English

In Situ Simulation: advantages, challenges and obstacles

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Abstract

Medical simulation is increasingly recognized as a modality that can reduce medical errors in a variety of care settings. In situ simulation, which is defined as simulation-based training that occurs in a real clinical environment with participants who are on-duty, is useful for identify gaps in training, systems issues and other areas for improvement. The aim of this paper is to describe the uses, advantages, and challenges of in situ simulation through the prism of our experience managing a variety of in situ programs in a tertiary care teaching hospital. We will also cover vital debriefing technics and logistics experiences we believe will benefit those hoping to create an in site simulation program of their own. The paper will describe how our own program has led to an improvement in the organization and assessment of our hospital's code management systems. Among a number of lessons learned further described below are: Clear goals must be established, evaluated, and revised throughout the process;Debriefing improves team performance, helps identify problems as well as solutions and allows participants to contribute to and emotionally process their training, and; In situ highlights deficiencies in a way that can easily inform hospital leadership and risk management officers to a health system's need. Our experience indicates that in-situ simulation is a valuable, safe and relatable tool to identify needs, promote effective communication, enhance technical skills and implement process improvements in a high-risk medical environment.

Keywords: *Patient Simulation; Crisis Intervention; Medical Education.*

Resumen

Simulación in situ: ventajas. retos y obstáculos

La simulación médica es cada vez más reconocida como modalidad a ser utilizada para reducir los errores médicos en una variedad de entornos de atención y diferentes grados de realismo. La simulación in situ, que se define como la formación basada en la simulación que tiene lugar en un entorno clínico con profesionales en el lugar de trabajo o actividad, se ha utilizado como herramienta para mejorar e identificar los vacíos en la formación del profesional de la salud. El objetivo de este artículo es describir las ventajas, retos y obstáculos para la implementación de la simulación in situ en un hospital universitario de tercer nivel. El programa dio lugar a una mejora en la organización y evaluación de sistemas de gestión de código (código azul) utilizado por el hospital. Como lecciones aprendidas se mencionan la necesidad de establecimiento, evaluación y revisión de metas claras durante todo el proceso; la técnica de debriefing mejora el rendimiento del equipo, ayuda a identificar los problemas y las soluciones, y les permite a los participantes contribuir y procesar emocionalmente a su formación, y la actividad desarrollada in situ identifica las deficiencias en la atención al paciente, especialmente en lo que se refiere a las necesidades de la gestión de riesgos. La experiencia indica que la simulación in situ es una herramienta valiosa y confiable para identificar las necesidades, promover la comunicación efectiva, mejorar las habilidades técnicas e implementar mejoras en los procesos en un entorno médico de alto riesgo.

Palabras-clave: *Simulación de Paciente; Intervención en la crisis; Educación Médica.*

Resumo

Simulação in situ: vantagens, desafios e obstáculos

A simulação médica tem sido cada vez mais reconhecida como uma modalidade a ser utilizada para reduzir os erros médicos em uma variedade de configurações de cuidados e diferentes graus de realismo. A simulação in situ, definida como treinamento baseado em simulação que ocorre em ambiente clínico com profissionais no local de trabalho ou de atuação, tem sido utilizada como ferramenta para melhorar e identificar lacunas na formação do profissional de saúde. O objetivo desse artigo é descrever as vantagens, desafios e obstáculos para a implementação da simulação in situ em um hospital de ensino de cuidados terciários. O programa levou a uma melhoria na organização e avaliação de sistemas de gerenciamento de código (Code Blue) utilizado pelo hospital. Como lições aprendidas destacamos: metas claras devem ser estabelecidas, avaliadas e revistas ao longo do processo; a técnica de debriefing melhora o desempenho da equipe, ajuda a identificar problemas, bem como soluções, e permite aos participantes de contribuir e processar emocionalmente a sua formação, e; a atividade desenvolvida in situ identifica deficiências no atendimento ao paciente especialmente no que se relaciona às necessidades do gerenciamento de risco. A experiência indica que a simulação in situ é uma ferramenta valiosa e segura para identificar as necessidades, promover a comunicação eficaz, melhorar as habilidades técnicas e implementar melhorias de processos em um ambiente médico de alto risco.

