SSH Society for Simulation in Healthcare — STORM

Simulation Technology & Operations Resource Magazine (STORM)

STORM highlights exemplary work contributing to the advancement of healthcare simulation operations. All submissions are peer reviewed before publication in the STORM special edition of the SSH Simulation Spotlight. With articles covering training, policy & procedure, emerging technologies, and professional development, STORM has everything needed to stay current and well-rounded in the pursuit of simulation operations excellence!

CONTENTS

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Letter from the Editor in Chief

Welcome to the new STORM!

To all those who design, manage, and implement healthcare simulation technologies, I am excited to present the first issue of Simulation Technology & Operations Resource Magazine (STORM).

Since becoming Editor-in-Chief a year ago, surrounded by an exceptional board of multidisciplinary experts, I have been astounded by the great progress made in bringing this much needed resource to fruition. With support from the Society for Simulation in Healthcare (SSH), we were able to quickly develop our guiding principles and submission process, which we believe best represent the field of healthcare simulation operations.

Simulating the healthcare experience is wrought with the operational challenge of standardizing how we utilize new and existing technologies to ensure the achievement of learning objectives. Although standards can be found in existing resources such as in the SSH accreditation materials, there remains significant differences between one simulation operation to the next.

However, I believe those tasked with managing the operational components of simulation are the true constant between not only different programs, but from one individual activity to the next. They are the common link between educators, learners, and numerous vendors, working effortlessly to bring technologies to life. Simulation Operations Specialists (SOS) must be recognized and embraced by their organizations as essential components in developing high quality simulations. They should also be empowered to develop best practices that follow quality improvement processes; practices that can be shared and modeled within and between programs. STORM provides an outlet for that recognition and empowerment.

As a peer reviewed electronic journal, STORM will feature exemplary work and is a place to present newly developed, robust methods for easy adoption at your home institution. Not only that, STORM will push the boundaries of what it means to be an SOS by communicating operational ideas that go beyond manikins, task trainers, and other technologies.

STORM will encourage every SOS to expand their value into the programmatic elements of a simulation operation by providing a new lens through which to view and grow the educational impact of simulation.

Ultimately, patient safety is at the heart of everything we do, and the SOS's keep that heart pumping. The more we define and standardize operational methods, focus on measurable learning objectives, and evaluate the fidelity of simulation technology, the more we can narrow the gap between simulated and clinical healthcare environments.

David Biffar, MS, CHSOS-A
STORM Editor-in-Chief

Development of a Cost-Effective Simulation-Based Central Line Task Trainer

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Brief Description / Abstract:

Simulation-based central venous catheter insertion training has been well established in the literature. This training modality has been associated with reduction in overall central line associated blood stream infections (CLABSIs) and positive return on investment. Unfortunately, commercial central line trainers and consumable products require a significant capital investment and can be cost-prohibitive for organizations planning widespread implementation of simulation- based central venous catheter insertion training. A novel central venous catheter insertion task trainer was developed to address this barrier. Practicing physicians and advanced practice providers participated in simulation-based central venous catheter insertion training using both the commercial task trainer and the novel task trainer. Participants were surveyed regarding their confidence, skill, and knowledge of central venous catheter insertion pre- and post-training using both the commercial task trainer and the novel, more cost- effective task trainer created in house. Participants reported equivalent improvement in confidence, skill, and knowledge related to central venous catheter insertion using both the commercial and novel central venous catheter insertion simulation task trainers. The novel, central venous catheter insertion simulation task trainer is a replicable, more economically efficient alternative to a commercial task trainer for simulation-based clinician central venous catheter insertion training.

Introduction

The medical world is one of continuous progression, development, evolution, and transformation. Procedural training can be a costly investment for institutions.

Internal jugular (IJ) line is an important venous access that is placed to help manage many medical conditions. Traditionally this procedure is taught using anatomical landmarks for guiding the needle insertion. This technique has disadvantages because it relies on the assumption that the patient has ideal anatomy. Complications with the landmark approach are higher such as inadvertent arterial puncture, pneumothorax, and nerve injuries. Presently, the availability of ultrasound imaging equipment has made the use of this technology a standard when performing these procedures. It is essential that a physician develop the necessary skills to proficiently place the IJ line and observe methods which reduce serious complications. However, mastering this skill requires practice. This practice can be performed via simulation-based training and task trainers. Simulation-based training and task trainers are a means by which providers can perform certain tasks, for which high competence is critical, in a patient-free and repetitious environment. One of such tasks is the insertion of a central venous catheter.

Reproducing this clinical experience as cost-effectively as possible permits providers to gain invaluable repetitions in a patient-free environment while preserving budget integrity.

The availability of task trainers is expansive for the placement of central venous catheter (CVC) or central line catheter (CLC). These task trainers are highly available and have proven their value.[1] While highly available, accessibility may be low; these task trainers can be cost-prohibitive, and this cost-prohibitive concern raises the need for a novel central venous catheter insertion task trainer that is effectual and cost-effective.

Related literature explores the concept of novel task trainers and their effect on training programs in recent years. Nitsche et al. identified the opportunity for a more cost-effective ultrasoundable task trainer for ultrasound-guided invasive procedures.[2] Results favored the economical novel task trainer.[2] Several central venous catheter and arterial line insertion and management task trainers have been produced and tested for efficacy, also with favorable results.[3-5]

A trend in the literature suggests a recurring need for “novel” and “low-cost” task trainers to get the job done. These motivators have driven other institutions to perform similar studies in hopes of achieving non-inferior outcomes.[6] Unfortunately a gap in literature still exists with regard to a generalizable study evaluating novel, low-cost task trainers; some suggest the respective task trainer simply “shows promise” and will likely require further research.[7] Chin et al. sought to validate the utility of their trainer with less emphasis on its novelty and financial partiality.[8] Their study showed a statistically significant difference between pre-intervention and post- intervention confidence.[8]

Others, however, seek to achieve the novelty of the task trainer but have little to no interest, or at least secondary interest, in the cost of production or its subsequent savings. Lichtenberger et al. and Park et al. have developed novel task trainers without attention to cost-effectiveness.[9,10] As technology and medicine advance in unison, one method of production is described in today’s world as “additive manufacturing” or “3D-printing.” This innovative means of production is turning heads, and with the knowledge to utilize it, researchers can produce various tools for training that tailor to many different areas of medicine.[9] While minimizing cost may not be the primary motivator for some researchers, it is certainly achievable with this modern method.[9] In the realm of 3D-printing, some researchers have increased accessibility to these tools with “negligible costs.” [10]

The goal of this study is to evaluate a low-cost central line trainer created in the Mirro Advanced Medical Simulation Lab as a cost-effective solution to implement widespread central line training within the health system. This will also serve to compare a novel simulation-based training to commercial training for central line insertion on participant confidence, skill, and knowledge.

Methods

Practicing physicians and advanced practice providers participated in simulation-based central venous catheter insertion training using both the commercial task trainer and the novel task trainer. Participants were surveyed regarding their confidence, skill, and knowledge of central venous catheter insertion pre- and post-training using both the commercial task trainer and the novel, more cost- effective task trainer created in house.

A non-inferiority analysis was undertaken to demonstrate that the new Advanced Medical Simulation Lab (AMSL) training was no worse than the commercial training. Thus, this analysis uses a one-sided test with a pre-specified minimum value, above which the AMSL training was considered not inferior to the commercial training. This minimum value of score improvement for AMSL training from pre- to post-assessment was expected to be within 0.5 points (within 10% on a 5-point scale) compared to the commercial training improvement. Paired t-tests were conducted between pre- and post-assessments scores to test that both training programs were effective.

