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Original article

Nurse Competence in IHCA Management: A Comparative Knowledge Level Study of Pre and Post COVID-19 Pandemic Protocols in Critical Care Units

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Abstract

Introduction: In-hospital cardiac arrest (IHCA) is a critical condition requiring immediate intervention. The COVID-19 pandemic introduced challenges in IHCA management, necessitating adapted guidelines. Nurses play a pivotal role in IHCA response, making their knowledge crucial for optimal patient outcomes. This study aims to assess nurses' knowledge in IHCA management before and during the COVID-19 pandemic, with a focus on understanding differences between general Advanced Life Support (ALS) guidelines and pandemic-special guidelines. ***Methods:*** A cross-sectional survey involving 168 nurses from Emergency Departments (EDs), Intensive Care Units (ICUs), and Cardiology Units was conducted over a three-month period. Participants' demographic information, education, and involvement in resuscitation teams were collected. Knowledge was evaluated based on a structured questionnaire encompassing both general ALS guidelines and COVID-19 pandemic-special guidelines. ***Results:*** The study revealed that a mere 13.9% of participants demonstrated adequate knowledge of general ALS guidelines, with a similarly low 12.7% possessing sufficient understanding of pandemic-special guidelines. Education and participation in certified programs, notably Basic Life Support (BLS) and ILS/ALS, correlated positively with higher knowledge levels. Notably, self-assessed proficiency in knowledge matched actual performance. ***Discussion:*** This study underscores significant gaps in nurses' knowledge of IHCA management, particularly in the context of the COVID-19 pandemic. Structured educational interventions and targeted training programs, such as BLS and ILS/ALS, are paramount to addressing these knowledge deficits and enhancing clinical competence within critical care units. These findings advocate for continuous improvements in cardiac arrest response to enhance patient outcomes.

Keywords: ***in-hospital cardiac arrest; IHCA; COVID-19; knowledge; nurses; resuscitation; guidelines***

Introduction

The international reference standard of the Utstein Resuscitation Registry defines in-hospital cardiac arrest (IHCA) as the clinical condition that requires immediate delivery of chest compressions and/or defibrillation to patients on site [1]. In addition, there are several reasons why IHCA is recognized and studied independently of out-of-hospital cardiac arrest (OHCA) [2]. One of the most important reasons is the assumption that it concerns a preventable condition [3], and this is underscored by the fact that in hospitalized patients it is rarely sudden [4], but rather, it is usually preceded by warning signs and symptoms in a deteriorating patient, in the previous 1 to 4 hours [5].

Continuing on, the annual incidence of IHCA in Europe is between 1.5 and 2.8 per 1,000 hospital admissions, while survival rates at 30 days/hospital discharge range from 15% to 34% [6]. Moving forward, in the rest of the world, an increased incidence is observed in the United States of America (6-7 cases per 1000 admissions) [7], while on the other hand, noticeably lower rates have been recorded by the National Cardiac Arrest Audit (NCAA) of the United Kingdom (1.6 IHCA/1000 admissions) [8] and similarly, the Danish Cardiac Arrest Registry reports rates of 1.8 per 1,000 admissions [9].

Taking this into account, as IHCA is a major and frequent cause of morbidity and mortality worldwide, it is entirely justified that the International Liaison Committee on Resuscitation (ILCOR), a global partnership of resuscitation councils, is dedicated to a vision of saving more and more lives worldwide [10], with this purpose achieved through the synthesis of recommendations [11], which are then converted into practical guidelines by regional resuscitation councils [10]. Specifically in Europe, the European Resuscitation Council (ERC) takes charge of producing the corresponding guidelines for resuscitation [12], and in the context of IHCA, these guidelines are referred to as Advanced Life Support (ALS) [13].

Considering the challenges, the adverse conjuncture of the SARS-Cov 2 virus and the upcoming pandemic due to COVID-19 [14], additionally impacted the usual practice of dealing with an IHCA. Given this situation, the ERC took the initiative to issue

emergency ALS guidelines with the aim of balancing the potential risk of infection to the healthcare professional and the consequent benefit to the patient [15].

