

Synthesizing Knowledge and Education in Cardiopulmonary Arrest: Exploring Relationship and Correlation

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Abstract

Introduction: Cardiopulmonary Arrest is a critical situation that requires an immediate response from nursing staff. Although advances have been made in its management, survival after cardiac arrest in hospital remains a challenge. This study investigates the effect of education on nurses' theoretical knowledge of cardiopulmonary arrest management in hospital patients.

Method: This prospective study was conducted in a hospital and involved nursing staff from different departments. An electronic questionnaire was used to collect data, which were analyzed by IBM SPSS STATISTICS 22.0 software. To describe the quantitative variables, central tendency and spreading focus methods were used. Categorical variables were described through frequency tables. To assess the correlation between categorical variables, chi-square and Fisher tests were used and 95% confidence intervals were calculated.

Result: The analyses showed a significant correlation between education and theoretical knowledge. Participation in certified Basic Life Support, Immediate Life Support/Advanced Life Support courses positively influenced knowledge levels in many topics, and even participation in non-certified programs appeared to have a positive effect on nurses' knowledge.

Discussion: The study highlights the importance of education in improving nurses' knowledge of cardiopulmonary arrest management. Recommended is the creation of a standardized training framework for nurses and nursing assistants, as well as the attendance of certified BLS, ILS and ALS courses.

Keywords: Nurses' knowledge; Cardiac arrest; IHCA; BLS; ILS; ALS; Cardiopulmonary resuscitation

Abbreviations: BLS: Basic Life Support; ERC: European Resuscitation Council; CPR: Cardiopulmonary Resuscitation; ALS: Advanced Life Support

Introduction

Cardiac Arrest (CA) is defined as a potentially reversible but life-threatening condition with termination of effective cardiac mechanical activity, leading to loss of consciousness combined with respiratory arrest [1]. In-Hospital Cardiac Arrest (IHCA) is CA that occurs within the hospital and is often associated with a high rate of definitive death [2]. The deterioration of a patient in the presence of CA is estimated at 1.3-6 patients per 1000 admissions [3] and despite advances in the management of IHCA over the last decade, it is still associated with high rates of negative outcomes [4].

Nurses and nursing assistants are the first line of response in emergency situations [5]. Their ability to respond immediately and effectively to such critical situations has been shown to be positively related to their knowledge of BLS principles [6]. Therefore, although this ERC certified course provides basic knowledge and skills for the management of a CA in the community, it nevertheless appears to work supportively and helps healthcare professionals to be able to identify an emergency cardiovascular collapse promptly, call the rapid response team and start CPR rapidly in a hospital setting [7].

On the other hand, educational programs that include theoretical knowledge and skills for supporting a cardiopulmonary arrest in a hospital setting are the ALS and ILS courses, which are also certified by the ERC and include the specific interventions following BLS, as well as the application of manual defibrillation [8]. The knowledge of expert skills deepens the complexity of nursing interventions that extend beyond the basics. Pharmacological management of an arrest, advanced airway management, deeper understanding of heart rhythms, and recognition of the reversible causes of an arrest, relate to the most salient aspects of these training programs [9]. In any case, the combination of BLS and ALS/ILS knowledge builds a "bridge" of fundamental skills and advanced nursing knowledge leading to a more effective emergency response [10].

Therefore, as the contribution of education is undoubted, several training programs on IHCA management have been developed by international organizations [11]. In our country, resuscitation training is considered essential for the future education of health professionals, but it is not mandatory and there are no structured in-hospital courses, only courses organized by various scientific societies and groups [12]. At the same time, postgraduate studies in emergency, critical care and cardiovascular care expand and consolidate the knowledge and skills base of health professionals, developing their clinical competence and cultivating the personal attributes required in specialized clinical practice, which is essential for providing safe and effective care [13].

Given the high-risk nature of IHCA, it is important to assess the preparedness and capabilities of different healthcare professionals in responding to such situations. Despite the various levels of education of nursing assistants from Higher Education nurses [14], their own familiarity with emergency protocols is equally important, as already mentioned they are potentially the first responders [15]. A cardiopulmonary arrest can occur at any time and in any department of a hospital [16]. Nursing assistants must also be able to recognize the signs of cardiopulmonary collapse and initiate CPR in a timely manner, assisting with defibrillation and ensuring smooth information sharing between team members. Smooth collaboration with nurses enhances effective management of IHCA, creating an integrated and coordinated approach to patient care during emergencies [17].