Palavras-chave: *Simulação de Paciente; Intervenção na Crise; Educação Médica.*

INTRODUCTION

Since the release of the Institute of Medicine's landmark report, "To Err is Human: Building a Safer Health System," there has been an increased focus on reducing iatrogenic injuries and errors in patient care[1]. Medical simulation has been increasingly recognized as a modality that can be used to reduce medical errors in a variety of care settings and with varying degrees of realism. Recent advances in simulator and wireless technology provide further opportunities to take this training directly into the work environment, hereafter referred to as *in situ* simulation, which is defined as simulation-based training that occurs in a clinical environment with participants who are on-duty[2].

While *in situ* medical simulation is still a relatively new learning methodology that requires further validation, a recent systematic review by Rosen *et al.* (2012) concluded that the simulation *in situ* has a positive impact on training, continuing education and organizational performance[3].

In this article we discuss the advantages, challenges and obstacles for implementing *in situ* simulation in a tertiary care hospital. In addition, we will discuss the debriefing and fidelity as related to in situ simulation. We also will present our experience.

METHOD

Advantages

Some examples of obstacles that can easily be identified *in situ* are: errors in the understanding or implementation of protocols, limitations imposed by the physical environment, and problems with communication between colleagues. For instance, practitioners may rehearse a cardiac arrest scenario in the simulation lab to learn or practice fundamental technical skills such as defibrillator use or cardiopulmonar resuscitation (RCP). When practicing in an actual work environment, new dimensions of the same skills (such as difficulty finding/applying/connecting the defibrillator or difficulty providing quality chest compressions on a hospital bed) may appear. In this manner, *in situ* simulation can help to uncover system-level issues and can be used as part of a continuous quality improvement program for patient care.

In situ simulation can be used to train an individual or even an entire healthcare team to perform infrequent (yet critical) tasks, use new or seldom needed equipment, and to implement or practice hospital protocols. In Situ simulation can be used as a tool to identify both gaps in training and areas for improvement[4].

Additionally, an *in situ* simulation program can be created in a cost effective manner. There is no need for an expensive simulation center, apart from physical storage space for the mannequin and related equipment. Additional compensation for training tim e can be reduced if the training can occur during work hours. Furthermore, in situ simulation is a highly visible way to present medical simulation training to health system leadership. This training can demonstrate the potential return on investment for staff training and patient safety before investing in a full simulation center or division.

Challenges

Creating an *in situ* simulation program can pose challenges that are technical, administrative, logistical, cultural and financial. Fortunately, effective planning and good communication can overcome most of these obstacles.

Occupying a patient care space while removing active clinical staff from patient care has the potential to result in delays in care or other harm to real patients. The team must always balance the risk versus the benefit of training in real time. There should be a low threshold to reschedule or cancel *in situ* training due to unit overcrowding, understaffing, or actual emergencies.

Logistical issues are particularly complex in high acuity units, such as the Emergency Department or Intensive Care Unit (ICU), and can also occur during hospital-wide patient surges. Facilitators should communicate early and often with administrative personnel to confirm the feasibility of running the simulation exercise. The team must also be flexible with training locations (e.g. using a break room or a less traveled hallway instead of a patient room). In our experience, increased realism can still be maintained in a number of these nontraditional hospital areas and room settings, despite physical space limitations. Establishing these parameters with hospital leadership, particularly nursing leadership, is essential to success.

Timing of the event is a fundamental aspect of a successful *in situ* simulation program. For our in-hospital mock codes, our goal is to be in and out of the unit within 30 minutes. This time includes set up, briefing of the primary responder to basic mannequin functions, running the scenario and debriefing. Equipment setup and removal takes approximately 10 minutes. The scenarios are standardized and pre-programmed to last for 10 minutes. Two faculty physician members of the simulation team perform a 10-minute debriefing with a standardized checklist: one list reviews technical skills and emphasizes crisis resource management skills (Table 1).