Further emphasizing, the increased incidence of IHCA in Emergency Departments [16], ICUs and Cardiology Units [17], coupled with the undeniable critical role of clinical nurses in assessment, treatment, and optimal outcomes [18], served as the primary driving forces for this study. Furthermore, the strong positive correlation between the level of theoretical knowledge in ALS principles and increased survival rates further motivated the writing team in undertaking this research endeavor.

Moving on to the scope, the purpose of this research study was centered around investigating the theoretical knowledge of nurses working in ICUs, Emergency Departments, and Cardiology Units, not only pertaining to the general guidelines of the ERC but also the emergency guidelines issued in response to COVID-19 pandemia. In addition, the study aimed to explore the potential statistical impact of various variables (demographics, education, information, etc.) on the aforementioned theoretical knowledge.

Material and Methods

Study design

A cross-sectional descriptive correlation study was designed, conducted online. The study was conducted using a specially designed questionnaire, which was created based on the international bibliography and the already existing professional experience of the writing team, while a pilot test was preceded by an acceptable degree of validity (Cronbach's alpha coefficient 0.82). As the latest ERC guidelines on ALS had already been announced almost a year ago and emergency guidance on Covid-19 had been available since 2020, knowledge questions focused on these guidelines. The time period of the survey was 3 months and nurses from all the country participated.

Study population

We included nurses and nursing assistants from the 7 health districts of the country. Criteria for participation in the study were established, which referred to the department of work, which should be Emergency Department, ICU and Cardiology Units of the National Health System. The sample of the study consisted of 168 nurses and nursing assistants, working with any employment relationship in the aforementioned departments. The study excluded nursing staff working in the private health system, as well as health professionals who did not belong to the studied population.

Intervention

The study sample was asked to complete an online questionnaire, which consisted of various sociodemographic characteristics, 11 background assessment questions for ALS guidelines, as well as 18 knowledge background assessment questions for special ALS guidelines during the Covid-19 pandemic.

The knowledge questions were multiple choices with one correct choice. Each question answered correctly received a grade of 3, while each incorrect question received 0. In this way, each participant had a score ranging from 0 to 33 for the general ALS instructions and 0 to 54 for knowledge in the special instructions, due to Covid-19. Also, regarding the general ALS guidelines, thresholds were set according to which the level of knowledge of participants with a score of 0-12 was characterized as incomplete, with 15-21 medium and 24-33 adequate. Similarly, the level of knowledge in the special instructions was characterized as incomplete for a score of 0-18, medium for a score of 21-36 and adequate with a score of 39-54.

Study outcomes

The main result of our study was the level of knowledge of the nursing staff regarding the ERC guidelines in ALS, as well as the emergency guidelines issued regarding the context of the Covid-19 pandemic. Secondary effects were the presence of various demographic factors and their possible statistically significant effect on the level of knowledge.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) v.27 was used to analyze the study data. The level of statistical significance was defined as $\alpha<0.05$. For descriptive statistics, data are presented as absolute (n) and relative frequencies (%). To investigate the relationship between categorical variables, the chi-square test and Pearson the fisher exact test were used. For the comparison of ratios (percentages) the statistical test z-test was applied.

Results

A total of 168 participants, working in ICUs, EDs and Cardiology Units in all health regions of the country, constituted the sample of the study. Of these, 89.3% (150) were registered nurses and 10.7% (18) nursing assistants. Regarding their cognitive background, particularly low percentages of correct answers were observed, as only 13.9% had sufficient knowledge regarding specialized life support, while the corresponding percentage for ERC special instructions during the pandemic was only 12.7%.

Descriptive statistics

The socio-demographic characteristics of the sample are presented in Table 1. The study involved a total of 168 nursing staff working within the National Health System (NHS). In terms of age distribution, the largest percentage of participants, comprising a significant 30.4%, fell within the age bracket of 30-39 years old, followed by an additional 29.2% aged 40-49. Moreover, about 25.6% were aged 22-29, and a remaining 14.9% fell in the age group of 50-59 years old. Notably, it is worth mentioning that a majority of an impressive 78.6% were women. As for their educational background, an overwhelming majority (up to) 89.3% held degrees from higher education institutions. Furthermore, more than half, specifically 51.3%, possessed a master's degree and a notable 10.7% had achieved a doctorate degree. When considering the various departments of employment, a significant 38.1% were engaged in Emergency Departments (EDs), followed by those in Intensive Care Units (ICUs) at 33.3%, and additionally, 17.9% in cardiology units. Additionally, a substantial proportion, which is equivalent to 61.3% of participants, were permanent employees. Furthermore, it is interesting to note that a noteworthy 38.7% reported having between 0 to 5 years of work experience. Regarding the presence of a resuscitation group within their workplaces, a significant 51.8% responded positively. Of particular interest is that among those, only 32% were actively engaged as members.