Thus, as CPR training is shown to be a key element of clinical skill development for healthcare providers [18], it appears that the most determinant of a patient's survival after CA is the presence of nurses who are trained, willing, able and equipped to act in an emergency situation [19]. However, as the positive effect of undergraduate knowledge is known to enhance subsequent professional qualifications leading to a reduction in the rates of unsuccessful cardiopulmonary resuscitation attempts [20], it is considered imperative that nursing students have a demanding undergraduate preparation.

The aim of this study is to evaluate the effect of the degree of training on the theoretical background of nursing staff in the principles and skills of first response to CA in a hospital setting.

Material and Methods

Study design and participants

This is a prospective study, which was conducted in XXX of XXX. This study included nursing staff working in various departments of the hospital who were nurses or nursing assistants. The exclusion criteria were as follows: nurses or nursing assistants who were not working in the hospital, unemployed nurses or nursing assistants, nursing students, other health professionals (doctors, physiotherapists, etc.). To determine the necessary sample size, a significance level of $\alpha=0.05$ (two-tailed) was considered and the required sample size calculated was 130 participants. The study included 153 participants (87 nurses and 66 nursing assistants) who were employed as permanent, contract or resident nurses in the hospital. Data collection took place between May 2023 and October 2023.

Data collection

During the conduct of a hospital nursing department training, data collection from the participants was carried out. Specifically, before the start of the education module "First response to in-hospital cardiopulmonary arrest", an electronic questionnaire was requested to be completed via the "Typeform" platform. The reliability, validity, clarity, and length of the questionnaire were tested by the research team by conducting a pilot test on ten nurses who were not included in the final sample. The results of the reliability test (Cronbach's $\alpha=0.87$) were found to be acceptable. The questionnaire used for data collection consisted of three different sections:

- 1) Socio-demographic data (age, gender, etc.),
- 2) Education data (basic education, postgraduate studies, BLS, ILS, etc.),
- 3) Knowledge data related to the main subject of the study, where only one question was correct.

The third part, included questions regarding knowledge and skills of immediate recognition of a cardiopulmonary arrest, theoretical knowledge of drug administration, recognition of Electrocardiographic (ECG) rhythms, administration of defibrillation, confirmation of reversible causes of arrest, etc. The content of the questions is fully aligned with the updated ERC guidelines [9].

Data analysis

Data were analyzed using IBM SPSS STATISTICS 22.0 software. For descriptive analysis of quantitative variables, methods focusing on central tendency and dispersion were used. Categorical variables were described through frequency tables, both in the form of numbers and percentages. The Kolmogorov-Smirnov test was used to assess normality in the distribution of quantitative variables. The chi-square test or Fisher's exact test, as appropriate, was used to test for association between categorical variables. 95% confidence intervals (95%CI) were also calculated, and differences were considered significant between variables when the p-value

was less than 0.05.

Ethical issues

Participants were informed about the research and all of them signed a consent form. The study protocol was approved by the Research, Ethics and Deontology Committee (Reference Number: 290/07.06.2023) and the Scientific Council of the university hospital where the study took place.

Result

Demographic profile of participants

The analysis of the demographic data, presented in (Table 1),

highlights significant insights into the characteristics of the study's participants. Regarding age, the distribution was relatively even, with the largest proportion (31.4%) belonging to the 40-49 age group, followed by participants aged 30-39 and 50-59. In terms of gender, the vast majority of participants were female, accounting for 88.9% of the sample, while male participants represented only 11.1%. Participants were employed across various hospital departments, showcasing strong diversity, although pathology departments were the most frequently represented. Employment status was similarly varied, with nearly half (47.1%) of the sample consisting of permanent hospital nurses and a significant proportion (41.8%) being contract nurses.

Table 1: Frequency table with demographic and other characteristics of the study sample.

		Count	Layer N %
Age	22-29 years old	29	19,0%
	30-39 years old	39	25,5%
	40-49 years old	48	31,4%
	50-59 years old	37	24,2%
Gender	Female	136	88,9%
	Male	17	11,1%
Work department	C Pathology clinic	20	13,1%
	Psychiatric clinic	20	13,1%
	A Pathology clinic	16	10,5%
	Cardiothoracic surgery clinic	15	9,8%
	A Surgical clinic	12	7,8%
	Dermatology clinic	11	7,2%
	Neurology clinic	11	7,2%
	B Pathology clinic	10	6,5%
	Artificial kidney unit	8	5,2%
	Emergency department	7	4,6%
	Blood donation department	6	3,9%
	Ophthalmology clinic	6	3,9%
	Rehabilitation center	4	2,6%
	Mediterranean anaemia unit	4	2,6%
	Anesthesiology department	3	2,0%
Employment status	Permanent nurses	72	47,1%
	Contracted nurses	64	41,8%
	Specialist staff	17	11,1%
Years of seniority	0-2 years	40	26,1%
	2-5 years	36	23,5%
	5-10 years	5	3,3%
	10-20 years	26	17,0%
	>20 years	46	30,1%
Basic education	Secondary education	66	43,1%
	Higher Technological Education	70	45,8%
	Higher University Education	17	11,1%