Since such a short debriefing session may be insufficient for some participants, we follow this with a standardized email to participants that contain both a written summary and 2-3 minutes of video debriefing . This asynchronous highlight reel and 2-3 minutes of video debriefing with notes for improvement is created and released within 48 hours of the session using standard video editing software[5]. It is likewise important to include multiple hospital shifts in planning (day and night) to achieve further saturation of training efforts, while also balancing the involvement of simulation staff and faculty. In situ simulation training usually requires the use of hospital equipment and medical supplies. The use of existing unit supplies can help to identify obstacles that may be present during real events (such as equipment/medication availability, accessibility, difficulties with administration, dosing, etc.) but can easily and quickly add significant costs to an ongoing *in situ* training program. A more cost effective approach is to use expired or mock supplies similar to the actual medications in the unit. We employ a mock code crash cart containing expired and artificial drug replicas with similar packaging. This practice is effective and popular, but caution must be taken so that these supplies are not inadvertently used for actual patient care! All of our artificial drugs and our mock crash cart are conspicuously labeled and processed separately to reduce the likelihood of error. Charges are absorbed through our hospital training budget and our pharmacy staff is intimately involved in the process of evaluating the use of the cart for best practice.

The amount of work technical personnel must provide for an effective *in situ* simulation experience (including transport and setup of equipment, running simulations, debriefing and clean up) should not be underestimated. Our experience demonstrates the value of having an interdisciplinary team to help distribute the workload. This team is comprised of clinical staff from different departments –nursing, pharmacy, respiratory therapy and physicians of various disciplines. Our key to success was the development of a team approach that provides opportunities for input and responsibility from all stakeholders. Equipment storage near to target units and having a dedicated gurney to transport the mannequin makes moving the equipment easier. Checklists of required equipment reduce the risk of loss or forgetting necessary supplies. Scheduling events at least 3 months out can help simulation personnel ensure sufficient staffing and can smooth out hospital ward availability and saturation. We have chosen late morning and late night training to avoid medication administration times, meal times, and morning physician rounds.

Table 1 – FV clinical case: critical actions, crisis management and questions

Critical actions	Crisis resource management	Open ended questions
Initial Assessment • Assess consciousness • Check pulses • Call for help • Start CPR • Place on monitor and attach pads	Use Effective Communication • Remain calm and professional • Use closed-loop communication • Share information and critical events • Share the plan and next steps in care	Advocacy: Identify if Performance Gap or Desired Actions • I noticed that the team did/ didn t…. • I saw team did/ didn t…. • I heard the team did/ didn t…. • I was concerned to see that the team did/ didn t…. •I was impressed by how the team did/ didn t….
*Role Assignments • Airway • CPR providers • Recorder • IV access • Medication • Team leader	Utilize Resources Well • Call for help early • Distribute workload optimally (no multitasking)	
RCP • Lower the bed & side rails • Use the back board • Appropriate CPR depth and rate • Minimal interruptions • Appropriate BVM • Use OPA/NPA • Early vasopressors: Epinepnrine/vasopressin • Amiodarone after 2-3 unsuccessful shocks • Rhythm check, pulse check every 2 min DESFIBRILLATION • Keep compressions through the load before the crash • Defibrillation unsynchronized 200J • Immediately resume CPR after the shock	Establish Role Clarity • Team leader identified • Appropriate leadership transition • Team member roles and tasks identified	

Simulation exercises are intimidating to some participants. Mistakes may be made in front of colleagues and even supervisors. Being recorded during the simulation adds stress, particularly if the participant does not understand the purpose of the recorded video. The simulation team should develop a consent process related to *in situ* simulations and clearly communicate the intended objectives to learners. Trust must be established between the simulation team and the participants. Any violation of how videos are used or whether participants are judged based on their simulation performance could endanger the fundamental principles of "safe learning." If any research is to be done with associated data, Institutional Review Board approval is a must.

Finally, clear goals must be evaluated and maintained or revised accordingly throughout the process. Sharing data about the potential impact on patient safety goals with hospital leadership and participants can further motivate learners and increase buy-in. In situ simulations can make existing challenges more visible and help all participants develop and apply new strategies for problem solving.

Debriefing

Debriefing is a critical aspect of simulation[6,7]. Without organized debriefing, the level of learning that is intended may not occur[8]. "Debriefing" means taking the time to share thoughts about team performance, solutions for discovered problems, and to express emotions and feelings about the event. Facilitators - in addition to providing direct feedback based on their own observations - must always seek input from the participants who have been involved in the exercise regarding their own performance and their suggested solutions.

As mentioned before, time constraints may be an obstacle to debriefing. We suggest the following steps to reduce these constraints:

• Have the objectives of the debriefing standardized and written ahead of time. Doing so helps focus the debriefing on the important items and avoids focusing on secondary or irrelevant issues.