Additionally, a mixed effects generalized linear model estimated the effect of the training program on scores, adjusted for patient baseline score, time and training condition.

Surveys

A within-subjects design was employed: each participant received both types of training. Items assessing confidence, skill, and knowledge were averaged for the pre-assessment and post- assessment administrations. Descriptive statistics were calculated for all measures.

Participants were asked to complete pre- and post-assessments to evaluate their level of comfort in the procedure and overall satisfaction whilst using these task trainers. The questionnaire (Figure 4) contains these two sections, each built to assess one or the other.

The first section asks participants to disclose their level of agreeance/agreement with the following statements: I feel confident in performing the procedure in my practice; My skill in performing the procedure is adequate; My knowledge of the procedure is adequate. The section asks participants to disclose their level of agreeance/agreement with the following statements: The instructor was knowledgeable about the procedure; The task trainer was realistic; The task trainer was easy to use; I had sufficient time to practice with the task trainer; The necessary equipment and tools for the indicated procedure were provided; I would recommend using this task trainer to a colleague or coworker.

Finally, participants are provided the opportunity to offer comments, feedback, and thoughts of prospective trainers that they would like to see offered.

Production Components

The Mirro Internal Jugular Line Trainer (Figure 3) provides an alternative option to live model practice by providing a system which replicates all the characteristics of a live model. Real tissue characteristics, laminar venous, and pulsatile carotid flow are recreated thus providing a realistic training environment. This novel task trainer was produced using the resources itemized in “Bill of Material” (Table 1).

The neck is the main component of the IJ trainer. It is composed of 10% ballistic gel that has carbon powder incorporated to provide opacity and realistic ultrasound granularity. There are two pairs of silicon tubing. One pair representing the right internal jugular vein and right carotid artery is located on the right half of the trainer. Water, used to represent blood, is pumped through the tubing via two separate miniature pumps. A dedicated electronic control system activates one pump to recreate a pulsatile blood flow to the carotid artery. Another pump, directly connected to a USB power bank or equivalent power supply, creates a laminar flow to the internal jugular vein. The other pair of silicone tubing is located on the left half of the neck and provides a cost effect option for prolonging the useful life of the gel neck. When the right pairs of tubing have been damaged due to the multiple needle puncture, the gel neck can be turned 180 degrees and reconnected to provide more practice. The compliance of the gel neck closely approximates human tissue. Similarly, puncturing the “blood vessels” will cause the neck to “bleed” just as it would in a live model.

Under ultrasound imaging, the artificial blood vessels are clearly defined. The carbon powder added to the ballistic gel provides granularity. Without this addition, an unrealistic image with large hypoechoic areas is interrupted only by the pairs of silicone tubing. Turning on the doppler mode, the practitioner is able to observe pulsatile flow in the carotid vessel and laminar flow in the internal jugular vein.

The pump base is a box with raised edges containing a pair of pumps, water reservoir, and tubing. The raised edge of the base allows for water to be recirculated when the gel neck is punctured and “bleeds”. Fluid drains back into the reservoir through two drain holes. One pump located inside the base provides a connection to the carotid tubing and the other pump provides a connection to the internal jugular tubing.

A compact circuit board regulates power to the carotid pump so that an intermittent activation of the pump can simulate carotid blood flow. USB connector designed into the circuit board allows any USB power bank to be used as a power source. Alternatively, a higher-powered power supply such as 6V is used to provide greater flow if one desires.

Production Process

Neck molds are made using aluminum to ensure the durability. Other materials such as silicone can be used which would be capable of withstanding prolonged temperatures of 250 degrees Fahrenheit. However, silicone or high temperature plastics would ultimately degrade under prolonged heat exposure. The mold consists of a semicircular main body and two end plate. The endplates have four holes grouped in two pairs. One pair is positioned at the lower right half and represents the carotid and internal jugular vessels. The other pair is located at the lower left half. The end plates can be replaced with different configurations. A normal anatomy would present the IJ superior and lateral to the carotid artery. Since there are variations to this, the end plate could configure multiple alignments of the vessels for increased challenge.

Molds – necessary materials include: Aluminum Mold
10% Ballistic Gel manufactured by Clear Ballistics 6mm Silicone Tubing
10” Stainless Steel rod 1/8” diameter Oven & Vacuum Chamber

1500g of 10% ballistic Gel is heated in an oven at 250 degrees Fahrenheit until completely melted. 7 grams of carbon powder is added to the gel and thoroughly mixed. 10 inches of silicone tubing is threaded through the corresponding hole in the end plates. Stainless steel rods are inserted through the tube to provide support. Without these rods, the tubing would assume unpredictable positions within the mold. The gel mixture is poured into the mold and placed into the vacuum chamber at -25in H20. After two hours or when the gel has cooled, the mold is reheated until the gel is in liquid state to release any remaining air bubbles. Once the gel has cooled, it is removed from the mold and stored in a container to keep dust from collecting on the surface.

Pump Base – necessary materials include: 2x Aluminum bar 4"x5"x0.125" Aluminum channel
2x Aluminum bar 4"x4"x0.25" Aluminum plate 4"x6"x0.08" 2x 5V Water pump model
4 Right angle brass connection ¼" NTP 4 Right angle plastic connectors
6mm Silicone tubing

The aluminum base supporting the gel is a water reservoir which also houses two internal water pumps. These pumps deliver pulsatile and steady flow through two tubing that connect to the neck gel. As the gel is punctured during the procedure, water will inevitably leak. Since there is a raised barrier around the gel, water will not flow onto the table. Instead, water will drain back into the pump base via holes drilled at one end (Figures 1 & 2).

The electronic pump control is designed to control the water pump located within the base. There are two settings: pulsatile and non-pulsatile.

Table 1*: Itemized, tabulated list of materials necessary for production.*

Neck Gel

Part	Per unit [USD]
Ballistic Gel 411g per unit	3.61
silicone tubing	0.40
silicone tubing	0.40
silicone tubing	0.40
silicone tubing	0.40
total	**5.21**

Pump Base

Part	Per unit [USD]
Aluminum Rectangle Tube 6063-T52-Extruded 1.5"x2.5"x0.125"	10.69
Aluminum Rectangle Bar 6061-T6511 Extruded	7.81
0.25"x2.5" Aluminum Rectangle Bar 6061-T6511 Extruded	3.90
0.25"x2.5" Aluminum Rectangle Bar 6061-T6511 Extruded	3.90
top plate	10.00
Hex coupling 1/4x1/4 NTP	5.00
1/4 NTP Elbow	12.29
total	**53.59**

Pump Control Circuit

Part Number	Description	Per unit [USD]	Per 100 units [USD]
	Printed Circuit board	0.68	0.40
KUSBX-SMT2AP5S-B	USB Connectors A TYPE SMT BLK PLUG 1.35mm POSTS SHIELD male Surface Mount	1.10	0.754
87583-2010BLF	USB Connectors 4P RECEPTACLE TYPE A Female surface mount	1.00	0.689
AP7370-33SA-7	3.3V SMT Volt Reg	0.52	0.281

2SS100L-W	Schottky Diodes & Rectifiers 100V 2A SM SCHOTTKY Barrier Rectifier	0.11	0.088
2SS100L-W	Schottky Diodes & Rectifiers 100V 2A SM SCHOTTKY Barrier Rectifier	0.11	0.088
LBC3225T330KR	Fixed Inductors 1210 33uH 533mOhms +/-10% 500mA	0.15	0.087
CRCW0603150RFKEAC	Thick Film Resistors - SMD 1/10Watt 150ohms 1%	0.10	0.010
CL31A107MQHNNWE	Multilayer Ceramic Capacitors MLCC - SMD/SMT 100uF+/- 20% 6.3V X5R 3216 Case 1206	0.49	0.209
CL31A107MQHNNWE	Multilayer Ceramic Capacitors MLCC - SMD/SMT 100uF+/- 20% 6.3V X5R 3216 Case 1206	0.49	0.209
PIC10F322T-E/OT	8-bit Microcontrollers - MCU 896 B Flash, 64 B RAM, 4 I/O, 8bit ADC, PWM, CLC, NCO, CWG, TEMP Indicator, 2.3V - 5.5V	0.66	0.536
SI2312BDS-T1-E3	MOSFET N-Channel 20V 3.9A	0.43	0.255
SK14D01G6	Slide Switch SP4T	0.43	0.350
CL21A106KOQNNNG	10uF MLCC capacitor	0.10	0.034
	total	**6.37**	**3.606**

Total production cost of novel trainer consisting of neck gel, pump base, pump control circuit:

$65.17 USD (single unit) or $62.41 USD (100 units)
*Production cost is slightly decreased when produced in large volumes due to bulk material purchase.

