Simulation training for continuing professional development of nurses in cardiology and cardiovascular surgery

Formation par simulation pour le développement professionnel continu des infirmiers en cardiologie et en chirurgie cardiovasculaire

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RÉSUMÉ

Introduction : Dans l'environnement particulier de la réanimation cardiologique, l'arrêt cardio-respiratoire constitue une situation fréquente et l'infirmier(e) joue un rôle clé dans sa prise en charge.

Objectif : Démontrer l'apport de la simulation en matière de développement des compétences infirmières dans ce cadre.

Méthodes : Etude comparative sur échantillons appariés (où le candidat est son propre "témoin" de type avant/après), menée auprès des infirmiers exerçant au pôle de cardiologie et chirurgie cardiovasculaire. Le critère de jugement principal était l'évolution des compétences jugées sur la base d'un score de compétence noté sur 20 évalué avant et après l'instruction par simulation.

Résultats : 32 infirmiers ont participé à l'étude. Malgré une ancienneté médiane de de 8.5 années [4.0–12.5], seuls 44% ont déjà participé à une séance de simulation. Si la plupart (84%) des candidats avaient déjà pratiqué un massage cardiaque externe, 34% seulement ont délivré un choc électrique externe au cours de leur exercice. Nous avons démontré une augmentation significative des scores globaux passant de 8,0 [5,0 – 9,8] à 17,5 [17,0 – 19,0] après la séance de formation par simulation ($p<0.0001$). Tous les critères jugés dans la grille d'évaluation (réanimation cardio-pulmonaire de base, choc électrique externe) ont été significativement améliorés et l'effet le plus positif a été observé au niveau de la défibrillation manuelle où l'expérience préalable des participants était limitée.

Conclusions : L'apprentissage par simulation a été d'un impact positif majeur sur le développement des compétences des infirmiers exerçant en milieu de réanimation cardiologique en matière de gestion de l'arrêt cardio-respiratoire.

Mots clés : Apprentissage par simulation ; arrêt cardio-respiratoire ; soins infirmiers

SUMMARY

Background: Nurses play a key role in cardiac arrest management, especially those assigned to cardiac intensive care units, where they are often actively involved in cardiopulmonary resuscitation.

Aim: To evaluate the effect of simulation training in in continuing professional development of nurses in this setting.

Methods: A comparative study using paired samples (where the candidate was his own control with repeated measures before and after intervention), was conducted among nurses working in the cardiology and cardiovascular surgery division of our institution. The primary endpoint was the change in skills judged on the basis of competency score of 20 assessed before and after simulation training.

Results: 32 nurses participated in the training session. Despite a median job seniority of 8.5 years [4.0 – 12.5], only 44% of nurses had already participated in a simulation session. Although most of the candidates (84%) had previously performed chest compressions, only 34% had delivered an electrical defibrillation during their exercise. We showed a significant increase in overall scores from 8.0 [5.0 - 9.8] to 17.5 [17.0 - 19.0] after the simulation training session ($p<0.0001$). All the criteria judged in the evaluation grid (basic life support, manual electrical defibrillation) were significantly improved and the most positive effect was observed in the manual defibrillation where the prior experience of the participants was limited.

Conclusions: Simulation learning had a major positive impact on the development of nurses' skills in terms of cardiopulmonary resuscitation.

Keywords : Simulation training; cardiac arrest; nurse

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INTRODUCTION

Cardiac arrest (CA) is a common situation in cardiac intensive care unit. The survival of people with cardiac arrest remains poor and early initiation of appropriate cardiopulmonary resuscitation (CPR) can sometimes save life (1).

The nurse plays a key role in the management of CA (2) especially in cardiology and cardiovascular surgery departments (cardiac intensive care unit, cardiac catheterization room, postoperative intensive care unit, operating room etc.), where he is often actively involved in the CPR process in collaboration with the medical team, particularly in some situations when the number of participants is limited (nights and holidays...).

Scientific societies recommend the development, by organizations and caregivers involved in cardiac arrest, of effective systems and strategies to improve survival after CA (1). These recommendations emphasize on the introduction of advanced courses for health personnel covering not only theoretical knowledge but also skills and attitudes needed to be part of a resuscitation team (2).

In Tunisia, no or only few institutional strategies for continuing professional development targeting nurses are available.

On this basis, we aimed through this study to clarify the interest of simulation learning in terms of continuing professional development involving nurses in the management of CA in the environment of cardiology and cardiovascular surgery.

METHODS

Study design

It was a comparative prospective observational study on paired samples (observations obtained in the same individuals where the candidate was his own control: “before and after design”), conducted over two days, targeting nurses working in the cardiology and cardiovascular surgery departments.