Postgraduate studies	I don't have one	66	75,9%
	Postgraduate Diploma	19	21,8%
	Doctoral Degree	2	2,3%
BLS Certified Seminar	Yes, I have.	48	31,4%
	No. I haven't.	105	68,6%
ILS/ALS certified seminar	Yes, I have.	6	3,9%
	No, I haven't.	147	96,1%
I have attended a non-certified seminar/ course	Yes.	55	35,9%
	No.	98	64,1%
I have not attended any seminar	Yes.	46	30,1%
	No.	107	69,9%

Years of professional experience displayed a bimodal pattern, with a large group (26.1%) reporting 0-2 years of experience, while another substantial proportion (30.1%) had more than 20 years of work experience. Regarding educational background, 43.1% of participants held two-year nursing assistant degrees, while 45.8% had completed technological nursing education. Only 11.1% of participants had a university-level undergraduate degree, and 21.8% of the sample had pursued postgraduate studies. Among these, only two participants had completed a doctoral degree.

Attendance in training programs

Training attendance among participants showed notable trends. Of the total sample, 31.4% had attended an ERC-certified BLS course, while only a small proportion (3.9%) held ILS or ALS certifications. Additionally, 35.9% had attended non-certified seminars on topics related to resuscitation. This demonstrates a relatively low engagement with certified advanced training programs but a higher inclination toward attending non-certified educational opportunities.

Knowledge assessment and demographics

The relationship between participants' demographic characteristics and their level of knowledge revealed several statistically significant findings. A key observation was the association between undergraduate education and knowledge of epinephrine administration, where nurses with technological or university-level education demonstrated significantly higher knowledge compared to those with secondary-level education (nursing assistants) ($p=0.007$). However, knowledge regarding other drugs, such as atropine and amiodarone, remained low across the board, with only 7.2% and 3.3% of participants, respectively, answering correctly. These percentages were not notably influenced by the level of undergraduate education.

Regarding knowledge of reversible causes of CA, correct responses were overall low, with only 28.1% of participants providing the correct answers. However, trends based on educational background were evident. Nurses with university-level education achieved the highest percentage of correct answers (35.3%), followed by those with technological education (30%), while nursing assistants scored the lowest (24.2%).

Impact of advanced education and training

Advanced education and training programs demonstrated varying levels of influence on knowledge outcomes. Regarding chest compression frequency, participants with postgraduate degrees exhibited significantly greater knowledge ($p=0.034$). Among these, 62.1% identified the range of 80–100 compressions per minute, and 27.3% identified the range of 100-120 compressions per minute. In stark contrast, 70.6% of participants without advanced education stated they were unsure about the correct compression frequency. All participants with a doctoral degree (100%) correctly identified the ideal range of 100-120 compressions per minute.

Despite these findings, no significant relationship was observed between postgraduate education and knowledge of epinephrine administration or defibrillable ECG rhythms. It is worth noting, however, that only 14 out of 153 participants correctly identified rhythms requiring defibrillation, underscoring a general knowledge deficit in this area.

Effect of training programs on knowledge

Attendance at certified training programs, particularly ERC-certified BLS courses, appeared to enhance participants' knowledge in several key areas. Participants with BLS certification displayed a higher understanding of CPR fundamentals, with 89.6% answering relevant questions correctly, compared to 82.9% of non-certified participants. Similarly, they demonstrated better knowledge of post-CA priorities, with 87.5% answering correctly compared to 77.1% of non-certified individuals. When asked about the chest compression-to-breath ratio after the placement of a laryngeal mask, 12.5% of BLS-certified participants provided the correct response, compared to only 3.8% of non-certified participants. The knowledge advantage of BLS-certified participants extended to identifying reversible causes of cardiac arrest, where they achieved a higher percentage of correct responses (33.3%) than their non-certified counterparts (25.7%). The effect of ILS/ALS certification was even more pronounced. A statistically significant relationship ($p<0.001$) was observed between ILS/ALS certification and knowledge of chest compression and ventilation coordination in cases where a laryngeal mask was used. The majority of those who correctly answered that chest compressions should be continuous while providing one breath every 4-5 seconds had

ILS/ALS certification. Moreover, these participants generally demonstrated superior knowledge across various topics, including chest compression frequency, epinephrine administration, and recognition of shockable rhythms (Table 2).