Total purchase cost of commercial trainer [CAE Blue Phantom Ultrasound Central Line Trainer]:

$2,915.00 USD (single unit)

Figure 1: *Front-side, transparent graphic of novel task trainer displaying internal components and respective measurements.*

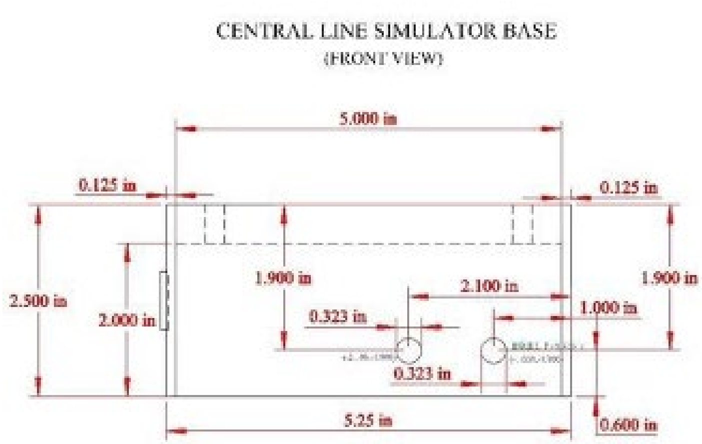

Figure 2: *Left-side, transparent graphic of novel task trainer displaying internal components and respective measurements.*

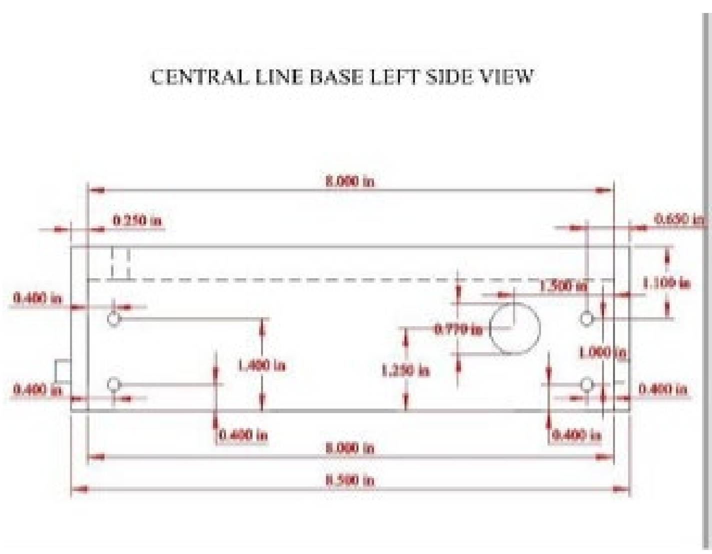

Figure 3*: Finalized concept model of novel task trainer.*[1]

Figure 4*: Pre- and post-assessment.*

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Task Trainer Survey

Date: ____________ Task trainer used: _______________________________

1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Agree, 5 Strongly agree

Question	Before					After				
	SD 1	D 2	N 3	A 4	SA 5	SD 1	D 2	N 3	A 4	SA 5
I feel confident in performing the procedure in my practice.										
My skill in performing the procedure is adequate.										
My knowledge of the procedure is adequate.										

1 Strongly Disagree, 2 Disagree, 3 Neutral, 4 Agree, 5 Strongly Agree

Question	SD 1	D 2	N 3	A 4	SA 5
The instructor was knowledgeable about the procedure.					
The task trainer was realistic.					
The task trainer was easy to use.					
I had sufficient time to practice with the task trainer.					
The necessary equipment and tools for the indicated procedure were provided.					
I would recommend using this task trainer to a colleague or coworker.					

Additional Comments

____

____

What types of task trainers would you like to see added to the Sim Lab?

____

____

Results

The improvement in scores for the AMSL training group was 1.46 (SD=0.87) and improvement for the commercial training group was 1.46 (SD=1.07). With the improvement scores for both types of training nearly identical, the hypothesis test of difference in score improvement was non-significant. The t-test for the difference in changes was $t(15)=0$, $p>.99$. The 95% confidence interval for estimated change due to either training was [0.94, 1.98]. The difference between pre- assessment and post-assessment mean scores for confidence, skill, knowledge for each training program was significant (Figure 5).

The estimated change in scores and 95% confidence intervals for each training program were calculated. Participants reported equivalent improvement in confidence, skill, and knowledge related to central venous catheter insertion using both the commercial and novel central venous catheter insertion simulation task trainers.

***Figure 5**: Tabulated statistical analysis of pre- and post-assessments.*

Training program	Pre-assessment	Post-assessment	Paired t-test
Commercial Training	2.67 (0.91)	4.13 (0.50)	$t(15)=5.47$, $p<.001$
AMSL Training	3.02 (0.91)	4.48 (0.49)	$t(15)=6.72$, $p<.001$

Discussion

This study reiterated the need for a task trainer of sufficient caliber to imitate currently available task trainers at a low cost. Participants in this study demonstrated improved knowledge and comfort scores for both the commercial trainer and the novel trainer, suggesting the efficacy of the novel trainer, as designed, is at least satisfactory in replacement of the commercial trainer.

These improvements from the pre-assessment to the post-assessment also suggest that, while utilization of both trainers lead to favorable – and similar – results, the money-saving novel trainer is clearly a beneficial alternative.

The favorable results of the survey analysis advocate for the production and implementation of similar projects moving forward. Participants in any future instructional sessions will have the opportunity to utilize and learn from a device that is adequate and, due to cost savings, more readily available. Internal production and implementation of this specific device will continue, and the hope is that this study will promote the adoption of this idea to external simulation centers as a means for non-inferior product realization and overall budget regulation and conservation.

While benefits of this novel simulation task trainer are promising, the study had several limitations. The sample size for this study was less than anticipated at n=15. This sample size is considered a limitation as its magnitude will not sufficiently represent the general population. This highlights a need for future research on similar, devices with a primary purpose of cost-saving. In future studies, conducting a longitudinal evaluation could allow for increased magnitude of data, despite the sample size. Additionally, subsequent studies utilizing the same device and surveying tools would allow researchers to, effectively, mimic an extended study of the same basis.

Additionally, employee salary costs to produce the trainer were not included in the bill of material cost. The cost savings discussed may be slightly depreciated by the fact that this internal production requires time and capital investment. This includes the design of the blueprints, gathering of materials, subsequent testing of multiple iterations of the device, the intellectual and human capital from which the idea originates, and, of course, the salaried investment input by the organization. While these may be exclusive to the initial stage of production, future reiterations of the device will require them as well.

