In-situ simulation of cardiac arrest in ventricular fibrillation for professional nursing training

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ABSTRACT

Objective: Report the experience and perception of nursing professionals with an unannounced *in-situ* simulation of cardiopulmonary arrest (CPA) in ventricular fibrillation in an in-hospital environment. **Methods:** A high-fidelity mannequin (Laerdal®) was placed on the isolation bed of a Coronary Care Unit with a monitoring center without the knowledge of the nursing professionals taking over the shift. A nurse technician from the previous shift was told to report the case as a fictitious newly admitted patient with acute myocardial infarction. After the care transition, the cardiac rhythm was changed from sinus rhythm to ventricular fibrillation. The time was recorded (in minutes and seconds) from the onset of ventricular fibrillation until a nursing professional triggered an effective action. After the professionals realized it was a mannequin, they were instructed to initiate the appropriate interventions as if the mannequin were an actual patient. After the end of the simulation, a questionnaire was used to assess the professionals' perception of the activity. **Results:** Fifteen professionals participated in this *in-situ* simulation. The reaction time was 28 seconds on the morning shift, two minutes and six seconds on the afternoon shift, and four minutes and three seconds on the night shift. All professionals (100%) recognized the importance of this training, and all thought it increased professional and patient safety. Most participants (90%) thought it could improve communication among the team. All professionals (100%) felt that such activities should be repeated. **Conclusion:** *In-situ* simulation is a feasible alternative to train nursing professionals in the initial CPA management in a Brazilian emergency hospital. Participants positively evaluated this activity.

Keywords: Simulation, Cardiac arrest, Health education, Nursing care.

INTRODUCTION

Simulation-based teaching is an active and widely employed learning methodology. One of the reasons is that it allows training of skills and competencies in a safe environment and without offering risks to patients.[1]

Due to the need to use mannequins and specialized equipment, this activity is usually carried out in simulation laboratories; thus, it is called off-site training. However, in recent decades, a new simulation format has been introduced, called *in situ*, from Latin and means in its place, in its initial position. In this format, the simulation activity takes place in the healthcare providers' environment, inside the hospital.[2]

The advantages of *in-situ* simulation include training the entire work team; using equipment, medications, and materials available locally; evaluating organizational aspects; and systematizing health care. These characteristics promote greater simulation fidelity and better approximation to daily practice; therefore, health professionals are expected to be very receptive to this type of training.[3,4]

The objective was to describe our experience of conducting an *in-situ* simulation within a permanent education program for training nursing professionals to recognize and treat in-hospital cardiopulmonary arrest (CPA) in ventricular fibrillation. Subsequently, the participants' perception of this pedagogical strategy was collected and reported.

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METHODS

The *in-situ* simulation took place at the Coronary Unit of the Emergency Unit of the Hospital das Clínicas of Ribeirão Preto School of Medicine, São Paulo University, on December 6, 2016, as part of the permanent education actions in this hospital.

This unit has ten beds exclusively dedicated to cardiac emergency care, one of which is for contact/respiratory isolation. It has an average of 50 admissions per month. All beds are monitored through the Dixtal DX2020 monitors interconnected by two monitoring centers, one positioned in front of the nursing station and the other in front of the medical prescription counter. This project was approved by the Human Research Ethics Committee of the HC-FMRP/USP (approval number 11745/2018). However, the approval to disclose this activity occurred after its execution because only after carrying out the training the authors realized the possibility of organizing a scientific article to report this experience.

The *in-situ* simulation was conducted with all nursing technicians and nurses on duty during the morning, afternoon, and night shifts on the same day between 7:00 am and 8:00 am, 1:00 pm and 2:00 pm, and 7:00 pm to 8:00 pm, respectively. These professionals were not previously informed about the activity. A cardiologist with training in realistic simulation and an instructor of the Advanced Cardiac Life Support course, as well as the head nurse of this unit, were in charge of planning, organizing, and executing the activity.

A Laerdal® mannequin was previously placed in the isolation bed in this unit without the knowledge of the professionals entering the shift day. The mannequin was programmed in sinus rhythm, with a heart rate of 79 bpm, a blood pressure of 137 × 85 mmHg, and an arterial oxygen saturation of 97%, with direct transmission to the monitoring centers. Figure 1A.

A nursing technician from the previous work shift was trained to perform the shift change using a fictional story that a 54-year-old patient called João da Silva was hospitalized in the isolation bed of the unit. He was admitted at night with a diagnosis of ST-elevation acute myocardial infarction. He underwent a primary angioplasty with coronary stent implantation four hours after the chest pain onset, and, since then, he had been stable and uneventful.

