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☑ Implementation science in nursing, health, and education

Knowledge of the nursing team about cardiac arrest and cardiopulmonary resuscitation: mixed methods studies

Conhecimento da equipe de enfermagem sobre parada e ressuscitação cardiopulmonar: estudos de métodos mistos

Conocimientos del equipo de enfermería sobre paro y reanimación cardiopulmonar: estudios de métodos mixtos

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ABSTRACT

Objective: To analyze the knowledge and perceptions of the nursing team about arrest and cardiopulmonary resuscitation in adults before and after in situ simulation in emergency care.

Method: A sequential explanatory mixed methods study conducted in an Emergency Care Unit. Quantitative data were obtained through pre- and post-simulation questionnaire answered by 21 professionals and analyzed using descriptive and inferential statistics. The qualitative data was obtained through individual structured interviews with 19 professionals, analyzed according to thematic content analysis. The data was combined through connection.

Results: In situ simulation did not significantly change pre- and post-simulation knowledge. Hand positioning for cardiac compressions and handling the automatic external defibrillator had the lowest number of correct answers. The qualitative data indicated difficulties related to knowledge, such as lack of training and insufficient experience with cardiopulmonary resuscitation.

Conclusion: No statistically significant differences were identified in the proportions of answers obtained through the pre- and post-simulation in situ questionnaire regarding correct answers and wrong answers. Furthermore, the qualitative data reinforced the professionals' lack of experience in critical situations, the lack of training and ongoing studies on the subject.

Descriptors: Cardiopulmonary resuscitation. Heart arrest. Simulation training. Nursing. Emergency Nursing.

RESUMO

Objetivo: Analisar o conhecimento e as percepções da equipe de enfermagem sobre parada e ressuscitação cardiopulmonar em adultos pré e pós-simulação *in situ* em pronto atendimento.

Método: Estudo explanatório sequencial de métodos mistos, realizado em Unidade de Pronto Atendimento. Os dados quantitativos foram obtidos por meio de questionário pré e pós-simulação, respondidos por 21 profissionais e analisados mediante estatística descritiva e inferencial. Os dados qualitativos, por meio de entrevista individual estruturada com 19 profissionais, analisadas conforme análise de conteúdo temática. Os dados foram combinados por conexão.

Resultados: A simulação *in situ* não modificou significativamente o conhecimento pré e pós-simulação. Local de posicionamento das mãos para as compressões cardíacas e o manejo do desfibrilador externo automático tiveram o menor número de acertos. Os dados qualitativos indicaram dificuldades relacionadas ao conhecimento, como ausência de treinamentos e falta de experiência com reanimações cardiopulmonares.

Conclusão: Não foram identificadas diferenças com significância estatística nas proporções das respostas obtidas por meio do questionário pré e pós-simulação *in situ* em relação à acerto e erro. Ainda, os dados qualitativos reforçaram a pouca experiência dos profissionais em situações críticas, ausência de treinamentos e de estudos contínuos com relação à temática.

Descritores: Reanimação cardiopulmonar. Parada cardíaca. Treinamento por simulação. Enfermagem. Enfermagem em emergência.

RESUMEN

Objetivo: Analizar los conocimientos y percepciones del equipo de enfermería sobre paro y reanimación cardiorrespiratoria en adultos antes y después de la simulación in situ en atención de emergencia.

Método: Estudio secuencial explicativo de métodos mixtos, realizado en Unidad de Cuidados de Emergencias. Los datos cuantitativos se obtuvieron mediante un cuestionario pre y post-simulación respondido por 21 profesionales y analizado mediante estadística descriptiva e inferencial. Los datos cualitativos procedieron de entrevistas individuales estructuradas con 19 profesionales, analizados según análisis de contenido temático. Los datos se combinaron por conexión.

Resultados: La simulación in situ no modificó significativamente los conocimientos previos y posteriores a la simulación. La colocación de las manos para las compresiones cardíacas y el manejo del desfibrilador externo automático obtuvieron el menor número de respuestas correctas. Los datos cualitativos indicaron dificultades relacionadas con los conocimientos, como la falta de formación y la falta de experiencia en reanimación cardiopulmonar.

Conclusión: No se identificaron diferencias estadísticamente significativas en las proporciones de respuestas correctas e incorrectas obtenidas mediante el cuestionario in situ previo y posterior a la simulación. Además, los datos cualitativos reforzaron falta de experiencia de los profesionales en situaciones críticas, ausencia de formación y estudios en curso sobre el tema.