• Distribute the standardized debriefing format to the simulation team. We have designed and rehearsed a

10-minute focused oral debriefing using two facilitators who focus on technical and crisis resources management issues, respectively.

• Follow the simulation event with a standardized follow-up written summary to highlight the critical actions of the simulation case.

• Consider video taping the simulation exercise (and even the oral debriefing). This allows for "asynchronous debriefing," which can further emphasize critical points in a multimedia format without any time constraints inherent in face-to-face debriefing.

• Inputs from the participants about the simulation exercise may not come during the debriefing time. This may be due to time constraints or from participant fear of being criticized or of criticizing their colleagues or the simulation team. An electronic survey and/or email system should be developed to allow for input about the exercises and suggests for solutions to problems encountered or ways to improve the simulation.

Video Taped Simulation Exercise

Although studies showed mixed results about the benefit of video taping simulation exercises, proper use of video adds further educational benefits for in situ simulations.

These benefits may include:

• Allowing participants to watch their own performance on their own time.

• Developing systems to objectively assess the participants' performance.

• Identification of any incongruities between actual and perceived performance.

• Performance and quality reviews to identify further issues that may not have been observed in the "live" in situ simulation.

• Aiding the simulation team to occupy the unit only for the shortest amount of time necessary to complete the goals of the simulation.

• Assisting in facilitator training for new staff.

Videotaping may be challenging due to:

• An anxiety provoking effect on participants.

• Time and labor commitments required for the team to review and edit such videos.

• Possible privacy issues related to any incidental taping of nearby patients and their families.

• Possible privacy concerns of the participant.

• Any cost associated with obtaining and using video taping equipment.

The purpose of the taping, how and where the videos will be stored, who has access to view the videos and whether the videos will be used for any assessment and evaluation purposes must all be clarified to the participants prior to taping. Institutional regulations must be followed and participant permission must be obtained.

Finally, videotaping may complicate how in situ simulations impact team performance due to the Hawthorne effect along with the additional anxiety of being video taped. The Hawthorne effect (also referred to as the observer effect) refers to the phenomenon whereby individuals improve or modify aspects of their behavior in response to their awareness of being observed. It may be difficult to determine if any improvement in performance is due solely to the Hawthorne effect or if improvement is due to the training that has occurred[9].

Fidelity

Dr. David Gaba, the "father" of medical simulation, says, "Simulation is a technique - not a technology – to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner[10]." It is implied, then, that an effective simulation does not necessarily require a high tech, high fidelity simulator device. A fancy simulator device may not result in a realistic simulation event unless great detail is taken in scenario planning.

The "fidelity" of an in situ simulation refers to how realistically it represents actual events. We will discuss the fidelity in three aspects: the mannequin, the environment and the scenario.

The Mannequin

The low fidelity mannequins have limited features. They may not be controlled by a computer and most likely do not capture data. Lee (2008) showed there was no difference in learning outcomes between high and the low fidelity mannequins[11]. While more cost-intensive, a systematic review recently concluded that the use of high fidelity mannequins can provide better learning in inter-professional simulation[12].

We have used a patient size solid dummy to train prehospital health care providers on many tasks such as communication, extractions, and transport. These affordable, human size dummies have been suitable to meet our objec-

tives as well as high fidelity mannequins in some settings, at a fraction of the cost. When simulations require emotional or verbal engagement, a standardized patient may be the best "simulator" of them all.

High fidelity mannequins may be more useful in achieving certain training objectives. The latest technology mannequins have a variety of clinical feedback options to providers. Physiology is as realistic as possible, given the obvious limitations. The mannequins can work with current hospital equipment, such as ventilators, invasive lines and defibrillators. Rechargeable batteries last long enough to run multiple scenarios and can be remotely controlled by a laptop. Portable CO2 cartridges and O2 delivery allow for realistic gas exchange scenarios. All of these features make it possible to run a code in a variety of hospital settings, including patient rooms, hallways, and clinics. These can be vital features if the scenario requires the movement of the mannequin from one place to another. Such wireless mannequins can be very valuable in disaster training or can be used in dynamic settings with pre-hospital arrival, triage, resuscitation room stabilization, and transport to further care. As with all expensive mannequins, making sure you understand the manufacturer's warranty and transporting the devices carefully is critical to maintain equipment quality.