After the nursing professionals finished the shift handover, the mannequin's heart rate was changed to ventricular fibrillation and the arterial oxygen saturation value and curve were removed from the monitor. The last noninvasive blood pressure measurement record was kept on

Figure 1. Illustration of the multiparameter monitor used in this *in-situ* simulation, initially in sinus rhythm (A) and later in ventricular fibrillation (B).

the monitor, as it is usually automatically checked every 30 minutes. Figure 1B.

The head nurse on duty was responsible for recording the time from ventricular fibrillation onset at the monitoring center in front of the nursing station until the perception of this change by a nursing professional. The physicians in this unit were informed about the simulation and were oriented not to trigger any intervention.

When a nursing professional noticed the ventricular fibrillation and entered the isolation bed, the head nurse explained that despite the patient being a mannequin, the nursing team needed to trigger the necessary actions as an actual situation.

A checklist previously developed by the simulation organizers was used to assess the competencies expected in the CPA setting. This checklist is shown in Table 1 and was based on the Basic Life Support course of the American Heart Association.[5]

After the activity ended, a debriefing was conducted with the team pointing out the positive aspects of the exercise and those that could be optimized to provide adequate care to the patient. Then, a questionnaire with questions developed by the organizers was given to the participants to be actively and anonymously filled out to evaluate their perception of the activity. The questionnaire contained ten questions listed in Table 2. All

Table 1

Characterization of nursing professionals who participated in the *in-situ* simulation of a cardiopulmonary arrest in ventricular fibrillation and checklist of the competencies expected in this scenario.

	Work shift		
	Morning N=5	Afternoon N=5	Night N=5
Characteristics			
Nursing technician; n(%)	4(80)	5(100)	4(80)
Nurse; n(%)	1(20)	0(00)	1(20)
Female; n(%)	4(80)	5(100)	3(60)
Age (years); mean ± SD	33±5	40±9	44±8
Time after undergraduate (years); mean ± SD	9±3	11±4	15±5
Time in the unit (years); mean ± SD	6±2	3±1	5±2
Basic Life Support course; n(%)	5(100)	4(80)	3(60)
Checklist			
Reaction time (minutes: seconds)	0:28	02:06	04:03
Recognize ventricular fibrillation	Yes	No	Yes
Assess responsiveness	No	No	No
Call the medical team	Yes	Yes	Yes
Bring the defibrillator	Yes	Yes	Yes
Put the gel on the paddles	No	No	No
Palpate the carotid pulse	No	No	No
Put the rigid platform in place	Yes	No	No
Start chest compression	Yes	Yes	Yes
Initiates bag-valve ventilation	Yes	Yes	Yes
Synchronizes compressions and ventilations	Yes	No	No
A healthcare provider assumes the leadership	Yes	No	Yes
Organize the setting	Yes	No	Yes

SD, standard deviation.

Table 2

Instrument used to assess nursing professionals' perception after the *in-situ* simulation of cardiopulmonary arrest (CPA) in ventricular fibrillation in the in-hospital environment.

	Questions	NO			MAYBE			YES		
Q1	Have you ever participated in a simulation?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q2	Was it easy to identify the rhythm on the monitor?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q3	Is it essential for nursing professionals to know how to recognize primary arrhythmias?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q4	Do you know the actions to be performed in a CPA?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q5	Do you realize that immediate defibrillation is the treatment for this patient?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q6	Do you consider this type of training necessary?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q7	After this training, do you feel more confident about CPA assistance?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q8	Can this type of simulation improve communication among the team during real service?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q9	Can this kind of simulation increase real patient safety?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Q10	Should similar activities be repeated?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

answers were quantified using a Likert-type scale ranging from one to nine, with number one referring to a negative response (no) and number nine referring to a positive answer (yes).[6,7]

Categorical variables were expressed as percentages. The Shapiro-Wilk test was used to evaluate the type of distribution of the variables. Continuous variables with normal distribution were expressed as mean ± standard deviation and the others as the median and interquartile range (IQR). STATA software version 13.1 was used for data analysis and graph construction.

RESULTS

The *in-situ* simulation was carried out with 15 nursing professionals, five professionals in each work shift, 13 nursing technicians (90%), and two nurses (9%), with a predominance of females (80%), with a mean age of 38±8 years, 11±4 years after finishing nursing training, 5±2 years working in this unit, and 12 professionals (80%) trained in Basic Life Support. Table 1

The reaction time of the nursing team was 28 seconds on the morning shift, two minutes and six seconds on the afternoon shift, and four minutes and three seconds on the night shift. The evaluation of the monitoring center on the morning and night shifts suggested ventricular fibrillation identification. On the afternoon shift, despite the immediate reaction, the nursing team did not raise this diagnosis.