Descriptores: Reanimación cardiopulmonar. Paro cardíaco. Entrenamiento simulado. Simulación de paciente. Enfermería. Enfermería de Urgencia.

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INTRODUCTION

Clinical simulation is an educational strategy based on real contexts through instructor-guided experiences. When the simulation occurs in the workplace, it is called in situ simulation (ISS). ISS is a realistic and immersive educational experience in the everyday scenario and usually occurs with professionals during their work shifts, representing a cost-effective strategy, as it does not require simulation centers. Also, it uses the team's familiarity with devices, equipment and environments, giving fidelity to the scenario[1-3].

Such experiential teaching strategies are those that underlie the adult learning theory and, therefore, allow the improvement of technical skills, such as manual dexterity and ability to act, and non-technical skills, like communication, initiative and self-confidence, favoring patient care and providing professionals with the opportunity to review their skills[3-6]. ISS, due to its pedagogical character, can be used as a permanent health education strategy (PHE), allowing training based on the demands of the team[5-7].

In critical situations, such as cardiopulmonary arrests (CPA), which pose great risks to patients, simulations allow us to understand team dynamics and system vulnerabilities[8-10]. The lack of training often leads to unsuccessful Cardiopulmonary Resuscitation (CPR), since improper handling of devices or even uncertainty regarding the necessary actions may occur[9]. The American Heart Association (AHA)[10], in its latest update, recommends for healthcare professionals, besides traditional CPR training, the ISS, including situation analysis and reflective learning.

A systematic review[11] that aimed to analyze the effectiveness of ISS on nursing competence pointed out that it is effective and practical for maintaining clinical competence of nurses, improving affective and cognitive skill learning. Further research is needed to determine the ideal frequency of ISS to mitigate skill deterioration, as well as to assess its potential benefits compared to high or low fidelity simulations[11]. In terms of CPR, this strategy can significantly contribute to the fundamental practices for patient survival. Unnecessary actions, lack of knowledge, lack of skills regarding treatment protocol, communication, role allocation, leadership and shared knowledge are associated with delays and errors during resuscitation[12]. Repeated CPR in situ simulation, especially in areas where there is no rapid response team, is therefore important to strengthen initial treatment according to guidelines[13].

When discussing the teaching and learning of CPR for nursing, traditional approaches are often adopted, with instructor-led laboratory skills training and lectures[14]. Considering ISS in the context of urgency and emergency, the following guiding question was established: what are the knowledge and perceptions of the nursing team about cardiopulmonary arrest and resuscitation before and after in situ simulation in an Emergency Care Unit? Given the above, the objective was to analyze the knowledge and perceptions of the nursing team about cardiopulmonary arrest and resuscitation in adults before and after in situ simulation in emergency care.

METHOD

A mixed methods study was conducted with a sequential explanatory design, characterized by the greater weight given to the quantitative stage, with data being collected and analyzed primarily. In this sequence, the qualitative stage aimed to deepen the initial quantitative data[15]. The combination of data occurred through connection. In this case, the quantitative results informed the qualitative sampling objectives[15]. To enhance the methodological rigor of the study, the Mixed Methods Appraisal Tool (MMAT)[16] was used and its recommendations were complied.

This study was developed in a 24-hour Emergency Care Unit (UPA 24h), size I, option III[17], located in a municipality in the mid-west region of the state of Santa Catarina, Brazil. The nursing team consisted of nine nurses and twelve nursing technicians. The inclusion criterion was to be part of the nursing team and to work at the location for at least six months; no exclusion criteria were applied.

Data collection started with communication with the department head and participants about the ISS and its theme. Printed information about the project, its objectives, and the meanings of the SIS were given by the researcher one week before the simulation. The simulated scenario was based on the model proposed by the National League for Nursing (NLN)/Jeffries Simulation Theory guidelines. As a characteristic of the approach, elements and the physical structure of the service were used to create the scenario, along with a medium-fidelity mannequin.