Despite limitations to the device and its respective study, this central venous catheter insertion simulation task trainer is a replicable, more economically efficient alternative to a commercial task trainer for simulation-based clinician central venous catheter insertion training. Furthermore, subsequent opportunity for research will provide additional insight into the concept of novel, low-cost task trainers.

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Designing Effective Simulation Experiences: A Proposed Template

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Brief Description

Simulation educators and operation specialists use planning templates and worksheets to guide the design, development, and delivery of high-quality simulation (sim) experiences. These can vary in small and big ways between and within institutions. In this paper, we introduce a template that tries to consolidate and streamline the information needed to create meaningful learning experiences.

Introduction

Institutions that build out their simulation capabilities and adopt debriefing practices often create internal templates to help operation staff and educators design effective simulation activities. As with anything, not all templates are created equal, and they can quickly become hindrance to securing funding or lab time. A good template earns its worth when designers consistently rely upon it to build learning activities. The proposed template was created after reviewing dozens of others and considering these core ideas:

Templates should:

1. Prompt the use of best practice in simulation design and delivery

2. Act as a project charter to get everyone on the same page and specify what's to be designed and how

3. Link activities to learning objectives, standards, and desired outcomes

4. Be flexible enough to meet the needs of different specialties and support innovation

5. Be functional and easy to use, improve the quality of the simulation activities, and positively impact learner outcomes

6. Be iterative. Teams should regularly meet to discuss components of the template and design process and determine if they warrant changes

Whether you adopt this template or not, we hope you will consider and evaluate your own templates using the guidance provided above.

You can find the full template in the appendix. In the remaining sections of this article, we break down each part of the template and provide our rationale for including it.

Figure 1*: Simulation Details.*

Simulation Details

Title:
Date:
Location:
Expected duration:
Type of learning activity:

- ☐ High-fidelity simulator
- ☐ Low-mid fidelity mannequin
- ☐ Standardized patient
- ☐ Role play
- ☐ Other:

Sim designers:
Sim facilitators:
Sim audience:

Rationale: This section collects background information and details about the simulation. It is meant to be an efficient snapshot of the involved stakeholders and the type of simulation planned. Additional information, not categorically included, may be added in the *other* section depending on the needs of the activity.

Figure 2*: Objectives.*

Objectives
What objectives does this learning exercise attempt to meet? Ensure the learning objectives are specific, goal- and action-oriented, realistic, achievable, and measurable.

Rationale: Clear behavioral objectives set the stage for a good sim activity. In this section, explicitly create goals and objectives that orient designers, learners, and evaluators. Use actionable verbs, such as those in Bloom's taxonomy.

Figure 3*: Clinical Context.*

Clinical Context
What is the clinical context for this learning activity? Provide a short description.
Ensure your clinical context is appropriate for the stated objectives.

Rationale: Briefly write a description of the context. What is the setting for this activity? Simulations in an operating room versus ones in a sim lab require different considerations. The clinical context section helps stakeholders orient to the activity and determine if the stated objectives are appropriate for the intended setting.

Figure 4*: Learning Activity Needs Assesment.*

Learning Activity Needs Assessment
State two guided study questions for this activity.

Briefly elaborate on the need and use of this learning activity. If relevant, state three references that support the need and use for this learning activity.

What content have learners been previously exposed to prior to this learning activity?

Rationale: In this section, indicate the necessity of your intended learning exercise. When simulation resources (time, money) are scarce, you want to have a good case for why you need this activity. Additionally, indicate how this exercise expands upon previous learning activities. If it is their first exposure to the target topic, simulation may not be appropriate, but if it is, elaborate on how you will introduce students to the topic before or during the exercise.

Figure 5*: ACGME Competencies.*

ACGME Competencies

- ☐ **Patient Care** that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health
- ☐ **Medical Knowledge** about established and evolving biomedical, clinical, and cognate (e.g., epidemiological and social-behavioral) sciences and the application of this knowledge to patient care
- ☐ **Practice-Based Learning and Improvement** that involves investigation and evaluation of their own patient care, appraisal and assimilation of scientific evidence, and improvements in patient care
- ☐ **Interpersonal and Communication Skills** that result in effective information exchange and teaming with patients, their families, and other health professionals
- ☐ **Professionalism**, as manifested through a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population
- ☐ **Systems-Based Practice**, as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value
- ☐ **Other:**

Rationale: Link your learning objectives to the relevant competencies of your discipline's professional governing bodies. Coordinating multiple objectives under the same umbrella reduces redundancies and connects learning to program requirements. Stakeholders and simulationists should also find this section helpful to contextualize the sim event. We adopted this portion from Children's Hospital of Philadelphia. In their template, they easily map objectives to residency program outcomes (CHOP, 2009). Skip this section if it does not apply to your program.

***Figure 6**: Knowledge, Skills, and Attitudes.*

Knowledge, Skills, and Attitudes:

Please list the knowledge, skills, and attitudes (KSA) that are specific to this context and indicate which learning objectives are met through these. Each objective should have at least one corresponding KSA, with more than two being recommended.

Examples:

- Asks open-ended questions
- Acknowledges patient's questions, concerns, and possible hesitations
- Ensures patients have modest draping during examination

KSA	Objective
Example: Gathers complete information about the situation prior to proceeding with a decision.	Example: Demonstrates understanding of the relevant medical information and knowledge.
#1	

Rationale: With competencies and learning objectives identified, you will now map onto the relevant knowledge and skills used to meet that objective. Inspired by and adopted from the TEACHS template (Benishek et al., 2015), we include an attitudes (A) portion that should spell out more details on the audience. Learner groups have different preferences and needs; you want to be aware of those attitudes, perspectives, and preferences before you build a simulation environment.

***Figure 7**: Case and Events.*

Case and Events

- State the scenario details.
- List the events during the case that the learner is involved in. Events consist of incidents that prompt the learner to respond (if the student does not respond to an intended incident, please document as well). Events can also involved various information gathering skills, physical examination maneuvers, and orders placed by the learner.
- State what KSAs and learning objectives are relevant to the stated event.

Event Sequence	Event Description	Response	KSA(s)	Objectives
Example	Junior resident informs the learner of fluid in the hepatorenal space on FAST.	Learner asks for full FAST exam, previous patient vitals, current vitals, available imaging, and CBC.	Gathers complete information about the situation prior to proceeding with a decision.	Demonstrates ability to accurately assess a critically ill patient. Demonstrates ability to communicate effectively with the team. Demonstrates understanding of the relevant medical information and knowledge.
#1				

Rationale: This section will be the most extensive and time-consuming to create, but it's one of the most important. Here, detail the events of the case, preferably in chronological order. Document the learner's responses mapped to KSAs and objectives listed in the previous section. *Case and Events* promotes effective design, observation, and evaluation.

Figure 8*: History and Physical.*

History and Physical

- HPI
- PMH
- PSH
- Meds
- Allergies
- SH & FH
- ROS
- PE
    - Vitals
    - General, HEENT, Resp, Heart, Abd, GU, Ext, Skin, Neuro

Rationale: After you build the details of the case, write a brief history and physical for the simulated patient. This section can be short or detailed, depending on assessed needs and the specifications of the simulator. Standard components of an H&P are provided to help organize facts, but add and omit components at your discretion.

Figure 9*: Equipment and Props.*

Equipment and Props

- Airway
- Labs
- EKG
- US
- Monitoring devices
- Blood products
- Imaging
- TLDs
- Medications
- Etc.:

Rationale: Equipment and props the operations specialist should gather or program for the sim event. Again, adapt this section based on your simulation context.