In all shifts, responsiveness and carotid pulse were not evaluated. They immediately called the medical team and brought the cardiac defibrillator into the isolation room. None of them put gel on the defibrillator paddles, anticipating the need for immediate defibrillation. The rigid platform was placed under the patient to optimize chest compressions only on the morning shift. All teams initiated chest compressions and bag-mask ventilation. Synchronization between the 30 compressions and the two ventilations was not performed in only one of the teams. One professional took on the leadership role and helped organize the setting in two of the three teams.

Debriefing took place immediately after the scenario, reflecting on items that were correctly performed by the team and those that were not remembered. The debriefer explained the importance of the execution of each item. Next, the questionnaire was applied to assess the nursing professionals' perception of the *in-situ* simulation.

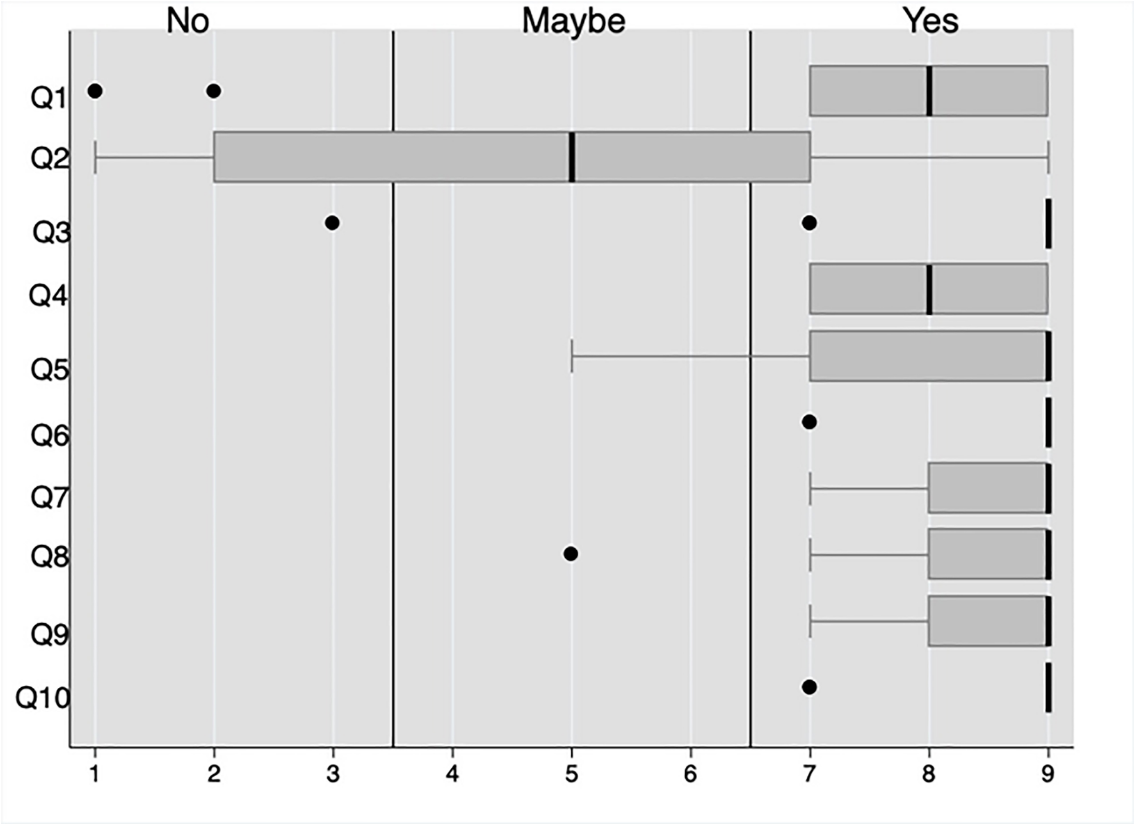

Figure 2. Box-plot graph showing the answers to the ten questions to assess the perception of nursing professionals about the *in-situ* simulation of cardiopulmonary arrest in ventricular fibrillation.

Most professionals had already participated in some simulation activity (80%), with a median of 8 (IQR 7−9). Six professionals (40%) had difficulty identifying ventricular fibrillation, with a median of 5 (IQR 2−7). Most professionals considered it essential to know how to identify this arrhythmia (90%). All professionals (100%) said they knew the actions in CPA care, with a median of 8 (IQR 7−9). Most professionals (90%) recognized that defibrillation is the immediate treatment for this situation, with a median of 9 (IQR 7−9). Figure 2

The black vertical bars represent the median (50th). The sides of the rectangle represent the 25th and 75th percentiles. The vertical bars on the side represent the 10th and 90th percentiles. The percentiles that were not represented on the graph coincided with the median.