Quantitative data collection (stage 1) took place between January and February 2023. A questionnaire with closed questions was applied immediately before and after the ISS and was answered by 21 professionals. The questionnaire was constructed based on information contained in the AHA Guideline, not validated, but submitted to a pilot test with a team from another ECU, the results of which did not comprise the sample of this study. The questionnaire was administered at both times at the workplace by the main researcher, in each shift (morning, afternoon and night), until the entire team was covered. The questionnaire was given individually to each participant in printed format, containing

15 closed questions, each with four response options and only one correct response. After completion (taking five to ten minutes), the questionnaire was immediately returned to the researcher and stored in an envelope, followed sequentially by the ISS. This same process was repeated immediately after the ISS ending, maintaining the same timing and storage method.

The simulated scenario was set up based on the structuring of the following elements: scenario title, target audience, knowledge before the simulation, simulation modality, location, available materials and equipment, physical structure, additional information, type of simulator, and actors. In the next stage, the objectives of the scenario, briefing time, scenario and debriefing were defined, as well as the preparation of the clinical case read to the participants before the start of the ISS. The scenario was not validated, but a pilot test was conducted with three different teams from another ECU for adjustments; these teams were not part of the study sample. The pilot test of the scenario was conducted by professionals with experience in the subject and support from two professors from a federal public university, one physician and one nurse. All simulations followed the same script and were completed by the lead researcher at the same time, regardless of the participants' performance. The simulation was filmed from the time the case was read until the conclusion of the debriefing.

The simulated scenario was set up inside the unit's Red Room. All materials available were real and could be used by the participants, thus avoiding any make-believe. The scenario was marked on the floor, and it was made clear that the participants could not leave the location to seek help and/or materials. Participants were divided into groups, with one nurse and two nursing technicians each, totaling seven groups with three participants.

The simulation was conducted with the nursing team, due to the limited number of physicians per shift, meaning that a physician would need to participate in the scenario many times while meet the unit's demands. Thus, a student in the 10th phase of the undergraduate nursing course at a private university was trained by a professor of the medical course with experience in the topic to act as a physician in the scene. In this sense, the team present at each simulation included: nursing professionals (one nurse and two nursing technicians), a nursing student (simulated physician), a lead researcher and a nursing student responsible for filming. The research group on scene comprised three individuals.

After completing the questionnaire (approximately 10 minutes), the ISS started with reading the case. Each simulation lasted approximately 35 minutes, with five minutes for the briefing (explanation of the case and resolution of doubts), 15 minutes for the scene and the same period for the debriefing. The case involved a 45-year-old patient who, after being admitted and classified as a top priority (red), was directed to the Red Room with signs of cardiopulmonary arrest. The team participating in the simulation had to evaluate and recognize these signs, then proceed with CPR. During the debriefing, participants were allowed to freely express, avoiding any type of guidance, and there was little interference by the researchers (only when asked). However, any doubts were promptly addressed.

The answer key for the questionnaire was made available to everyone individually so that they could check the errors and correct answers (which were noted at the end of the pre- and post- ISS questionnaires) after all the ISS were completed. The responsible researcher was available throughout the research to answer any questions or provide any necessary explanations, via email or text messaging app.

To meet the methodological assumptions of sequential explanatory mixed methods research, after the quantitative data collection (stage 1), the primary analysis of these data was performed using descriptive statistics to plan the qualitative follow-up. The analysis identified important gaps related to the team's knowledge, as well as the absence of significant changes in this knowledge after the simulation, indicating the need for a qualitative investigation of the phenomenon. Thus, the collection of qualitative data was continued to understand the difficulties related to knowledge, as well as the lack of changes in relation to errors and successes related to CPA/CPR and the general perceptions of professionals concerning this type of care. Based on the primary analysis of the quantitative data, it was decided not to delve into any specific issue.

The qualitative data collection (stage 2) took place between March and April 2023, through structured individual interviews with the professionals who participated in the ISS, scheduled previously at the discretion of the participants, and conducted in a private room at the workplace. Nineteen out of the twenty-one professionals from the first stage participated, as two were no longer part of the staff.

The interviews, which lasted an average of 30 to 40 minutes, were transcribed and recorded in digital media for later validation by the participants and data analysis. The interview script was prepared by the authors and included sample characterization data and essay questions that addressed the participants' perceptions regarding feelings and perceptions during their stay in the scenario, attitudes during the scene, difficulties and feelings after reviewing the answer key concerning the errors and correct answers in the questionnaire and scenario.

The script was previously submitted to a pilot test with a nurse invited from another ECU, who signed the Informed Consent Form, received an explanation of the first stage of the research, as well as justifications for the need of the qualitative stage. This test was not included in the analyses.