The Knowledge Evaluation

The evaluation of the sample's cognizance constituted a significant step towards comprehending pragmatic proficiencies in the realm of cardiopulmonary resuscitation (CPR). At the outset, for the purpose of assessing understanding of general guidelines, a series of questions was formulated. These inquiries were tailored to measure comprehension of essential protocols, including primary assessment (X-ABCDE approach), recognition of cardiac arrest, pharmaceutical administration protocols, and similar aspects (as outlined in Table 2). Following that, with the aim of determining the grasp of specialized guidelines, questions were designed, highlighting distinctions from the previously established practices. The distribution of correct answers, accompanied by concise explanations, can be found in Table 3. Lastly, Table 4 presents the rating scales categorized as insufficient, moderate, and adequate for both ALS guidelines.

The influence of demographic variables

Regarding the demographic factors of the sample and their potential correlation with the respondents' cognitive proficiency, it was evident in each case that distinct factors impacted knowledge in the guidelines applicable prior to the pandemic, as well as the distinct special guidelines influenced by the pandemic's context.

To elaborate, it was clarified that specific demographic factors significantly affected the guidelines prior to the pandemic. Notably, the possession of postgraduate studies (p=0.020) and the department of employment (χ^2=12.70, p=0.048) were critical variables. Participants holding a master's degree displayed a higher inclination towards having an adequate knowledge level (51.3%) compared to those without such a qualification (18.2%). Although participants with a PhD exhibited substantial knowledge, it's imperative to acknowledge the limited sample size for this group (11 individuals in total). Additionally, nearly 70% of healthcare professionals with satisfactory knowledge were employed in cardiology units and ICUs. Conversely, chi-square analysis indicated that factors like age, gender, basic education, work experience, and job relationship did not exhibit a statistically significant impact on the knowledge level.

With regard to the special guidelines and whether demographic factors influenced the knowledge level, it became apparent that a significant correlation existed with age (χ^2=16.26, p=0.011), postgraduate education (p=0.007), and prior work experience (χ^2=16.09, p=0.013). Notably, participants with a master's degree demonstrated a higher knowledge level, while only 18 out of 76 individuals possessed insufficient knowledge. Conversely, individuals with a PhD demonstrated insufficient knowledge. Furthermore, among those aged between 22-29, 50% exhibited inadequate knowledge, while 21.4% and 19% had a moderate and adequate knowledge level, respectively. In contrast, variables such as gender, basic education, job department, and job relationship showed no significant association (p >0.05).

The influence of education and information

The interaction between the variables of education and awareness, and the level of knowledge, proved to be particularly intriguing, shedding light on both commonalities and disparities between the two guidelines.

Initially, with regard to the presence or absence of a resuscitation team in the hospital, a statistically significant correlation was found with the level of knowledge (χ^2 = 7.06, p = 0.029) in the general guidelines, while this association was not evident for knowledge in the special guidelines (χ^2 = 2.54, p = 0.272). Moreover, participants' involvement in resuscitation groups did not appear to exert an influence on the level of knowledge in the general guidelines (p = 0.339), but it did demonstrate an impact in the special guidelines (p = 0.002). Significantly, a correlation emerged between the knowledge level and participation in educational programs for both sets of guidelines. Specifically, individuals who attended BLS and ILS/ALS programs exhibited significantly higher knowledge levels compared to those who participated in non-certified seminars or had no attendance (χ^2 = 46.92, p = 0.001 for general and p = 0.041 for special). Additionally, personal assessments of knowledge proficiency seemed to be linked with the actual knowledge level. Those who reported a "High" level of knowledge proficiency for CPR were more likely to possess adequate knowledge not only in general guidelines (χ^2 = 7.92, p = 0.038) but also in special guidelines (p = 0.012). Finally, no statistically significant correlation was found between the time since the last training and the knowledge level in either the general guidelines (p = 0.757) or specific guidelines (p = 0.168).