All professionals (100%) recognized the importance of this type of training, with a median of 9 (IQR 9−9). All professionals (100%) thought that this training could increase the safety of nursing professionals in real care, with a median of 9 (IQR 8−9). Most (90%) of them thought that the training could improve staff communication, with a median of 9 (IQR 8−9). They all agreed (100%) that *in-situ* simulation could increase real patient safety, with a median of 9 (IQR 8−9). All professionals (100%) thought that new activities like this should be implemented in the hospital, with a median of 9 (IQR 9−9).

DISCUSSION

The report of this experience showed that the *in-situ* simulation is viable for training nursing professionals in CPA care in the hospital environment and that these healthcare providers positively evaluated this educational activity.

By definition, *in-situ* simulation is an educational strategy involving a multidisciplinary team of healthcare professionals in their work environment. Generally, this type of simulation is used with the following objectives: to improve the professionals' skills; to improve the clinical outcomes of the patients; to improve organizational aspects and the safety culture within the hospital; to understand and explore the reason for repeated adverse events; to enhance soft-skills, such as communication between teams; to test the functioning of new spaces for clinical care, equipment, and procedures; and to assess skills in complex clinical scenarios.[8]

There is also an intermediate simulation technique, called off-site in-house simulation, in which there is a physical space planned for the execution of realistic simulations within the hospital environment itself.[9]

The main objective of the reported *in-situ* simulation was to improve the competencies of nursing professionals in recognizing CPA in ventricular fibrillation and triggering the necessary actions within this context after a significant delay in activating this chain of events during a clinical event that occurred in this unit.

As with the off-site simulation, studies show that the *in-situ* simulation can also be theoretically divided into three distinct stages: briefing, the simulated scenario itself, and debriefing. However, it is worth emphasizing that a consensus or standards are still needed to guide the best educational practices for *in-situ* simulations, as there is for off-site simulation.[10,11]

The briefing is adopted in most *in-situ* simulations. This usually involves providing guidance to the participants regarding the objectives of the activity, general instructions about the mannequin and the environment, emphasizing essential concepts for the development of the activity.[10] In this reported experience, the briefing was not carried out first, as this step would interfere with the primary objective of the simulation, which was the recognition of ventricular fibrillation in the monitoring center. However, when the nursing professional entered the isolation room and noticed the mannequin, a short briefing was held, explaining that it was a simulation and that the professional should trigger the necessary actions as if they were with a real patient found in the same situation.

In-situ simulation can be classified as announced versus unannounced. In our investigation, nursing professionals were not previously informed about the activity; therefore, it is classified as unannounced. Generally, the briefing is not conducted in an unannounced *in-situ* simulation. The unannounced *in-situ* simulation may have some potential advantages, such as the evaluation of organizational aspects of the unit, without prior preparation of professionals; however, this may trigger more psychological stress in the team.[12]

In *in-situ* simulation scenarios, the mannequins used can be of low, medium, or high fidelity, depending on their availability. However, even low-fidelity mannequins are effective for learning purposes, allowing this activity to be carried out even in hospitals with fewer financial resources. In most *in-situ* simulations, mannequins are used; however, actors and hybrid formats (actors and integrated mannequins) can be useful.[10]

In-situ simulation scenarios tend to have a short duration (10–30 minutes), but long-term scenarios have been described, such as a 12-hour work shift.[13] Most of the described scenarios were related to CPA, airway management, interpretation of vital signs, and hemorrhage control. There was also a description of scenarios for training skills such as blood collection, insertion of nasogastric and urinary tubes, and venous access.[10]

Debriefing is considered the essential step within the teaching-learning strategy of the *in-situ* simulation, just as in off-site simulation. This is the moment of reflection on all the activities conducted. While different methodologies can be used, a common technique is the plus-delta, which was used in this simulation. In this method, the positive points are initially highlighted, that is, those points executed adequately. Later, issues are mentioned that could be improved both from an individual and team point of view, always carried out within a safe environment and without judgments.[1,14]

Table 3
Comparison between organizational and educational characteristics of off-site versus *in-situ* simulation.