Upon completion of both data collection stages, the final analysis of the quantitative and qualitative data was carried out. Quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25.0, through descriptive and inferential analysis, based on the correction of the questionnaires, according to the content of the AHA protocol, and the McNemar test was applied to compare the proportions obtained at the two evaluated times. A p-value < 0.05 was considered statistically significant.

In the analysis of qualitative data, the interviews were initially transcribed literally and later adapted with spelling correction. The data were submitted to a coding process performed using the computerized system ATLAS.ti 22 and analyzed based on the Thematic Content Analysis[18], consisting of three phases: pre-analysis, material exploration, and treatment of the results obtained. The coding revealed thematic categories that were discussed and validated by the study authors.

The study complied with all legal and ethical requirements regarding research with human beings, as set forth in Resolution No. 466/12. The project was assessed by the Research Ethics Committee (CEPSH/UFSC) under number CAAE 46220721,5,0000,0121 registered on the *Plataforma Brasil* and approved under opinion number 4,739,665/2022. The research participants (including those who participated in the pilot stages) signed the Informed Consent Form (ICF), granting authorization for voice and image recording, only for the purposes of this study. For participant identification in stage 2, the initials of the profession were used, that is, N for nurses and NT for Nursing Technicians, followed by a number according to the order in which the interviews were conducted.

RESULTS

Regarding the employment relationship of the participants, 16 (71.42%) were public servants and the majority were female, 18 (85.71%). The characterization of the participants can be observed in Table 1.

In the quantitative study, the questionnaire with 15 questions was answered individually and the in situ simulation did not result in significant changes in pre- and post-simulation knowledge for nurses and nursing technicians, as shown in Table 2. No statistically significant differences were identified in the proportions of responses obtained through the pre- and post-in situ simulation questionnaire regarding correct and incorrect answers ($p > 0.05$).

Table 1 – Characteristics of the study participants. Florianópolis, Santa Catarina, Brazil, 2023

Variables	Professional Category	
	Nurses (n=9)	Nursing Technicians (n=12)
Highest qualification		
Specialist	8 (88.8%)	NA
Master's degree	1 (11.1%)	NA
Studying higher education	NA	1 (8.3%)
Time of experience (in years)*		
Professional experience	8.75±2.76	8.72±4.3
ECU-24h experience	6.12±2.53	5±2.5

* values expressed as mean and standard deviation (±).
NA: not applicable; ECU: emergency care unit (UPA).

Table 2 – Analysis of knowledge about Cardiopulmonary Resuscitation pre- and post-in situ simulation (n=21). Florianópolis, Santa Catarina, Brazil, 2023

Pre- and Post-In Situ Simulation Questionnaire	Pre-In Situ Simulation		Post-In Situ Simulation		p-value*
	Correct n (%)	Incorrect n (%)	Correct n (%)	Incorrect n (%)	
1. What is the sequence of actions that leads the professional to recognize unresponsiveness in a victim suspected of cardiopulmonary arrest	14 (66.7)	7 (33.3)	14 (66.7)	7 (33.3)	1.00
2. When assessing the pulse and breathing to recognize cardiopulmonary arrest, the professional should	13 (61.9)	8 (38.1)	13 (61.9)	8 (38.1)	1.00
3. In the stage of "early recognition and activation of the emergency medical service", within a health institution, help must be requested immediately after identifying the victim's unresponsiveness. This step consists of providing	20 (95.2)	1 (4.8)	18 (85.7)	3 (14.3)	0.50
4. Regarding the recommendation to change professionals during external chest compression and pulse checking	9 (42.9)	12 (57.1)	10 (47.6)	11 (52.4)	1.00
5. On the chest of an adult victim, the correct location for positioning the professional's hands during chest compression is	2 (9.5)	19 (90.5)	2 (9.5)	19 (90.5)	1.00
6. The frequency per minute indicated for external chest compressions in cardiopulmonary resuscitation is	15 (71.4)	6 (28.6)	16 (76.2)	5 (23.8)	1.00
7. Regarding the return of the chest wall while the professional performs external chest compression, it is necessary to	13 (61.9)	8 (38.1)	13 (61.9)	8 (38.1)	1.00
8. When there is no suspicion of cervical injury, airway management in cardiopulmonary resuscitation should occur as follows	15 (71.4)	6 (28.6)	13 (61.9)	8 (38.1)	1.00

Table 2 – Cont.