Moreover, 73.9% of individuals with adequate knowledge possessed personal familiarity with the general guidelines (χ^2 (2) = 6.71, p = 0.035). In terms of sources of personal information, 70.6% of those with sufficient knowledge gained information through the European Resuscitation Council and official scientific articles (two-tailed p = 0.044).

Also, regarding special instructions, 100% of individuals with adequate knowledge received information personally (X^2 (4) = 11.20 p = 0.004). Additionally, 90.5% of those with sufficient knowledge relied on the official guidelines of the European Resuscitation Council or reliable scientific articles from recognized databases as sources of information.

Table 1. Demographic characteristics.

Demographic Characteristics	n	%
Age		
22-29	43	25.6
30-39	51	30.4
40-49	49	29.2
50-59	25	14.9
Gender		
Male	36	21.4
Female	132	78.6
Basic Education		
Secondary Education	18	10.7
Technological Tertiary Education	108	64.3
University Tertiary Education	42	25.0
Postgraduate Studies		
No	62	41.3
Master's	77	51.3
Doctorate	11	7.3
Work Department		
ED	64	38.1
ICU	56	33.3
HDU	18	10.7
Cardiology Unit	30	17.9
Employment Relationship		
Permanent Employee	103	61.3
Temporary Staff	46	27.4
Trainee	19	11.3
Work Experience		

0-5 years	65	38.7
>5-10 years	13	7.7
>10-20 years	45	26.8
>20 years	45	26.8
Hospital Resuscitation Team		
No	81	48.2
Yes	87	51.8
Member of Resuscitation Team		
No	59	67.8
Yes	28	32.2

Table 2: The evaluation of knowledge on the general ALS guidelines.

Category	Brief Comment	Correct Answer Percentage
Patient Assessment (1 question)	A significant number recognize primary assessment (ABCDE's).	57.1%
Cardiopulmonary Arrest Recognition (1 question)	Significant correct recognition of head tilt and breath check.	63.7%
Recognizing Shockable Rhythms (1 question)	High recognition of ventricular tachycardia (VT) as shockable rhythm.	78.6%
Recognizing Non-Shockable Rhythms (1 question)	Moderate recognition of PEA as non-shockable rhythm.	63.7%
Medication Management (2 questions)	Moderate recognition of correct use of amiodarone and lower of atropine use.	41.1% (amiodarone) 27.4% (atropine)
Interruptions of chest compressions (2 questions)	Limited awareness regarding the interruption of chest compressions.	37.5%/29.2% (2 questions)
Combination of Laryngeal Mask with Compressions and Breaths (1 question)	Very low knowledge of the correct combination.	20.8%
Reversible causes (1 question)	Moderate knowledge of recognition the cardiac tamponade as one of the reversible causes.	58.9%
Return to ROSC (1 question)	Low percentage of knowledge in the use of ETCO2	29.2%

Table 3: The evaluation of knowledge on the special (COVID-19) ALS guidelines.

Category	Brief Comment	Correct Answer Percentage
Cardiac Arrest Recognition (1 question)	Moderate knowledge in the technique of recognizing arrest.	56.0%
Airway and Lung Management (3 questions)	Low level in basic airway release techniques, but understanding the benefits of definitive airway management.	11.9% (basic) 58.9 (definitive) 71.4 (videolar.)
Chest Compessions (4 questions)	High percentages of correct answers about initiating chest compressions, good understanding that chest compressions do not cause aerosol, but uncertainty about the use of a mechanical compression device	79,2% and 66.7% (chest compressions) 73.2% (aerosol) 56.0% (mechanical compressions)
Use of Ambu and Combination with Chest Compessions (3 questions)	Adequate knowledge in chest compressions/ambu combination, good understanding of ambu use, but incomplete knowledge in recommendation for use by two people.	79.8% (combination) 61.9% (ambu use) 33.3% (2 people)
CPR in Prone Position (3 questions)	Moderate knowledge about the management of arrest in the prone position and even lower knowledge about the point of delivery for compressions and the delivery of defibrillation in this position.	44.0% (management of arrest) 26.5% (compressions) 24.0% (defibrilation)
Personnel safety (2 questions)	Moderate knowledge about limiting the number of HCWs for safety reasons, but high rates of knowledge about not extubating an intubated patient in case of arrest	48,8% 78.0%
Defibrillation delivery (2 questions)	Moderate knowledge that defibrillation administration does not produce aerosol, but very low on the recommendation for three consecutive defibrillations at a shockable rythm	44,6% 19.6%

Table 4: The evaluation of knowledge on the special (COVID-19) ALS guidelines.