Study population

The participants were to be volunteers among the nurses working in the cardiology and cardiovascular surgery departments who could be brought to act in the context of CA. A call for participation was launched by the respective supervisors of both departments. We did not include nurses who did not answer to this call (continuity of care, refusal to participate, leave ...) as well as trainees and volunteers. We excluded administrative health staff and care aides.

Program of the training

The study was conducted over a period of two days in prehospital emergency department of the North Est (SAMU 01 of Tunis) equipped with a simulation unit and a medical team trained in cardiac arrest, basic and advanced CPR learning programs.

This training was designed in two stages. The first stage consisted of a four-hour theoretical teaching session focusing on the current recommendations for basic and advanced life supports (1). The second stage of our study took place in the simulation laboratory. Participants were divided into four groups of eight people. Four trainers (and at the same time assessors) conducted this procedural simulation learning session. The two technical skills targeted by this training were: basic life support including chest compressions and automated external defibrillation (AED) on one hand (Figure 1); and performing manual defibrillation after identification of heart rhythm on electrocardiographic monitoring on the other hand (Figure 2). A demonstration on manikin of the various technical gestures to acquire followed by a debriefing was provided by the instructors.

Figure 1. Low-fidelity procedural training mannikin allowing to assess quality of chest compressions.

Figure 2. Evaluation of manual defibrillation performed by nurse after arrythmia categorization on high-fidelity mannikin.

Study endpoints

A datasheet dedicated to the assessment of the skills targeted by this training was developed beforehand. This datasheet included a grid of 20 criteria rated "0" in case of non-realization and "1" in case of realization (Table 1). This measuring instrument had been evaluated prior to the study with 2 nurses to verify its validity.

Table 1. Datasheet at times T0 (before simulation training) and T1 (after simulation training).

	Yes	No
Basic life support		
1. Alert	□	□
2. Cardiac arrest recognition	□	□
Chest compression		
3. Time interval between alert and chest compressions < 10 s	□	□
4. Put the heel of hand in the centre of the chest	□	□
5. Place one hand on top of the other	□	□
6. Interlace the fingers and avoid pressing on the ribs	□	□
7. Frequency: 100 to 120 b/min	□	□
8. Cycles ratio 30:2 (compressions / ventilation)	□	□
9. Depth: 5cm but not more than 6cm	□	□
10. Compression time = release time	□	□
11. If possible, relays every 2 min	□	□
Automatic external defibrillation		
12. Time interval between alert and setting up automatic external defibrillation <2min	□	□
13. Correct use and follow-up of instructions	□	□
Manual defibrillation		
14. Put the gel	□	□
15. Choose the maximum energy	□	□
16. Remove oxygen	□	□
17. Load pallets	□	□
18. Take the pallets one by one	□	□
19. Safety measures	□	□
20. Last look	□	□

An overall skill score of 20 points was thus assigned to each nurse during a first pass (T0) after the theoretical training provided the day before. In a second run after the demonstration on manikins, a second score (T1), based on the same evaluation grid, was calculated for each candidate.

The primary endpoint of our study was the evolution of skill scores before and after simulation training.

The secondary endpoint was the evolution of notes by items namely: a) basic life support including: diagnosis of CA, alert, chest compressions and AED; and b) manual defibrillation on high-fidelity manikins.

In addition, we obtained from a questionnaire administered before the simulation learning session a self-assessment of the candidates in relation to their performance in terms of management of CA and noted their motivation to participate in such practical training as part of their continuing education.

Ethical considerations

The study was conducted after free and informed consent of the participants. All participants were informed of the anonymity and confidentiality of their responses at the time of the investigation.

Statistical analysis

We conducted descriptive statistical analysis of socio-demographic data to profile participants. Skill assessment scores in pre (T0) and post-simulation training (T1), were subjected to descriptive and correlational analysis on matched samples. The significance level was set at 0.05 and the analysis were performed using SPSS software version 22.0.

RESULTS

Thirty-two nurses participated in this work. The median age was 35 years with [IQR: 32 – 42]. 72% were female. The median seniority was 8.5 years [IQR: 4.0 – 12.5].

Pre-simulation training questionnaire

Data from the questionnaire administered on the second day of training (after theoretical teaching and before practical training) revealed mainly that only 44% of participants had already participated in a simulation learning session and that although most of the candidates participating in the study had already practiced chest compressions (84%),

66% of them had never delivered manual defibrillation in real life despite the median job seniority of 8.5 years. A strong motivation was showed by the participants (94%) in this simulation training organized around the theme of CA. Data from this questionnaire were summarized in table 2.