Characteristics	Type of simulation	
	Off-site	***In-situ***
Place	Simulation laboratory	Hospital environment
Previous knowledge of the activity	Always announced	Can be announced or unannounced
Fidelity	Lower	Higher
Scenarios	Several	More restrictive
Equipment	Standardized in the laboratory	Available in the workplace
Duration	Without time restriction	Usually short (10–20 min)
Debriefing	Actions can be recorded in videos	Does not allow video record
Debriefing time	Longer	Shorter
Debriefing location	Comfortable	Improvised
External interference	Nothing	Can happen
Cancellation risk	Lower	Higher
Team displacement	Required	Not required
Individual learning	Similar	Similar
Organizational aspects	Does not allow evaluation	Allows evaluation
Risks for the patient	None	Small
Financial resources	Expensive	Affordable
Learner satisfaction	Similar	Similar

In Table 3, we compare the educational and organizational aspects of off-site versus *in-situ* simulation.

Specifically in the simulation performed, the following positive points were highlighted in the debriefing: rapid recognition of the ventricular fibrillation on the monitor, with a response time of less than five minutes in the three simulations, performed emphasizing the importance of early recognition of this rhythm for a favorable patient outcome. In all shifts, the professionals called the medical team and brought the defibrillator to the scene anticipating the need for defibrillation; they started chest compressions and bag-mask ventilation, with only one group not properly synchronizing the two parameters.

The points for improvement highlighted in the debriefing include the need to assess the responsiveness and carotid pulse to differentiate ventricular fibrillation from a potential artifact in the electrocardiographic monitoring; placement of gel on the defibrillator paddles, emphasizing the importance of this measure to increase the effectiveness of electrical shock; and the placement of a rigid board under the patient to enhance the performance of chest compressions.[14]

Investigations comparing the *in-situ* simulation with off-site simulation are scarce but point out that one of the significant advantages of the first is to allow the evaluation and discussion of organizational aspects of the unit. Some nonrandomized studies suggest that *in-situ* simulation is more effective for learning, mainly because it takes place in a more authentic environment.[15] However, a randomized study comparing these two types of simulation did not show any difference in the variables measured: individual knowledge, attitudes toward patient safety, mental stress, and perceptions of professionals.[3, 16, 17] A recent investigation showed that *in-situ* simulation was a valuable tool to improve interprofessional collaboration and communication among the work team in a post-anesthesia care unit.[18]

Some weaknesses and threats found in the organization of this *in-situ* simulation include the requirement of transporting a mannequin from a simulation laboratory to the hospital unit;

the need to temporarily block a hospital bed to carry out the activity; a small physical space for carrying out the debriefing, which took place with all professionals standing next to the hospital bed; the need to prepare the scenario before each shift change; the displacement of professionals to carry out the activity to the detriment of patient care. On the other hand, opportunities and strengths of this activity include the evaluation of the organizational aspects of the unit; the use of the unit's equipment, such as the defibrillator; the opportunity to discuss the importance of adequate monitoring of these patients, as well as the differentiation of severe arrhythmias with monitoring artifacts through simple steps such as assessing responsiveness and checking the carotid pulse; and most important, due to institutional regulations, it would be impossible to move these professionals to a simulation laboratory during their working hours. Thus, this activity could only be performed in this format.

Regarding the professionals' perception of the activity performed, most professionals considered that it could improve several aspects of care, such as professional and patient safety and communication among healthcare providers. In addition, most thought that this training was necessary and that similar activities should be expanded within continuing education. In other investigations, participants also positively evaluated *in-situ* simulations in questionnaires administered after the exercise, with most participants feeling that they benefited from these activities.[19,20]

We can highlight some limitations concerning our work. First, we evaluated a reduced sample size of nursing professionals (n=15). Second, the researchers developed the perception questionnaire and did not have any prior methodological validation of this tool. In addition, the difficulties inherent in assessing perception using instruments consisting of dichotomous responses, such as the one used in this investigation, are noted. However, no questionnaire was found in the scientific literature that met the needs of the researchers. The quality of chest compressions was not evaluated, such as the frequency, depth, and chest recoil. The quality of chest compressions is an essential component of resuscitation. Feedback devices can evaluate the quality of chest compressions; however, the mannequin used did not have this technological resource.[21] Only one simulation activity was performed in each group. It is known that the repetition of these activities can increase familiarity with the method and, consequently, improve the participants' performance, even modifying their perception.[7]

In-situ simulation is frequently used in large American and European hospitals; however, its use still needs to be widespread in Brazil.[16] Thus, successful experiences like the one described in this article should be publicized in our country.

CONCLUSION

In-situ simulation is a viable alternative to train nursing professionals and should be incorporated into Brazilian hospital units. The participants positively evaluated this educational activity.

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