Figure 10: *Guided Debrief.*

Guided Debrief

- Decide how you'd like to debrief (individual vs group)
- Set the ground rules for debriefing
- What materials do you need for debriefing?
- What questions would you like to use?
    - Did the scenario meet the intended purpose and objectives?
    - What worked well?
    - What can be improved upon?
- Did this simulation inspire future ones?

Rationale: There are countless debriefing methods available. In this section, consider factors from the particular sim event that may direct you to use one method over another. We recommend *Debriefing with Good Judgement* (Rudolph et al., 2007) and *PEARLS* (Bajaj et al., 2018). Both allow you to explore events of the simulation and reflect on the learners' experience. A plus-delta approach might be applicable when time is brief (Dismukes, 2000).

Conclusion

The proposed template is intended to be comprehensive, user-friendly, and interdisciplinary. Certain parts will require more or less detail and should always be informed by the needs of the simulation designer, educators, and learners. Apply your own clinical and education judgment when deciding whether to use all or some of the parts of this template.

Simulation education is relatively new and rapidly evolving, dictating a need for further evolution of simulation templates. Additional research, trials, and proposals are needed to further develop and validate all templates.

Appendix

Simulation Template

SSimulation Details

Title:
Date:
Location:
Expected duration:

Type of learning activity:

- High-fidelity simulator
- Low-mid fidelity mannequin
- Standardized patient
- Role play
- Other:

Sim designers:
Sim facilitators:
Sim audience:

Objectives

What objectives does this learning exercise attempt to meet? Ensure the learning objectives are specific, goal- and action-oriented, realistic, achievable, and measurable.

Clinical Context

What is the clinical context for this learning activity? Provide a short description.
Ensure your clinical context is appropriate for the stated objectives.

Learning Activity Needs Assessment

State two guided study questions for this activity. Briefly elaborate on the need and use of this learning activity. If relevant, state three references that support the need and use for this learning activity. What content have learners been previously exposed to prior to this learning activity?

ACGME Competencies

- **Patient Care** that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health

- **Medical Knowledge** about established and evolving biomedical, clinical, and cognate (e.g., epidemiological and social-behavioral) sciences and the application of this knowledge to patient care

- **Practice-Based Learning and Improvement** that involves investigation and evaluation of their own patient care, appraisal and assimilation of scientific evidence, and improvements in patient care

- **Interpersonal and Communication Skills** that result in effective information exchange and teaming with patients, their families, and other health professionals

- **Professionalism**, as manifested through a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population

- **Systems-Based Practice**, as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value

- **Other:**

Knowledge, Skills, and Attitudes:

Please list the knowledge, skills, and attitudes (KSA) that are specific to this context and indicate which learning objectives are met through these. Each objective should have at least one corresponding KSA, with more than two being recommended.

Examples:

- Asks open-ended questions
- Acknowledges patient's questions, concerns, and possible hesitations
- Ensures patients have modest draping during examination

KSA	Objective
Example: Gathers complete information about the situation prior to proceeding with a decision.	Example: Demonstrates understanding of the relevant medical information and knowledge.
#1	

Case and Events

- State the scenario details.
- List the events during the case that the learner is involved in. Events consist of incidents that prompt the learner to respond (if the student does not respond to an intended incident, please document as well). Events can also involve various information gathering skills, physical examination maneuvers, and orders placed by the learner.
- State what KSAs and learning objectives are relevant to the stated event.

Event Sequence	Event Description	Response	KSA(s)	Objectives
Example	Junior resident informs the learner of fluid in the hepatorenal space on FAST.	Learner asks for full FAST exam, previous patient vitals, current vitals, available imaging, and CBC.	Gathers complete information about the situation prior to proceeding with a decision.	Demonstrates ability to accurately assess a critically ill patient. Demonstrates ability to communicate effectively with the team. Demonstrates understanding of the relevant medical information and knowledge.
#1				

History and Physical

- HPI
- PMH
- PSH
- Meds
- Allergies
- SH & FH
- ROS
- PE
  - Vitals
  - General, HEENT, Resp, Heart, Abd, GU, Ext, Skin, Neuro

Equipment and Props

- Airway
- Labs
- EKG
- US
- Monitoring devices
- Blood products
- Imaging
- TLDs
- Medications
- Etc.:

Guided Debrief

- Decide how you'd like to debrief (individual vs group)
- Set the ground rules for debriefing
- What materials do you need for debriefing?
- What questions would you like to use?
    - Did the scenario meet the intended purpose and objectives?
    - What worked well?
    - What can be improved upon?
- Did this simulation inspire future ones?

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An Inter-Professional Education Experience Between Physician Assistant and Physical Therapy Students Utilizing Standardized Patients: A Technical Report

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Abstract

Introduction: Healthcare simulation is being used to promote inter-professional education (IPE). While literature discussing simulation experiences between physician assistant (PA) and physical therapy (PT) students is limited, it is of importance that each discipline learns the value of the other, as both are assuming a more critical role in acute-care discharge planning. The purpose of this paper is to describe an IPE methodology developed to provide PA and PT students an opportunity to collaborate on implementing a comprehensive plan of care, including discharge location, utilizing standardized patients.

Methods: The methods were divided into three parts: inter-departmental collaborations, standardized patient utilization, and use of an electronic management system (EMS). Four clinical cases, as acted out by standardized patients, were developed. Twenty-eight PT students and eighty PA students participated in the IPE as part of the respective curricula.

Results: Faculty and staff from two professional healthcare programs and SIM Center successfully implemented the institution's first simulation IPE experience. Objectives, schedules, and clinical cases were collectively developed. Twelve standardized patients participated in the entirety of the IPE. Lastly, the EMS housed all information and captured audio and visual data without difficulty.

Conclusion: As a result of collaboration and communication between multiple programs, the IPE experience using standardized patients was successful. It facilitated teamwork between students of two disciplines to develop a comprehensive plan of care and discharge plan, optimizing patient outcomes.

Introduction

Healthcare simulation (sim) is defined as "a technique to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner"[1], allowing assessments of students in multiple domains.[2] One mode of simulation is the use of standardized patients (SPs), who are trained to play the same diagnostic role, with or without specific behavioral characteristics, with the expectation of a predictable performance, increasing internal validity.[3]SPs are very accurate in their presentations of cases, both in providing detailed medical histories and physical examination findings.[4]Additionally, SPs' roles can be tailored to accommodate the students' level of skill and knowledge.[3]This is compared to an actual patient, where the students may need guidance from their clinical supervisor depending upon the students' placement in the curriculum.SPs allow the students' experiences clinical and administrative situations found in real life practice and which may not be encountered in shorter clinical internships.[5] For these reasons, SPs in clinical healthcare simulations are described as a valuable and effective resource for teaching and assessing communication and physical examination skills in medical students. [6,7]

Since the 1960s, simulation has served as an adjunct to medical education, being integrated into various medical specialties.[8] Other healthcare disciplines, including physician assistant (PA) and physical therapy (PT) programs, more recently began following suit.