Table 2. Results of the self-assessment and motivation questionnaire administered before the simulation training session, n = 32.

Questions (yes/no)	No	Yes
I have already participated in a simulation learning session	18 (56%)	14 (44%)
I have already practiced chest compressions	5 (16%)	27 (84%)
I have already delivered manual defibrillation	21 (66%)	11 (34%)
I have seen during my training or my exercise an ineffective resuscitation followed by a death	6 (19%)	26 (81%)

Questions (Likert scale)	Strongly disagree	Disagree	Agree	Totally agree
Simulation scenarios practices are beneficial to my learning	0 (0%)	1 (3%)	1 (3%)	30 (94%)
There should be more of these practices during our training	1 (3%)	2 (6%)	2 (6%)	27 (85%)
Simulation scenarios reflect the reality	2 (6%)	1 (3%)	5 (16%)	24 (75%)
These practices reduce my stress and anxiety in real situations	0 (0%)	3 (9%)	3 (9%)	26 (81%)
These practices increase my performance in real situations	0 (0%)	1 (3%)	5 (16%)	26 (81%)
I feel more anxious during simulation practice than real situations, because I feel observed and judged	7 (22%)	5 (16%)	8 (25%)	12 (37%)
I feel comfortable delivering manual defibrillation	2 (6%)	7 (22%)	7 (22%)	16 (50%)
I feel comfortable conducting a cardiopulmonary resuscitation	0 (0%)	5 (16%)	6 (19%)	21 (65%)

T0 evaluation

Despite prior theoretical training, the median overall skill score was 8.0 out of 20 [IQR: 5.0 – 9.8] at T0. Only 23 candidates (72%) were able to correctly diagnose CA. With respect to criteria evaluating basic life support, median score (reported to 20) was 9.3 [IQR: 6.5 – 10.8] at T0. The median time between the call and the beginning of chest compressions was 20 seconds [IQR: 10.0 – 22.5]. No one was able to use AED at T0. Regarding criteria evaluating manual defibrillation, median score (reported to 20) was 3.0 over 20 [IQR: 3.0 – 5.8] at T0.

T1 evaluation

The evolution of median overall score and specific scores to basic life support and manual defibrillation were summarized in table 3. All criteria assessed were significantly improved.

Table 3. Skill score evolution before (T0) and after simulation training (T1), n = 32.

Variables	T0	T1	Difference	p
Overall score / 20	8.0 [IQR: 5.0 – 9.8]	17.5 [IQR: 17.0 – 19.0]	9,5	<0,0001
Basic life support score / 20*	9.3 [IQR: 6.5 – 10.8]	18,5 [IQR: 17.0 – 20.0]	9,2	<0,0001
Manual defibrillation score / 20†	3.0 [IQR: 3.0 – 5.8]	17.0 [IQR: 14,3 – 17.0]	14	<0,0001

*13 assessed criteria, score reported to 20; †7 assessed criteria, score reported to 20.

The overall skill score out of 20 increased from 8.0 at T0 to 17.5 at T1 [IQR: 17.0 – 19.0] (p<0.0001).

With respect to criteria evaluating basic life support, the median score increased from 9.3 at T0 to 18.5 at T1 [IQR = 17.0 – 20.0] (p<0.0001). After training, all participants were able to correctly diagnose cardiac arrest. A shortening of chest compressions initiation delay from 20 at T0 to 10 seconds at T1 [IQR: 7 – 12] was observed (p<0.0001). An alert within 10 seconds was given by 69% of participants. All nurses were able to use AED after a CPR cycle following the instructor's demonstration. However, its correct use with proper follow-up of instructions was ensured by only 23 candidates (72%). Among the two skills targeted by this training, the most significant evolution was noted in

the manual defibrillation where the median score had increased from 3.0 to 17.0 [IQR: 14.3 – 17.0] at T1 (p <0.0001), (Figure 3).

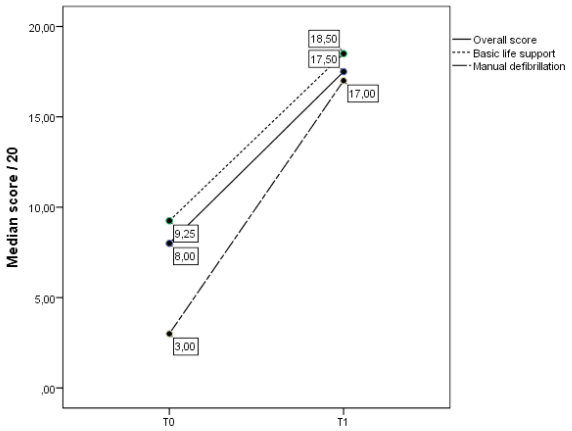

Figure 3. Overall skill score and specific scores to basic life support and manual defibrillation evolution between T0 (before simulation training) and T1 (after simulation training).