High fidelity mannequins often record important scenario data. This helps to objectively assess team performance with certain tasks and to conduct related research. Data such as bagging rate, tidal volume delivered, frequency of pulse checks, chest compression quality, and the speed/success of intubation can be used in debriefing or to track improvement of the team over time. High fidelity mannequins can also be programmed to run the same scenario repeatedly, in exactly the same way, allowing for controlled and standardized cases for the purpose of research.

It must be noted that participants may not be familiar with what mannequins can or cannot do. Proper orientation of participants is critical so that participant interaction with the device is appropriate. An email orientation with a short video clip about the mannequin (where they can feel the pulse, where they can place an IV, whether or not they can intubate the mannequin, etc.) makes running the scenario easier and more realistic.

The Scenario

Scenarios should be created based on events that have occurred or could occur in the unit involved. We recommend a focus on events that carry potential for significant patient harm in order to justify the time and expense of running the scenario. Make the event as realistic and "true to life" as possible. This will allow the scenario to be a tool to evaluate team communication, training and system issues that could occur in a real event.

The scenarios should be direct, with clear goals and not too complicated. In our hospital, we use mock "Code Blue" events (cardiac arrest events). These are simple scenarios that could happen in any unit of the hospital at any time. We alternate different, yet straightforward scenarios of arrest for both shockable and non-shockable rhythms. Keeping the scenarios simple allows us to focus on system level issues without distracting the participants or introducing more opportunities for technical errors to occur.

Recently, we have begun to run trauma mock codes in the emergency department using a slightly different approach. We ask the emergency department and trauma surgery personnel to identify different items that they believe may adversely affect patient safety, or issues from recent morbidity and mortality conferences. We then design trauma mock code scenarios that involve these pre-identified areas. By running the scenario in different stages (EMS, triage, resuscitation room, radiology, etc.) we can identify deficiencies in real time and discuss possible solutions. Thus, morbidity and mortality rounds may be a good resource to design valuable relevant scenarios.

The Physical and Psychological Environment

It is very important that the psychological environment is as realistic as possible. Facilitators should minimize interruptions as the scenario evolves. Using cameras to broadcast the event into an adjacent, but physically separated place for the facilitator to watch without being seen may increase the fidelity. This usually adds to the cost and increases the chance of a technical error. Another option is to use a curtain to separate the facilitators from the participants. True psychological realism cannot be established, but making the environment as realistic as possible will help to identify realistic errors.

RESULTS

Practitioners with different backgrounds assemble to form a Code Blue team and provide in-hospital cardiac arrest care at our facility. Nurses from the unit initiate the code. Nearby physicians typically join in the effort and are followed by a dedicated group of ICU nurses and resident

physicians from on-call teams. Often these practitioners do not know each other, yet these personnel are expected to communicate, coordinate and cooperate as a single, cohesive unit. Good protocols, communication skills and teamwork behaviors are critical to success. In situ mock Code Blue events help us to practice this process and identify areas for improvement. Providers practice skills in a safe and controlled environment, including chest compressions, basic/advanced airway management, medication administration, and defibrillation technique. It is important to recognize that a frequent source of error is related to communication[13,14]. Hence, behavior such as calling for help early, identifying a team leader, having members announce their arrival, utilizing closed loop communication, and distributing the work optimally are observed and are reinforced during the debriefing process.

Despite cost issues, Calhoun et al. (2011) has demonstrated the feasibility of in situ simulation program using minimal space and reduced costs in a children's hospital setting[15]. Between August 2012 and December 2013, we conducted a total of 32 simulated cardiopulmonary arrest codes. These involved groups numbering between 6 and 20 interdisciplinary participants. We recorded and tracked compression fraction (the proportion of time that chest compressions were on-going during periods of pulselessness), average time to epinephrine administration and the average number of RCP interruptions in each event. We have noted trends toward improvement in units where our mock codes have occurred more frequently and have continued the codes throughout 2014 (our data is currently pending publication). Most importantly, we have identified clear opportunities for improvement in the overall organization of code management in our hospital system.

CONCLUSION

In situ simulation has given us a window into the potential challenges and opportunities facing our current model of inpatient medical care. The data we have acquired has helped us to identify actionable areas of improvement with our health system leadership and risk management office. Our experience demonstrates that in situ simulation with interdisciplinary participation in a real patient care setting is a valuable tool to identify needs and to promote effective communication, technical skills and process improvement in a complex and high-risk environment.

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