SPs were introduced into PA curricula in the late 1990s, with the addition of an objective structured clinical examination (OSCE) for formative evaluations as a part of a program's physical examination course.[9] Coerver, et al. reported that the use of SPs was the most common simulation modality used in PA curricula, with the primary aim to train students in medical knowledge through summative assessments.[10,11]

While a valuable teaching and learning tool[6], the effects of the incorporation of SPs in to PT education are not clear.[7] Historically, SPs have commonly been integrated into PT clinical scenarios that take place in the acute care setting.This is because PT students generally have the greatest challenge in adapting to the acute care environment, which is compounded in the intensive care unit (ICU).[12] Therefore, simulation experiences allow the PT students to be immersed in the complex clinical scenarios to develop interpersonal skills, clinical decision-making, and physical therapy management without risk to an actual patient.[12]

While each discipline has used simulation independently, simulation is now being used to promote inter-professional education (IPE).IPE "occurs when two or more professions learn with, about, and from each other to enable effective collaboration and improve health outcomes"[13], which is enforced by The Institute of Medicine's Health Professions Education Summit.[14] PA students most commonly participate in IPE with medical students and nurses, with the primary competency being interpersonal communication skills.[10]PT students have participated in simulation with nursing students to examine student attitudes toward inter-professional collaboration and inter-professional learning[15], and social work and nursing students to explore the ability to communicate and use clinical thinking to make a safe and appropriate inter-professional discharge recommendation.[16]Lastly, Wise, et al. conducted a survey to understand data on current and projected IPE initiatives within PT education.[17] The results showed that 58.5% of the 106 respondents reported that IPE was a focus of their physical therapist education curriculum; 46.2% identified IPE as a focus of their institution and supported by the institution's strategic plan, mission, or vision. [17]

Literature discussing simulation experiences between PA and PT students is limited to assessment of cross-cultural experiences via IPE modules[18] and use of a computer-based virtual patient to collaborate and develop an appropriate treatment plan.[12] It is imperative that PAs and PTs learn the value of each other's discipline, as each discipline is assuming a more critical role in acute-care discharge planning. PAs have greater content knowledge related to pathology, diagnostics, clinical interventions, and medications while PTs have unique content knowledge related to function, functional prognosis, functional needs, and site-specific disposition requirements. The purpose of this paper is to describe our simulation inter-professional education (Sim-IPE) methodology, which was developed to permit PA and PT students an opportunity to independently assess SPs and collaborate on findings to come up with a comprehensive, interdisciplinary care and discharge plan.

Methods

The DeSales University's Institutional Review Board approved this study. The methods are divided into three parts: 1) inter-departmental collaborations, 2) standardized patient utilization, and 3) use of an electronic management system.

1. Inter-departmental Collaborations

Three PA faculty, two PT faculty and two simulation center staff met biweekly for eight months prior to implementation of the encounter to develop a) Sim-IPE objectives and corresponding clinical cases, b) encounter design (summative vs. formative) and c) schedules for 80 first year PA students and 28 second year PT students. The overarching goal was to provide an authentic experience with a simulation modality that would meet the learning objectives assigned to the encounter by both departments.

1a. Objectives and Case Development

The aims of this Sim-IPE were to assess if there is a difference in 1) discharge location between PA and PT students, 2) priorities when making discharge location recommendations between PA and PT students, and 3) culture, perception, and appreciation of the other discipline after an inter-professional interaction. These aims were developed based on where the students were in the didactic portion of the curriculum and feedback from clinical rotations.

The objectives were to be met by twelve SPs acting out one of four clinical complex cases, with admitting diagnoses of normal pressure hydrocephalus, septic joint leading to endocarditis, cerebrovascular accident, and pneumonia superimposed on chronic obstructive pulmonary disease. The diagnoses were chosen because of the medical complexity and necessity to consult PAs and PTs. Inpatient medical charts were developed by PA and PT faculty, with one faculty member being the primary author for one chart. Charts were then cross referenced by a minimum of one faculty member from within and between the other department for accuracy and face validity. Medical charts included an admission note, daily notes from a minimum of four disciplines appropriate for the case (including PA and PT), diagnostic testing and imaging results, daily lab values, vital signs, and medical orders that followed that patient's progress for at least 3 days after admission. Paper charts were placed in binders for PT students. Electronic charts were placed in SIMULATIONiQ® for PA students. This difference was to accommodate scheduling logistics.

1b&c. Encounter Design & Scheduling

The encounter was divided into three phases: individual discipline's assessments, Sim-IPE experience, and debrief. The only summative component was the individual PT assessment, which was counted as the students' final lab practical in their course. Otherwise, it was a formative experience.

Individual Discipline's Assessments

Encounters occurred on 2 days per week over 4 consecutive weeks. This was done to accommodate intra-departmental didactic schedules, as each cohort of students had limited availability. On Day 1, 8 PT students completed an individual treatment session with the SP. Each PT student had one hour to read the case and develop a plan of care, followed by a one-hour SP encounter, and 30 minutes to document a daily SOAP note.

On Day 2, 20 PA students completed their SP assessment. In contrast to the PT students, each PA students saw three patients. PA students were granted access to their patients' charts 24 hours in advance, and were allotted 12 minutes per patient encounter to examine and assess the patient's current status. The PA students did not document their findings. This was designed to parallel clinical practice, with the idea that the PA students were evaluating their assigned patients ahead of morning rounds.

All encounters were 1 student to 1 SP. The PT students' schedule and the PA students' schedule for individual encounters with the SP can be found in Table 1 and Table 2, respectively. After individual encounters, all students completed a survey indicating their recommended discharge location and ranked factors contributing to their decision. Additional outcome measures were also completed.

Sim-IPE Experience

Upon completion of all individual encounters, a PT student was paired with 2-3 PA students to discuss their individual findings and develop a unified discharge disposition. These "healthcare teams" were assigned by faculty based on the common case between participants. Healthcare teams representing each case then participated in clinical rounds with their "attendings" (PA and PT faculty) and SPs. During the rounds, each healthcare team presented their findings, explained the rationale for the disposition recommendation, and answered case specific questions. Additionally, respective SPs participated in an abbreviated bedside assessment and discussion, and were asked hospital discharge related questions designed to replicate the type of teaching seen in morning rounding on a clinical floor.

Debrief

After completion of clinical rounds, all students and faculty gathered for a group debriefing on the SIM-IPE experience. A standard group of 6 questions, as developed by the faculty, were posed to the group inquiring about learning and collaborative opportunities. A sample schedule for the IPE experience is found in Table 3.

2. Standardized Patient Utilization

Once the cases were developed, the simulation staff hired SPs to fulfill the roles. Due to the volume of work and intricacy of four distinct cases over multiple weeks, 12 SPs, with 3 assigned to each case, were contracted. SPs were men and women and were between 32 and 88 years of age with an average age of 66 years, and had tenure of 5.6 years of experience as SPs. SPs received a copy of the assigned case and participated in approximately 12 hours of training with PA and PT faculty and simulation staff. The first training (~ 8 hours) was a reading of the case and round table discussion with the primary authoring faculty member to familiarize themselves with the case and answer questions related to the medical and social history. The second training (~ 4 hours) was a dress rehearsal in the acute care environment, with hospital gown, moulage, and applied lines / tubes / drains. During this time, PT faculty met with the SPs from each case to discuss psychomotor and affective presentations. Overall, the total number of hours, including training and encounter, committed by all SPs for this experience was 352 hours.

3. Use of an Electronic Management System

SIMULATIONiQÒ (Education Management Solutions, Exton, PA)*,* was the software used for a) scheduling the students, b) recording SP and student encounters, and c) electronic documentation.

3a. Scheduling the students

SIMULATIONiQÒ randomly scheduled all students into time slots, which also randomly assigned them to clinical cases. Specific to the PT encounters, they were summative so strict scheduling was mandatory. Since the timing was different for the PA and PT encounters, two different cases needed to be created in the software for each of the disciplines.

3b. Recording

SIMULATIONiQÒ has a built-in, ready-to-use recording feature, which timed and recorded all individual patient encounters for the PA and PT students. Recordings allowed the faculty members to watch student performance in real time, and review afterwards if necessary. Additionally, the software allowed the students to self-evaluate their performance post-encounter, permitting inquiry and reflective thinking for students' learning.[19]

Other recordings included the clinical rounds and debriefing. The rounding experience was recorded onto SD cards using a standard handheld camcorder. One case per week was recorded, largely for qualitative reflection and analysis. The debriefing was video and audio recorded using *Panopto* (Seattle, WA) because the space in which the debriefing was held was not covered within the SIMULATIONiQÒ system. The only portion of the Sim-IPE that was not recorded was the collaboration period between PA and PT students, as was not recorded anywhere because we wanted to students to work, think, and discuss without fear of being watched.