Cognitive Background Scale	General Guidelines		Special (COVID-19) Guidelines	
	N	%	N	%
Insufficient knowledge level	78	46,4	28	16,9
Moderate knowledge level	67	39,9	117	70,4
Adequate knowledge level	23	13,7	21	12,7

Discussion

The present study aimed to evaluate nurse competence in in-hospital cardiac arrest (IHCA) management by comparing their knowledge levels before and after the COVID-19 pandemic. The results reveal notable insights into the knowledge gaps and trends observed in critical care units. This discussion will delve into the implications of these findings and compare them to existing literature.

To begin, the results demonstrate that in terms of overall knowledge levels, the participants were concerning, with particularly low percentages of correct answers in both general and special guidelines. Only a fraction of participants demonstrated sufficient knowledge in advanced life support and ERC special instructions during the pandemic. These findings are consistent with earlier studies that indicated gaps in knowledge retention among healthcare professionals [19-21]. This indicates the lack of sufficient knowledge regarding protocols, especially during the pandemic, which in turn highlights a critical area for improvement in information, education, and training.

Furthermore, the influence of demographic variables on knowledge levels is noteworthy. Specifically, postgraduate studies and the department of employment emerged as significant factors that impacted the participants' knowledge levels before the pandemic. Interestingly, master's degree holders displayed a higher inclination towards adequate knowledge, emphasizing the potential benefits of higher education in improving clinical competency. Moreover, the study's focus on critical care units reflects the importance of specialized education in these settings, consistent with previous research [22,23].

Moving forward, the interaction between education, awareness, and knowledge underscores the importance of continuous education programs. In particular, the involvement of participants in resuscitation teams and educational programs significantly correlated with higher knowledge levels in general and special guidelines. Attending certified programs like BLS and ILS/ALS was associated with increased knowledge, aligning with existing literature that emphasizes the effectiveness of structured training programs in enhancing clinical competency [21,24-26]. Of note, the alignment between self-assessed knowledge proficiency and actual knowledge levels suggests that accurate self-evaluation might serve as a marker for effective training.

Implications and Recommendations

The study's results highlight the need for targeted educational interventions, especially in critical care units, to bridge the knowledge gaps identified. Enhanced emphasis on specialized life support and pandemic-specific guidelines is imperative. Implementation of structured training programs, such as BLS and ILS/ALS, in critical care settings could serve to improve knowledge retention and overall clinical competence. Moreover, facilitating access to updated guidelines from reputable sources, such as the European Resuscitation Council, is crucial to fostering evidence-based practice among nurses.

Limitations

While this study provides valuable insights, some limitations should be acknowledged. The cross-sectional design limits the establishment of causal relationships. Additionally, the study's focus on critical care units may limit the generalizability of findings to other healthcare settings.

Conclusion

In conclusion, this study provides a comprehensive assessment of nurse competence in IHCA management, comparing knowledge levels before and after the COVID-19 pandemic in critical care units. The findings underscore the importance of tailored educational interventions and structured training programs to address knowledge gaps and improve clinical competency. By aligning with existing literature, the study contributes to the ongoing efforts to enhance cardiac arrest response and patient outcomes in critical care units.

Abbreviations

IHCA: In-hospital cardiac arrest
ED: Emergency Department
ICU: Intensive Care Unit

Ethics approval and consent to participate

Not applicable

Consent for publication

This Consent to Publish gives the Publisher the permission of the Author to publish the Work. The signed Transfer of Copyright empowers the Publisher to protect the Work against unauthorized use and to maintain the integrity of the Work from a bibliographical and archival standpoint.

Data Availability

The data that support the findings of this study are available on request from the corresponding author.