Pre- and Post-In Situ Simulation Questionnaire	Pre-In Situ Simulation		Post-In Situ Simulation		p-value*
	Correct n (%)	Incorrect n (%)	Correct n (%)	Incorrect n (%)	
9. In adult victims, when external chest compression is performed synchronized with bag-valve-mask ventilation, it is recommended	19 (90.5)	2 (9.5)	21 (100.0)	0 (0.0)	**
10. In an adult victim who has an advanced airway, ventilation should be provided as follows	14 (66.7)	7 (33.3)	15 (71.4)	6 (28.6)	1.00
11. Upon arrival of the automated external defibrillator on the scene, the immediate conduct is	10 (47.6)	11 (52.4)	12 (57.1)	9 (42.9)	0.62
12. The cardiac rhythms indicated for shock by the automated external defibrillator are	11 (52.4)	10 (47.6)	12 (57.1)	9 (42.9)	1.00
13. The recommended conduct for the professional in a scenario in which the Automated External Defibrillator assesses the cardiac rhythm and does not indicate a shock is	5 (23.8)	16 (76.2)	4 (19.0)	17 (81.0)	1.00
14. Regarding the use of epinephrine during cardiopulmonary resuscitation, it is correct what is presented in	14 (66.7)	7 (33.3)	17 (81.0)	4 (19.0)	0.25
15. The administration of amiodarone may be considered in shockable rhythms, and its use is recommended as follows	7 (33.3)	14 (66.7)	9 (42.9)	12 (57.1)	0.50

*McNemar Test; **no statistics calculated because the Post-ISS item is a constant.
Values expressed in absolute (n) and relative (%) frequency.

Although there were no significant changes in the level of knowledge about CPA and CPR, the number of errors in certain questions was significant, especially in question 5, about the correct positioning of the professionals' hands during external chest compressions, for which the number of correct answers among all participants (n=21) was only 2 (9.5%). The number of correct answers to this question, remained unchanged after the ISS.

Out of the 15 questions, some indicated the team's deficient knowledge regarding CPR, for example, the recommendation to change professionals every 120 seconds of chest compressions and who should check the pulse, the correct positioning of hands, the use of the automated external defibrillator and the recommendation to use amiodarone.

In the qualitative study, following the analytical process after transcribing the interviews, the data were entered into the ATLAS.ti.22 software for organization. The relationship between the phases of thematic content analysis and the

interviews were called primary documents, which had numerous fragments selected, called quotations. These are always associated with codes, which are the codes assigned by researchers according to their research object, as shown in Table 3.

The codes represent the aspects involved by the nursing team in the care of cardiopulmonary arrest in the emergency care unit and were organized into two analytical categories: Care for cardiopulmonary arrest: team knowledge and organization; and Search for knowledge and self-education: self-perceived weaknesses, as shown in Table 4.

Chart 1 – Relationships between the phases of content analysis and the ATLAS.ti software. Florianópolis, Santa Catarina, Brazil, 2023

Phases of analysis	ATLAS.ti Software
1st Phase: Pre-analysis	Creation and saving of the hermeneutic unit. Insertion of selected primary documents
2nd Phase: Material Exploration	Selection of quotations. Creation of codes. Grouping of codes into families. Creation of memos
3rd Phase: Interpretation	Articulation between quotations, Codes, Families, and Memos, guided by the objectives and theoretical framework. Generation of Networks. Extraction of Outputs

Table 3 – Distribution of the number of quotations [n=66] according to the codes [8] on nursing team care in cardiopulmonary arrest and resuscitation after in situ simulation. Florianópolis, Santa Catarina, Brazil, 2023

Codes	Quotations n (%)
1. disorganization	14 (21.2)
2. difficulties	12 (18.2)
3. cardiac compressions	10 (15.1)
4. medications	8 (12.1)
5. doubts	7 (10.6)
6. training	5 (7.6)
7. leadership	5 (7.6)
8. study more	5 (7.6)
Total	**66 (100.0)**

Values expressed in absolute (n) and relative (%) frequency.

Table 4 – Analytical categories based on the grouping of codes [8] and quotations [66]. Florianópolis, Santa Catarina, Brazil, 2023

Category title	Codes	Quotations
Care for cardiopulmonary arrest: team knowledge and organization	1, 2, 3, 4, 5, 7	85.1%
Search for knowledge and self-education: self-perceived weaknesses	6, 8	14.9%
Total		**100**

resources available in the software aimed to synthesize this association, as shown in Chart 1.