Table 2: Table of distribution of percentages of correct answers according to whether or not they attended the ILS/ALS seminar.

Questions	Percentage of Correct Responses for Each Subcategory	
	Have attended the ILS/ALS Course	Have not attended the ILS/ALS Course
"The frequency of chest compressions is:"	50%	19.7%
"Regarding epinephrine administration, choose the right one:"	50%	34%
"For ECG arrest rhythms requiring defibrillation, select the correct one:"	50%	15%
"Regarding atropine administration, choose the right one:"	16.7%	6.8%
"Immediately after confirming a cardiac arrest, ask your colleague:"	100%	79.6%
"In case a laryngeal mask has already been placed on the patient, chest compressions and administration of breaths through self-expanding bag (ambu) should be combined as follows:"	16.7%	6.1%

Attendance at non-certified training programs also had a positive effect, although the impact was less substantial (Table 3). Participants who had never attended any training program showed the lowest levels of knowledge across all domains. For instance, only 13% of untrained participants correctly answered

the question regarding chest compression frequency, compared to 23.4% of those who had attended a training program. Similarly, in response to a question about the first action after confirming a CA, 73.9% of untrained participants answered correctly, compared to 83.2% of trained participants.

Table 3: Table of distribution of percentages of correct answers according to whether or not they attended a non-certificated seminar.

Questions	Percentage of Correct Responses for each Subcategory	
	Have attended a non-certificated seminar	Have not attended any seminar
"The frequency of chest compressions is:"	25.5%	17.3%
"Regarding epinephrine administration, choose the right one:"	36.4%	33.7%
"For ECG arrest rhythms requiring defibrillation, select the correct one:"	21.8%	13.3%
"Regarding amiodarone administration, choose the right one:"	7.3%	1%

Overall, knowledge evaluation

The overall assessment of participants' knowledge, as shown in (Table 4), revealed relatively low levels of correct responses across most domains. However, participation in training programs-

whether certified or non-certified-consistently improved performance. Despite these positive effects, the findings highlight substantial gaps in knowledge, suggesting the need for enhanced training initiatives tailored to nursing staff.

Table 4: Attendance of educational programs and correlation with overall sample correct response rates.

Variables	Total Percentage of Correct Answers Based on Subcategory of Variables	N
BLS Certified Course		
Yes	34.03%	48
No	31.3%	105
ILS/ALS Certified Course		
Yes	38.9%	6
No	30.98%	147
Have attended a non-certified seminar/ course		
Yes	35.96%	55
No	36.28%	98
Have not attended any seminar (certified or not)		
Yes	31.4%	46
No	36.6%	107

Discussion

It is widely known and research-based that theoretical knowledge is the cornerstone for providing quality cardiopulmonary resuscitation. A recent In-situ study, highlighted delays in the diagnosis of CA, initiation of chest compressions and resuscitation team call, which were associated with several factors, including knowledge deficits [15]. The present effort aimed to clarify various factors that may influence the level of nurses' theoretical knowledge regarding the recognition and management of a cardiopulmonary arrest. Emphasis was placed on whether educational factors (basic undergraduate, postgraduate, BLS, ILS/ALS seminars, etc.) might influence the level of knowledge of the sample.

In this context, our study confirmed an earlier monocentric study in the country [21], that undergraduate education is an important pillar for knowledge consolidation, as nurses compared to nursing assistants showed higher rates of correct answers to some questions and subsequently nurses of university education had better theoretical knowledge performance than those of technological education. In particular, university-educated nurses appeared to know more regarding the administration of epinephrine in a CA case, but also to have a higher degree of knowledge regarding the recognition of reversible causes of CA as reported by the ERC (4H's & 4T's): Hypoxia, Hypovolaemia, Hypo/Hyperkalaemia, Hypothermia, Thrombosis, Cardiac Tamponade, Toxins, and Tension pneumothorax [22-25]. The above findings are fully justified as university education is more comprehensive and includes learning both at the theoretical level and in a laboratory, setting using manikins and simulation systems. However, there is relative heterogeneity between the curricula of the different university faculties in the country and this is an area for improvement. Also, due to the marked heterogeneity of the country's nursing workforce, future research efforts regarding Misses Nursing Care (MNC) in the field of IHCA are suggested, although with a particularly careful methodological approach, as it has been shown that there are statistically significant differences between the way nurses and nursing assistants' rate MNC [14].