3c. Electronic Document Access

Upon completion of the patient medical charts, they were uploaded to SIMULATIONiQÒ, where PA students accessed them prior to their individual encounter. By using a centralized system, faculty and staff were able to maintain integrity of the cases, as well as track when or if students accessed their respective cases. Additionally, PT students wrote a treatment note, which were part of their summative encounter, in SIMULATIONiQÒ*.* Afterwards, notes were printed and graded by faculty. Lastly, SIMULATIONiQÒ provided a stable and reliable platform to compile, store, and evaluate data related to additional outcome measures.

Results

Faculty from two professional healthcare departments and SIM staff successfully implemented the institution's first Sim-IPE experience. Together, mutual and discipline-specific encounter objectives, schedules to accommodate an uneven distribution of students, and clinical cases were developed. All twelve SPs participated in the entirety of the Sim-IPE. They were successfully trained in their respective cases, underwent multiple training sessions with faculty and staff, and portrayed the character accurately. The electronic medical system housed all information (including electronic medical records, questionnaires, student documentation) and captured and archived audio and visual data without difficulty. Lastly, and most importantly, students found the experience to be beneficial to their learning. In the debriefs, the students unanimously commented that they learned from and with each other in an authentic clinical experience. By having a one-on-one simulation encounter, they were able to take ownership of the patient's care and, therefore, have active meaningful dialogue with their counterpart. Further results can be found in *Carp, et al. Journal of Interprofessional Education & Practice, 2020*.

Discussion

This was the first Sim-IPE experience at our institution. The experience involved individual discipline assessments of SPs with the primary objective to determine an appropriate discharge disposition. By creating the Sim-IPE experience around the objective, communication between disciplines was necessary.

The first benefit of our design was that the students had similar experiences thus far in each of the curricula. Both disciplines had completed the majority of their didactic curriculum, with both having minimal clinical experiences. PA students had had integrated clinical experiences, which involved three semesters of four hours / week, however considering that this was part of their didactic year, was mostly observation. PT students had completed one outpatient orthopaedic clinical experience.

Secondly, the methodology promoted effective communication, and ultimately learning, between students of each discipline. This granted greater autonomy and ownership of the patient's care to the students, compared to a faculty member facilitating the discussions.

An unexpected occurrence was that the SPs became a support system within themselves. When not actively participating in an encounter, the additional SPs would watch live feed of individual encounters. This allowed them to learn and improve their own skills, provide feedback to each other, and collectively problem solve, as each brought personal healthcare experiences to their acting.

While we consider our institution's first Sim-IPE experience a success, it was not without three basic challenges. First, faculty had to create a scenario where PA and PT would realistically interact. Second, the authenticity had to be maintained despite a discrepancy in class sizes and within the confines of academic schedules, as both cohorts of students were still engaged in curricula. Lastly, identification of common time for faculty to meet and evolve the Sim-IPE experience was challenging. Neither set of faculty were provided buy out for their contributions to the project.

Future directions of Sim-IPE are dependent on expansions into education and research.From an education perspective, Sim-IPE should involve students of multiple disciplines placed in various healthcare situations, both clinical and non-clinical. The simulations should occur in multiple clinical settings.From a research perspective, further work is needed to identify the most effective methodology, including most appropriate simulation technique, electronic management system, and outcome measures.

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Exploring Auditory Fidelity Use in Simulation Programs

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Brief description

Auditory fidelity, the sound aspect of high-fidelity simulation, is thought to promote a more realistic learning environment in simulation education; however, beyond a description of auditory fidelity, little is known on its prevalence or effect on learning.

Using the Society for Simulation in Healthcare SIM Center directory, a contact list was created and used to distribute a survey about auditory fidelity. The 13-question author-developed questionnaire was based on gaps in the literature about auditory fidelity.

Respondents who indicated they had the ability to create auditory fidelity in simulation (82.6%, n = 72) reported using options of pre-programmed sound from the manikin, a computer application external to the manikin, live voice actors or actresses, or an external electronic device. Approximately half of respondents using auditory fidelity or 53.09% (n = 43) reported that learners notice or comment on auditory fidelity and just under half or 46.5% (n = 36) reported noticing a difference in learner performance since implementing auditory fidelity.

Auditory fidelity is widely used in the simulation centers sampled. However, many simulation centers have not appraised its value.

Exploring auditory fidelity use in simulation programs

Fidelity is defined as the “degree to which a simulation replicates the real event and/or workplace including physical, psychological, and environmental elements” (Lioce et al., 2020, p. 16). To enhance reality, many high-fidelity simulations may utilize a mix of elements including audio and visual cues.

This manuscript specifically focuses on the auditory aspect of fidelity in simulation; the sounds that replicate a real event in a workplace or accurately reflect the voice of the patient portrayed in the simulation. Although the Healthcare Simulation Dictionary (Lioce et al., 2020) does not offer a specific definition for *auditory fidelity*, it does acknowledge that there are many types of fidelity in simulation. The authors investigated how widespread the use of auditory fidelity is in the simulated environment, specifically background sounds in the environment and/or congruence of age or gender of the voice to the manikin.

Although simulation education has become more widely used and fidelity has increased with use of advancing technology, published literature on operations topics like auditory fidelity is limited. Beyond its mention as an aspect of high-fidelity simulation, auditory fidelity is not specifically studied in current literature. According to the Healthcare Simulation Standards of Best Practice: Simulation Design™ (2021), the use of various types of fidelity help create the perception of realism with cues and stimuli that help the learner take appropriate action. Sound can be part of the physical, conceptual, or psychological fidelity simulation environment.

The authors aimed to increase what is known about auditory fidelity in healthcare simulation as a background for future study of auditory fidelity and its value.

Background

Because manikins often lack the physical characteristics of movement and facial expressions of human responses, students interact differently with them than they would humans. Learners appreciate when the plastic manikin has the ability to answer questions through microphones and speakers (Power et al., 2016), however report they sometimes find it difficult to simulate communications with task trainers and manikins in scenarios (Barry et al., 2012). Learners also anecdotally describe difficulty with realism when the manikin voice is incongruent with the expected age or gender of the simulated patient.

High fidelity characteristics can create a more realistic patient and simulation scenario. However, the effect of learning may not be proportional to fidelity level (Kim et al., 2016). High-fidelity background noises that are not associated with or are incongruent with the objectives may confuse learners and learning may be impacted. Some realism is too intense for training conditions. For example, replicating realistic high noise conditions such as clinical patient care conditions in an aircraft have been shown to negatively impact performance and increase errors (McNeill, 2018).

Survey Methods

A 13-question exploratory survey was created by the research team and deployed using Qualitrics™ survey software. Questions were created based on gaps in the literature and comments from learner feedback. Question types included multiple choice, select all that apply, and some free response options where respondents could expand further on the questions. Using the Society for Simulation in Healthcare SIM Center Directory, an email contact list of programs in the United States and Canada was created and used to distribute the survey link. This project received a research exemption from the University of Wyoming Institutional Review Board.

Results

The survey was deployed to 311 email addresses and posted on two simulation organization electronic message boards. A total of 24 emails were returned as non-deliverable. In all, a total of 112 partial and complete responses were received for a response rate of 39% (n = 112).