A file was created in the software that gathered the research data, called the hermeneutic unit. All the inserted

Care for cardiopulmonary arrest: team knowledge and organization

This category represented 85.1% of quotations and, based on the answers to the questionnaire, indicated the difficulties in knowledge related to CPA care, focusing on the disorganization of the team, difficulties in care, errors in performing cardiac compressions, medication of administration, doubts about how to act, and lack of leadership.

Regarding care, the lack of teamwork and lack of leadership were striking for the participants:

> *I know how to puncture, I know how to dilute, I think I know how to do cardiac compressions correctly. I don't have practical difficulties, but the care was disorganized. I always think it could be less messy.* (NT1)

> *I don't like it when we have to respond to cardiopulmonary arrest. Depending on the team that is attending and how it is, I feel lost.* (NT4)

> *During resuscitation, regarding compressions, I was unsure how many times I needed to do them. I still get confused. Because it changes whether the patient is intubated or not.* (NT6)

> *The group had a general difficulty in responding to cardiopulmonary arrest. Everyone was lost. The professional who took over the leadership of the care was very insecure. Everything was very disorganized.* (N4)

> *If I had been the team leader, I would have managed to think about the sequence and not miss important things.* (N1)

Medication administration was also a challenge, even though instructions for dilution and administration were visible:

> *Even regarding medications, I find it quite difficult. Even though the dilutions posted on the wall, we need to practice. With more severe patients, I find it more difficult. During the simulated care, we interacted with the team, but even so, we ended up getting confused with the medication.* (NT2)

Regarding cardiac compressions, the doubts about counting, timing, quantity and depth of compressions and the feeling of ineffectiveness also reflected the feeling of disorganization and lack of practical knowledge.

> *I didn't know that I didn't need to stop compressions to place the monitoring electrodes.* (NT7)

> *Compressions have a pattern, you can't compress the chest anytime, I didn't know that. Sometimes we get desperate and that's not good.* (NT9)

> *Despite having a sequence in mind for CPA care, I got stuck on compressions and couldn't explain to the team how the care sequence should be.* (N01)

> *We forgot to place the rigid board under the patient to do the compressions. We need to improve the compressions, sometimes we stop to do other things.* (NT2)

The sense of learning from reading the pre-simulation questions and having access to the answer key for review proved to be a way to reflect on practice:

> *I learned from the training and from the questions we answered before and after the training. Having access to the answer key also helped a lot. The questions were focused on practice. So, I learned, thought, reflected... if we do everything the same every day, we don't challenge ourselves and we don't think.* (N03)

The difficulties related to CPA care in the 24-hour ECU are modifiable aspects of care practice. The participants' statements reflected the need for better organization and experience in care, but mainly the acquisition of knowledge and review of topics related to CPA care.

Search for knowledge and self-education: self-perceived weaknesses

This category represented 14.9% of quotations, indicating the source of part of the difficulties regarding knowledge about CPA/CPR felt by professionals participating in the in situ simulation, caring for a simulated patient.

> *I'll be honest and say I don't study. I work, take care of the house, husband, children. What I learn, I learn through working. When we have doubts and feel confident in a professional, we ask them to explain. Or a nursing technician shares information with another. And, depending on the doctor, if they have patience, they also explain a lot, especially about medications.* (NT1)
>
> *In the technical course, we had some classes on resuscitation. But I don't study by grabbing a book and spending hours and hours reading, I won't lie. But when I have doubts, I always ask.* (NT6)
>
> *I don't seek out knowledge as often as I should, but from time to time I try to take some in-person, practical course, to update myself on the protocols, at least.* (N1)

Among nursing technicians, the search for knowledge or confirmation of information is done with doctors or nurses if they feel comfortable doing so. Theoretical knowledge seems to be dissociated from practice and privileges experiential knowledge. However, there were reports that, since they are in an undergraduate course, there is a need to study, although still based on everyday experience.

> *I am a nursing student, so I try to study, to learn about things that I see at work, during my internship: something I have never done, something I'm not familiar with, medication I have never seen. That is why I study, but even before, if it was something I didn't know, I would look for it, a new medication to administer, dilution, and what it's used for. I look for it to provide more security to the patient.* (NT3)

In the group of nurses, the perception of the demand for knowledge based on experience or routine in the unit remains. The questionnaire applied to measure knowledge and the in situ simulation indicated the need for theoretical deepening.

