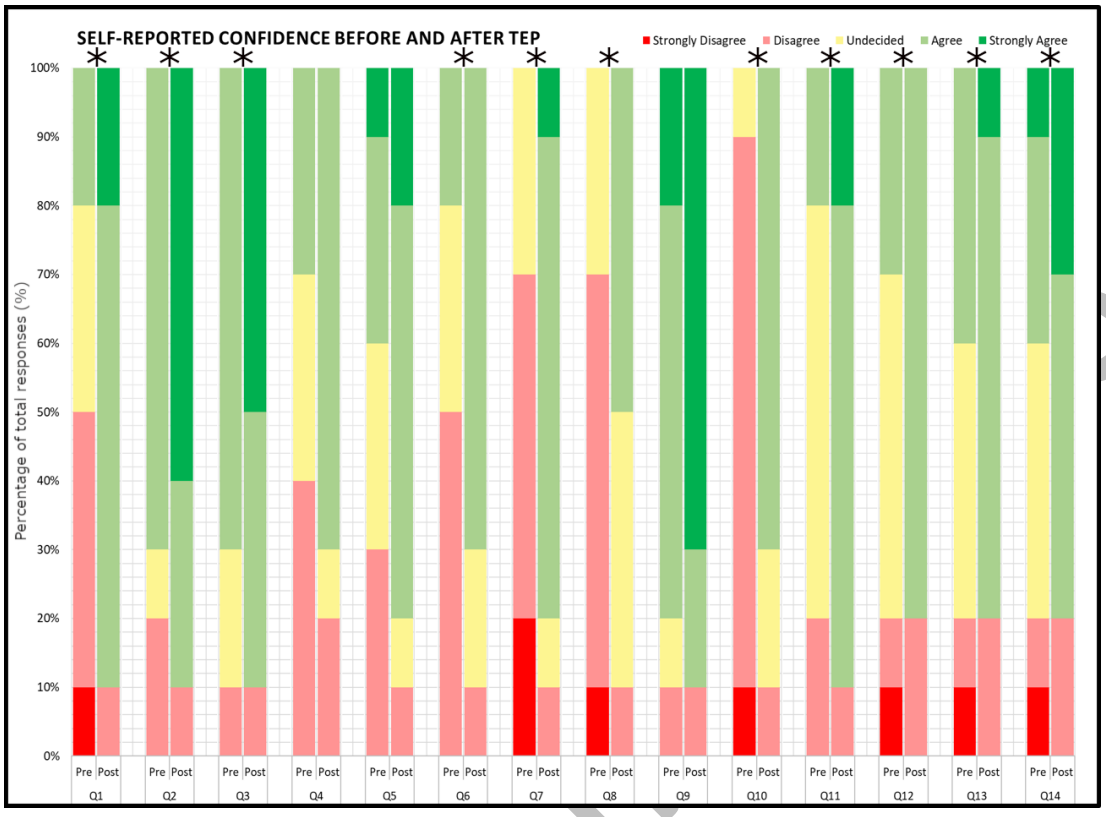

Figure 2. Results grouped by question.

Pre-survey responses are on the left and post-survey responses are on the right; a star above a question column indicates a statistically significant increase in subject self-reported confidence from the pre-survey to the post-survey. The y-axis depicts the total responses, and each color band represents the percentage of total responses comprised by the corresponding response choice for each question.

*TEP: transitional education program. *: statistically significant, p<.05.*

Discussion

This study found a statistically significant increase in subject self-reported confidence to competently perform procedures and make clinical decisions common to emergency medicine after participating in simulated versions of those procedures and cases. These simulations closely mirror real-world procedures, and require many technical and management skills that first year residents are expected to perform. The results from this study support the growing trend found in medical education literature indicating some modality of simulation is beneficial in the training of medical students and residents - especially for those transitioning into real world clinical practice.[8–16] This study focused on those about to enter an emergency medicine residency program, but there are several other documented studies where the use of simulation has positively impacted the confidence of a broader range of students.[3,4,17–20]

Simulation has been established as a successful, evidence-based tool in medical education for several decades.[8,21] Simulation use in emergency medicine education - both in medical schools and residency programs – has become widespread in the last 20 years. Okuda et al. (2008) found that 91% of U.S. emergency medicine residency programs reported using some form of simulation in 2008, and other studies show even more "boot camp"-style (defined as an early preparatory course or orientation sessions for learners undergoing a transition in medical education) simulation sessions are being developed at schools and residency programs across North America each year.[9–11,22,23]