Approximately 83% (n = 76) of respondents indicated their facility had the ability to create auditory fidelity in simulations while the remaining 16% (n = 15) indicated they did not have auditory fidelity capabilities. The most commonly reported technique to demonstrate auditory fidelity was “manikin voice” (n = 57) followed by use of voice actors and actresses (n = 50), computer application external to the manikin software (n = 39), and voice changing external devices (n = 24). In the free response option to the question some answered “matching instructor voice” (i.e., using male instructor voice when the simulated patient is a male, or a female instructor voice when the simulated patient is a female) (*n* = 10). Others reported using pre-recorded unique audio to match the simulation scenario (*n* = 3).

The use of background noise in scenarios was reported by 40.22% (*n* = 37) respondents, while 56.52% (*n* = 52) indicated they did not use background noises. Using the free response option, respondents indicated they used background noises such as first responder sirens/fire alarms, sounds depicting a place, sounds simulating a disaster or mass casualty situation, and equipment alarms commonly heard in the hospital or clinical setting.

Many centers reported serving multiple types of learners. Nursing students, nurses, and other health professionals were the most frequently identified learner categories. Medical students, physicians, emergency medical services and pharmacy students were also identified in descending order of numbers served. Additional health groups served identified in the free response box were physician assistant students, dental students, physical/occupational therapy, graduate nursing/DNP students, respiratory therapy, social work, certified nurse aides/medical assistant students and hospital employees (not clinical staff). Results reported are displayed in Table 1. The number of learner types is larger than the number of responding centers due to the diversity of learners served.

Of the respondents that use auditory fidelity, a majority (*n* = 43) indicated their learners ***do*** notice or comment on the use of auditory fidelity in scenarios. Less than 20% (*n* = 16) indicate their learners ***do not*** notice or do not comment on its use, and slightly more than a quarter (*n* = 22) indicate they have not assessed or are unsure whether their learners notice or comment on auditory fidelity use.

Just under half of respondents, (*n* = 36) using auditory fidelity noticed a difference in learner performance while less than 8% (*n* = 6) did not notice a difference, and many (*n* = 36) had not assessed or were unsure about differences in learner performance. Difference in learner engagement (*n* = 53), learner anxiety levels (*n* = 36), learner satisfaction (*n* = 32), learner clinical judgement (*n* =14), learner confidence (*n* = 13), and simulated patient outcomes (*n* = 11) were areas that respondents thought may be impacted by auditory fidelity.

Facilitator performance was also impacted by auditory fidelity. After implementing auditory fidelity respondents reported differences in facilitator and learner interactions (*n* = 35), facilitator satisfaction (*n* = 17), and facilitator performance (*n* = 3).

Just under half of respondents (*n* = 36) who use auditory fidelity reported they had received feedback from learners on the use of auditory fidelity, while just over half (*n* = 42) indicated they have not received any student feedback. Free text narrative answers stated opinions and experiences since implementing auditory fidelity. Respondents said they believed that Auditory fidelity increased realism experienced by the students, including sounds and background noises heard in healthcare settings, and increased the ease of assessment and navigation during simulation scenarios. Some reported reduced stress with the use of auditory fidelity, although it is unclear whether this was from the learner or the operations viewpoint. Two respondents indicated their students engage more with the manikin when they do not recognize the voice through the microphone, achieved through the use of voice changing technologies. One respondent further explained that a higher level of engagement is noticed when a female instructor's voice is changed to a male voice. However, respondents also indicated that there is sometimes difficulty understanding and hearing the manikin's voice in simulation during high stress simulations or when many learners are present. Some respondents also indicated that the use of alarms has been distracting, especially to new learners or students who have not had experience with simulation manikins.

Discussion

Although the impact of auditory fidelity has not been studied in simulation, the survey findings show that many simulation centers employ auditory fidelity resources during simulations and that it is a contributor to attempted realism. There is currently no literature available that identifies a link between the fidelity of sound in a simulation and learning, although many of the survey respondents clearly believe that sound plays a role in learner engagement. Despite this affirmation, only about half of respondents indicated their learners notice or comment on the use of auditory fidelity. Learners may not notice or recognize the use of auditory fidelity if the sounds are as expected for the patient and environment and they may not comment unless feedback is directly solicited. Unless simulationists intentionally assess for differences in engagement, learner performance, and other variables it is unclear whether auditory fidelity plays a major or minor role in simulation and simulation design. Although some respondents said they noted differences in learner anxiety, satisfaction, and confidence and others identified differences in learner clinical performance, the contribution of auditory fidelity is difficult to tease out unless there is a discussion about sound accuracy as a part of the debriefing process or some other learning assessment.

Learners do not expect a child-sized manikin to have a booming bass voice or manikins who represent male patients to have the voice of a female facilitator; however, we don’t yet know whether this impacts learning or engagement. We do know that the majority of simulation centers responding to this survey have the technology or capability of creating congruence of age and gender with the voice of the manikin. Again, more study is needed to determine whether it is worth the cost and effort for programs and centers without patient voice congruence methods to upgrade their simulation capabilities.

There also seems to be a divide between simulation centers and labs that do or do not use background noises during simulation scenarios. The most commonly reported background noises used by respondents were alarms found in the clinical settings such as call lights. Alarms can serve as a learning tool that require a call to action such as with fire alarms or IV pump alarms, but background noises can also create distractions that divide a learner’s attention. If the sound is part of a cue that supports the learning objectives of the scenario, it could be a positive tool. Noises that confuse or distract the learner undermine the learning purpose, therefore background noise for the purpose of fidelity must be carefully selected.

Many different learner types use simulation as a method to further educate and develop clinical skills; therefore, different types of audio fidelity may be indicated for different disciplines and scenarios. The background sound of a fetal heartrate dropping may be an excellent cue to action during an obstetric scenario for maternal child health professions learners, while the shrill tone of a bed alarm might be a better cue for others in a long-term care scenario portraying a confused elder. Given that many disciplines and types of learners use simulation, carefully selected audio prompts could enhance the simulation learning experience.

Table 1
Types of Learners

	n	%
Practicing Professionals	178	
Physicians	43	24.16
Nurses	53	29.78
EMS	32	17.98
Other Health Professionals	50	28.09
Students	159	
Nursing Students	76	47.80
Medical Students	46	28.93
Pharmacy Students	21	13.21
EMS Students	16	10.06
Other Indications	68	
Physician Assistant Students	6	8.82
Dental Students	10	14.71
Physical Therapy/Occupational Therapy	14	20.59
Graduate Nursing/DNP	6	8.82
Respiratory Therapy Students	9	13.24
Social Work	8	11.76
Certified Nurse Assistant/Medical Assistant/Tech Students	9	13.24
Hospital Employees (not clinical staff)	6	8.82
Other Disciplines Indicated [a]	24	35.29

Notes. n = number of responses. "%" Refers to the percentage of responses within the broad categories listed.
[a] "Other Disciplines Indicated" includes indications that were made using free text that had more than 5 responses

Limitations

The definition of auditory fidelity is not well known which may have resulted in limited understanding of survey questions by respondents. The contact list numbers of simulation centers used for the survey are low in relation to the number of centers/labs throughout the United States and Canada. Additionally, the sample reflects centers that are affiliated with one simulation organization and therefore cannot be generalized. The survey format allowed for questions to be skipped, leading to a varied number of responses per question.

Conclusion

Although the literature contains references to different types of fidelity in simulation, there are very few that mention sound or auditory fidelity. Many simulation centers have the ability to employ sound as a part of scenarios, however, we do not yet understand how that may relate to learning. Although sound can provide cues, it can also be a distractor and depends on the objective of the simulated activity. Future inquiry about auditory fidelity is needed to determine the importance of its impact.

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