> *I always try to organize myself to attend courses, especially since we have institutional support, including funding, it is motivating. The day-to-day situations that challenge me prompt me to seek information, so I'm always studying.* (N4)
>
> *After the questionnaire, I realized that it is always necessary to study more. Because with my work routine, I fall into my comfort zone, I can handle my work comfortably, and these activities make me realize the need to be prepared and trained for emergencies. Because our greatest demand is for mild cases, but we are also a reference for emergencies, and when they occur, we must be prepared.* (N5)
>
> *I think it would be a great opportunity for us to attend other simulations of cardiac arrest. Some people have outdated knowledge: the key points to accelerate the start of maneuvers, which are essential for good patient recovery, including reflections on post-care.* (N7)

The evaluation of care after its occurrence, a strategy used by the in situ simulation, was indicated as a way to reflect on one's own practice.

DISCUSSION

The integration of quantitative and qualitative data through the mixed methods design, allowed to establish associations and broadened the focus of the discussion on several aspects related to the knowledge of the nursing team and its performance in response to a CPA followed by CPR in an emergency care unit. The results of this study indicate a deficient knowledge regarding the management of a CPA, with special importance given to the recommendation to

change professionals every 120 seconds of chest compressions and who should check the pulse, the correct hand positioning, the use of the automatic external defibrillator and the recommendation of the use of amiodarone. These are important topics not only for the effectiveness of care, but also for its organization. These aspects were mentioned by the participants during the interviews.

Regarding hand positioning, a position that is too cranial would compress the ascending aorta or the left ventricular outflow tract, which could lead to lower systolic blood pressure and less effective chest compression, hence the importance of this knowledge for healthcare professionals[18]. According to the AHA, interruptions in compressions should be minimized, and compressions should be performed in the center of the chest, with adequate frequency and chest depth, allowing full chest return between compressions [10].

Regarding the reversible causes of CPA in adults (hypovolemia, hypoxia, acidemia, hypo/hyperkalemia, hypothermia, pneumothorax, cardiac tamponade, toxins, coronary thrombosis and pulmonary thrombosis)[10] are clinical events that can occur within a 24-hour ECU, requiring adequate management and thus, knowledge from the entire team.

The fundamental aspects of CPA care are described in the AHA protocols, which have been widely disseminated internationally in several languages for many years and are subject to periodic reviews. Training professionals to act in CPA scenarios, from undergraduate education level onwards, must follow the AHA precepts, as well as subsequent training in Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS)[19-20]. This protocol is proposed by the Brazilian Society of Cardiology as a model in Brazil.

Successful nursing teams have theoretical knowledge, mastery of resuscitation skills and efficiency in communication and team dynamics. The team's knowledge and response time are important variables and closely linked to a favorable prognosis[19-20]. A recent research[19] showed a progressive decrease in the knowledge of healthcare professionals as they progress from basic to advanced life support (especially that related to the adult survival chain). However, a simulation training program has a positive impact on the knowledge of these professionals and should focus on defibrillation, advanced life support, and post-cardiac arrest care, as well as the leadership functions of nurses. Furthermore, the evaluation of healthcare professionals' skills in urgent care revealed that high-quality chest compressions, responsiveness checks, and management of tachycardia need improvement, as well as the weak leadership performance among nurses[19].

Another study[20] indicated that efforts aimed at the benefit of early defibrillation, before the arrival of the rapid response team, should be replicated, especially regarding the use of the Automated External Defibrillator (AED), since personnel working in a hospital environment where there is no continuous cardiac monitoring will also be less likely to have received training in advanced cardiac rhythm analysis. It is also noteworthy that the use of AED by untrained personnel, without additional educational reinforcement based on theory, is likely to be unsuccessful[20].

To ensure effectiveness in the level of knowledge of those trained, it is necessary to periodically perform simulated scenarios[21-22]. Speaking specifically about ISS, this is a valid strategy for training, however, if it does not occur periodically, it may not represent a significant gain in the daily lives of professionals[23-26]. A research[23] using ISS for CPR training showed that the methodology promoted the development of technical skills with an interval of approximately every four months. For medical interns, there was a statistically significant difference between CPR knowledge pre- and post-ISS, but it was noted that the number of simulations performed in each group showed a positive correlation with their individual skills[23].