DISCUSSION

This study was the first of its kind carried out in our institution, with the aim to demonstrate the interest of simulation learning program of emergency gestures for nurses.

Major findings of our study were: a) Despite being assigned to the cardiology and cardiovascular surgery division and a median job seniority of 8.5 years, only 44% of nurses had participated before in a simulation session. b) Most of the study's candidates (84%) had practiced chest compressions while only 34% had delivered manual defibrillation during their daily practice. c) A strong motivation was expressed by the participants in the simulation training organized around the theme of CA. d) Despite a theoretical training regarding the management of CA (the day before), the skill score evaluating before the simulation learning session was of 8.0 out of 20 [IQR: 5.0 – 9.8]. f) A significant improvement of this score was obtained after the simulation session (primary endpoint of our study). After training, the median score increased from 8.0 to 17.5 out of 20 [17.0 – 19.0] (p<0.0001). g) The two items judged in the evaluation grid (basic life support and manual defibrillation) were significantly improved and the most positive effect was observed in manual defibrillation where the prior experience of the participants was limited.

Current CPR guidelines encourage all the structures interfering with CA management to implement effective systems in terms of resources to improve outcomes (1). In this context, the establishment of advanced training sessions, covering theoretical knowledge, skills and attitudes, is recommended for health personnel to join a resuscitation team (2).

Our study highlighted many persistent gaps in the execution of gestures despite prior theoretical training. A practical training was provided based on the decomposition of these skills in a real-time demonstration with explanation of the facts. This pedagogical approach did not only allow visualization, but also understanding and processing of the knowledge acquired with reaching the upper level of the Miller pyramid in terms of technical skills (3,4). Thus, simulation training should be integrated in continuing education for nurses. This pedagogical tool was preferentially recommended over others approaches to teach CPR mainly on the basis of a meta-analysis of 182 studies involving 16 636 participants where simulation-based resuscitation training was associated to enhanced performance in terms of knowledge and skills. In comparison to no intervention, simulation training improved outcomes of knowledge (Hedges' g) 1.05 (95% confidence interval, 0.81–1.29), process skill 1.13 (0.99–1.27), product skill 1.92 (1.26–2.60), time skill 1.77 (1.13–2.42) and patient outcomes 0.26 (0.047–0.48). In comparison with non-simulation intervention, learner satisfaction 0.79 (0.27–1.31) and process skill 0.35 (0.12–0.59) outcomes favoured simulation. Simulation training effectiveness was demonstrated regardless of assessed outcome, level of learner, study design, or specific task trained (5).

In our study, low-fidelity mannikin was used for basic life support and AED manipulation while high-fidelity manikin was used for demonstration and assessment of manual defibrillation including the heart rhythm analysis beforehand. Although being more popular among learners (with a better realism compared to low-fidelity manikin), simulation training using high-fidelity manikins seems to offer only a slight improvement in results. In a systematic review, high-fidelity manikins for advanced life support training was associated with moderate benefits based on skills performance outcome at course conclusion and no significant benefit at one year (6). The main limitation of

high-fidelity simulation is its cost and its availability and low-fidelity simulation remains valid in specific situations.

In addition to technical skills training, experts recommend that a complement of non-technical skills should be integrated in resuscitation courses (1). Indeed, successful resuscitation is a team performance in most cases and, as with any other skill, there is a need for effective communication, leadership and teamwork training (7,8). This team performance has been shown to improve, in real CA scenarios or in advanced in-hospital resuscitation simulations, when specific formation for leadership and team working was added to CPR courses (9–13). Thus, additional simulation sessions with more complex scenarios, involving both the doctors and nurses, should be considered in our continuing professional development program in order to develop these non-technical skills and to improve the prognosis of CA.

Study limitations: were mainly related to the small size of investigated sample despite the bicentric recruitment of nurses. Beyond the pioneering nature of this simulation training within our institution specifically targeting nurses of cardiology and cardiovascular surgery departments, a retraining will be necessary to maintain acquired knowledge and skills. (14–18).

CONCLUSIONS

Simulation learning has a major positive impact on the development of nurses' skills intervening in CPR for CA. Theoretical teaching alone is not enough to achieve these skills. Beyond this pioneering experience, which provoked a strong motivation among the participants, an institutional program of continuing education generalized to all the nurses would allow to improve team performance in terms of in-hospital CA management.

Conflicts of interest: None

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