The efficacy of simulation in medical education as a tool to facilitate *competency* in clinical skills is well supported in current literature.[8–11,21] However, studies assessing subject *confidence* in one's ability to perform procedures or make decisions in real-world clinical settings are substantially less prevalent in the current available literature. Okuda et al. (2009) extensively aggregated evidence for the usefulness of simulations in several specific medical specialties, though their findings for emergency medicine focused more on competence in crew resource management and acute care team protocols, rather than self-reported confidence in ability to independently perform procedures or make clinical decisions.[2] Gottleib

(2022) thoroughly investigated the link between self-reported confidence and competence in learners, and advocated for evaluation methods that consider both qualities simultaneously when assessing medical professionals' ability to perform tasks.[24]

Literature covering the correlation between subject confidence and simulation-based education in emergency medicine scenarios was severely lacking; however, several published studies supported a positive relationship between simulation-based education and subject confidence in specific medical skills or in other areas of healthcare. Bowers et al. (2020) found that the comfort and confidence level of third and fourth year medical students increased after they participated in an advanced cardiac life support simulation training.[17] In a multi-specialty simulation-based course, Dermody et al. (2020) observed that a majority of a cohort of 30 medical students had an increased confidence in their skills.[18] Biron et al. (2013) observed that knowledge, skill, and confidence level increased between pre-session and post-session questionnaires and assessments in a cohort of 120 medical students participating in a multi-sensory cricothyrotomy educational experience.[12] Morgan and Cleave-Hogg (2002) demonstrated an increase in subject confidence in a population of 144 final-year medical students upon participation in several simulated anesthesia procedures.[25] Sattler et al. (2020) found an increase in self-reported confidence in a population of internal medicine residents upon completion of a simulation course covering six invasive bedside procedures.[13]

Several studies, including this one, have used mainly self-reported perceived changes in their studied outcomes. Therefore, the role of simulations as an objective improvement tool in medical education is still unclear. A proposed solution to this limitation is a longitudinal approach assessing both competence and confidence, where students perform in these simulated scenarios across several sessions, studying both long-term retention and self-reported confidence in these skills, as well as objective measures of performance improvement in these skills. Other potential sources of bias in this study are the possibilities of central tendency bias in survey responses and observer bias during simulation sessions. The subjects were aware that they were part of a study investigating the effectiveness of simulations in

education, creating some degree of bias in their responses. Central tendency bias is the tendency for subjects to avoid the extremes of a rating scale, e.g., subjects avoiding the "strongly agree" and "strongly disagree" choices on the Likert scale in the study survey used here. Though this bias was likely present, its effect was unlikely to significantly sway results, and it has been argued to be closer to a data pattern than a bias.[26] Furthermore, simulations in general may be prone to some degree of inherent observer effect; participants are aware that there are likely no real consequences to failure, or at least none as severe as would be present in real-world scenarios, and therefore might not make the same decisions or actions in a simulation that they would in the real world. As the technology underlying simulations advances, future studies might be able to simulate real-world scenarios even more accurately through the addition of virtual reality or related innovations, providing a more immersive experience and potentially an observer bias.

The secondary survey was included to gather general feedback about the TEP to identify subject perceived areas of strength and weakness in the TEP, which will serve to refine its implementation for future classes. Secondary survey responses indicated a generally positive perception of the use of simulation in medical education, which is consistent with prior studies.[2] The non-simulation sessions in the TEP, consisting of 3rd year clinical horror stories and Q&A sessions with residents and faculty, may have affected subject self-reported confidence as well. While these sessions were not focused on directly practicing a specific skill in a simulated scenario and thus were not addressed in the study surveys, they may have served to ease subject anxiety by establishing a sense of rapport and camaraderie between students and residents or faculty. The designers of the TEP wanted to include these sessions for student benefit but there is no good way to test the impact these sessions may have had on primary and secondary survey data, and thus we want to acknowledge these sessions as potential confounders.

One limitation in our study is the small sample size of 10 subjects - a result of sampling only UTCOMLS students that had already matched into emergency medicine residency programs. Additionally, not every student in the study population participated or followed study procedures

properly, which invalidated several survey responses and reduced our study sample. One way to increase the statistical power of this study would be to replicate the TEP annually with students in each year's graduating class, and aggregate data to generate a larger sample size. We plan to employ this plan for the next several years, and plan to incorporate more measurable outcomes in future manuscripts.

Conclusion

Despite the small number of subjects in this study, we found a significant correlation between participation in simulated emergency medicine procedures and cases and student self-reported confidence in performing competently in those scenarios. The study also found a strongly positive opinion held by subjects regarding the effectiveness of simulations as an educational tool. This study supports current literature citing the educational and self-reported confidence benefits of participating in simulated medical procedures, particularly when using advanced high-fidelity simulation technology. We advocate for the use of simulations in medical education and training, especially for graduating students transitioning into the first year of emergency medicine residency programs.

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