On the other hand, the positive impact of the BLS courses attendance and ERC guidelines [26], regarding that all health professionals should receive high quality resuscitation training at all levels from basic to advanced life support, were confirmed. Our findings showed that certified BLS, scored higher rates of correct responses compared to others, on a range of issues such as the first actions to take in an uncommunicative patient, the first intervention after confirmation of an arrest, identification of reversible causes, and the correct way to combine chest compressions and administration of breaths through a self-expanding bag in a patient who already has a supraglottic device placed. Although BLS programs may delve into basic support and community, however, they offer an understanding of the algorithmic process as well as introduce trainees to principles, preferences and priorities regarding the recognition and management of an arrest.

A particular emphasis was placed on whether participants had attended an ILS/ALS certified course. After all, it is known

that knowledge of the protocols of these training programs aligns with increased rates of Return of Spontaneous Circulation (ROSC) [27]. An earlier study in the country reports that attending such a program is a particularly critical positive knowledge factor, associated with higher scores on ALS knowledge questions [12]. This finding was confirmed in our study, as those who had attended an ILS/ALS program appeared to have a higher level of knowledge compared with those who had attended no educational program or had attended BLS, on basic support issues such as frequency of chest compressions, but also in more advanced knowledge, such as recognizing a defibrillatable ECG, combining chest compressions and ventilation when a supraglottic device has been placed, administering epinephrine, and more easily recognizing that atropine is no longer used in cardiopulmonary resuscitation. Finally, they all chose the correct instruction to give to their colleague when CA has been confirmed. Note that the previous skills, are considered particularly critical in advanced support, as delay in performing it is associated with a decrease in survival rates [28]. These results are entirely expected, as these programs are the cornerstone training, in the advanced support of an IHCA, as they also adequately prepare the members of a resuscitation team, and their implementation has been associated with reduced rates of arrests and a parallel increase in positive outcomes of such cases [20].

Finally, even attending a non-certified training program seemed to have a positive effect on the level of knowledge, compared to not attending any training. This finding clarifies the particularly critical value of continuing lifetime training provided by the professional institution. In summary, the author team is particularly worried about the exceptionally low knowledge rates of the sample in several topics, such as the use of drugs (atropine-amiodarone), the identification of reversible causes and the evaluation of defibrillable and non-defibrillable ECG rhythms.

Also discouraging is the small number of participants certified with BLS and the even smaller number with ILS/ALS. The authors, recognizing the impact of both undergraduate and continuing education, suggest the establishment of a standardized framework of theoretical and practical education for nursing students in all academic institutions in the country, as well as the attendance of certified BLS, ILS and ALS programs for all professional nurses and nursing assistants at regular time periods. In addition, the role of clinical instructors is undisputed, who should also undertake ongoing non-certified education in all nursing institutions, as this is vertically implemented in the respective nursing institutions in Denmark for both nurses and nursing assistants at a frequency repeated every 2 years [29]. However, there are studies that have shown that training of shorter duration, repeated more frequently, is more constructive [30-32]. In fact, recently the American Heart Association (AHA), promoted the Resuscitation Quality Improvement Program, where healthcare professionals are trained on a manikin with automated feedback a few minutes every 3 months as an alternative to traditional annual retraining [32]. As long as there are research gaps regarding optimal training experiences, the need for further educational research increases

[26], with the ultimate goal remaining the education of all healthcare professionals to enable them to stand worthy as first responders to a cardiopulmonary arrest.

Limitations

This research study sought to correlate various educational factors regarding the level of knowledge of nurses and nursing assistants in first response to an in-hospital cardiopulmonary arrest case. Despite the great findings, there are some limitations to the study. Firstly, as we are talking about a healthcare setting, future larger studies of a multicenter character are needed so that the findings can be extended to a country wide scale. Also, the study was only concerned with theoretical knowledge of the sample, so it would be inappropriate to seek a correlation with possible practical skills deficits. Finally, the comparative study of theoretical knowledge before and after an educational intervention may in the future indicate the critical and most appropriate educational interventions.

Conclusion

Nurses and nursing assistants are the healthcare professionals who more often than anyone else are the first bystanders in a CA. Their training influences their level of theoretical knowledge, and it is also known that theoretical knowledge is associated with both practical skills and a positive outcome of such an incident. This study clarifies some critical training factors, while highlighting the need for more research in this field.

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