A recent study[19] already mentioned, which aimed to identify nursing knowledge and attitudes regarding CPA, conducted with thirty hospital nurses, revealed considerable errors in the questions related to resuscitation maneuvers by the participants; the lowest rates of correct answers referred to the recommended criteria for high-quality chest compressions. Furthermore, some of the interviewees stated that it had been more than two years since they received practical training related to CPR[19].

Another study[24] that investigated the experiences in hospitals in non-intensive care areas and in wards regarding CPR showed that performing Basic Life Support is considered a stressful experience and causes anxiety in nurses working in wards, as these professionals are not prepared for the complexities of resuscitation. The reasons include a lack of leadership during the arrest, anxiety about their own performance, insufficient or outdated knowledge, as well as skills that are lost over time[25-26]. An in situ simulation on CPR developed with multidisciplinary teams in different sectors of a hospital highlighted as a latent threat the technical skills, lack of knowledge, or failure in the proper use of the defibrillator, and ignorance about how to perform effective chest compressions[10].

In addition to whether there are changes in knowledge and skill in procedures, ISS has an influence on non-technical skills and on the potential for reflection of those involved about their own knowledge, as indicated in the qualitative results of this study. This demonstrates that the strategy is useful for provoking reflections on knowledge gaps and weaknesses and strengths of the care provided by the team.

A research[27] that used in situ simulation for CPR training showed its feasibility in emergency care units and its usefulness for development of resuscitation protocols. Participants also reported benefits for themselves and for patients when simulations are recurrent and interprofessional. These benefits include the acquired communication skills, increased understanding of team members regarding their skills, and knowledge about the resources available in the unit[27].

On the other hand, leadership is a non-technical skill whose behavioral pattern is rarely identified in nursing professionals who have undergone cardiovascular emergency simulations[7]. When compared with traditional methods, ISS improves the self-confidence of nursing professionals regarding patient care in CPA[1].

Experience with cardiopulmonary resuscitation causes mood changes and cognitive growth within teams, which can impact leadership actions, and develop self-confidence as they participate in more resuscitations and accumulate experience[28]. In Emergency Rooms, increased confidence in team performance after participating in simulations makes them more effective, strengthening actions aimed at ensuring patient safety[29].

The discovery of areas of fragility in groups that work in CPA and deficiencies in teamwork and leadership, as well as communication skills, is possible through ISS[10]. Even with weaknesses, the individual perception of their own knowledge and the act of studying individually can influence team performance. The effectiveness of ISS in improving individual performance is already known, but long-term skill retention should not be based exclusively on ISS[29]. Thus, the search for specific certified courses, such as those that follow the AHA guidelines, can contribute to the continuous improvement of professionals[7].

A research[29] indicated that healthcare professionals who attended more resuscitation courses (3-6 courses within three years) were associated with a significant increase in knowledge compared to those who attended only a single course. In addition, a long experience in clinical practice (5-10 and more than 10 years) had a similar beneficial effect on CPR knowledge[29].

One research[30] emphasized the value of in situ simulation as a potential tool for assessing CPR performance in hospital settings, since its results have been associated with real patient outcomes. Since CPR requires individual skills and knowledge, as well as optimized teamwork and effective communication, simulation-based training provides the ideal practice environment[30].

This study has limitations regarding the quantitative sample, which was small. Additionally, the data were collected in a single emergency care unit and the questionnaire, although constructed based on AHA topics, was not validated by experts. New research including a larger number of participants and different settings may provide further information about the investigated phenomenon.

CONCLUSION

No statistically significant differences were identified in the proportions of responses obtained from the pre- and post-in situ simulation questionnaires concerning errors and correct answers. This required subjective interpretation of the findings. These, in turn, strengthen the quantitative data and help to understand the phenomenon, since they indicate disorganization, lack of knowledge and lack of leadership, especially, as contributors to the sense of insecurity when resuscitating patients in CPA and, although the ISS did not change knowledge pre- and post-simulation, it highlighted the perception of errors and successes of the nursing team. The results presented reinforce the importance of periodic training regarding CPA/CPR, frequent discussions about protocols and the need to improve leadership in these events. ISS is an effective strategy for reflecting on one's practice and perceiving weaknesses and strengths in patient care in emergency care units.

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