Conflicts of Interest

No conflict of interest.

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The authors received no funding for the production of the present study.

Authors' contributions

George Kipourgos: Conceptualization, Methodology.
Grigorios Kourtis: Formal analysis.
Konstantina Karanikola: Investigation.
Christos Marneras: Visualization.
Nikolaos Bakalis: Validation.
Sotiriadou Chrysanthi: Theory development
Eleni Albani: Writing-Original draft and Editing.
Anastasios Tzenalis: Project administration, Supervision

References

[1] Nolan JP, Berg RA, Andersen LW, Bhanji F, Chan PS, Donnino MW, et al. (2019) Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Template for In-Hospital Cardiac Arrest: A Consensus Report From a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia). Resuscitation 144(166–77).

[2] Andersson A, Arctaedius I, Cronberg T, Levin H, Nielsen N, Friberg H, et al. (2022) In-hospital versus out-of-hospital cardiac arrest: Characteristics and outcomes in patients admitted to intensive care after return of

spontaneous circulation. Resuscitation 176:1–8. https://doi.org/10.1016/J.RESUSCITATION.2022.04.023

[3] Zheng K, Bai Y, Zhai QR, Du LF, Ge HX, Wang GX, et al. (2022) Correlation between the warning symptoms and prognosis of cardiac arrest. World J Clin Cases 10:7738–48. https://doi.org/10.12998/WJCC.V10.I22.7738.

[4] Churpek MM, Yuen TC, Huber MT, Park SY, Hall JB, Edelson DP. (2012) Predicting cardiac arrest on the wards: a nested case-control study. Chest 141:1170–6. https://doi.org/10.1378/CHEST.11-1301.

[5] Andersen LW, Kim WY, Chase M, Berg KM, Mortensen SJ, Moskowitz A, et al. (2016) The prevalence and significance of abnormal vital signs prior to in-hospital cardiac arrest. Resuscitation 98:112–7. https://doi.org/10.1016/J.RESUSCITATION.2015.08.016

[6] Gräsner JT, Herlitz J, Tjelmeland IBM, Wnent J, Masterson S, Lilja G, et al. (2021) European Resuscitation Council Guidelines 2021: Epidemiology of cardiac arrest in Europe. Resuscitation 161:61–79. https://doi.org/10.1016/J.RESUSCITATION.2021.02.007

[7] Merchant RM, Yang L, Becker LB, Berg RA, Nadkarni V, Nichol G, et al. (2011) Incidence of treated cardiac arrest in hospitalized patients in the United States. Crit Care Med 39:2401. https://doi.org/10.1097/CCM.0B013E3182257459.

[8] Nolan JP, Soar J, Smith GB, Gwinnutt C, Parrott F, Power S, et al. (2014) Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation 85:987–92. https://doi.org/10.1016/J.RESUSCITATION.2014.04.002

[9] Andersen LW, Holmberg MJ, Løfgren B, Kirkegaard H, Granfeldt A. (2019) Adult in-hospital cardiac arrest in Denmark. Resuscitation 140:31–6. https://doi.org/10.1016/J.RESUSCITATION.2019.04.046

[10] Perkins GD, Nolan JP. (2022) Advanced Life Support Update. Crit Care 26. https://doi.org/10.1186/S13054-022-03912-6.

[11] Morley PT, Atkins DL, Finn JC, Maconochie I, Nolan JP, Rabi Y, et al. (2020) Evidence Evaluation Process and Management of Potential Conflicts of Interest: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation 156: A23–34. https://doi.org/10.1016/J.RESUSCITATION.2020.09.011

[12] Perkins GD, Graesner JT, Semeraro F, Olasveengen T, Soar J, Lott C, et al. (2021) European Resuscitation Council Guidelines 2021: Executive summary. Resuscitation 161:1–60. https://doi.org/10.1016/J.RESUSCITATION.2021.02.003

[13] Soar J, Böttiger BW, Carli P, Couper K, Deakin CD, Djärv T, et al. (2021) European Resuscitation Council Guidelines 2021: Adult advanced life support. Resuscitation 161:115–51. https://doi.org/10.1016/J.RESUSCITATION.2021.02.010

[14] WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. n.d. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020 (accessed January 25, 2022).

[15] Nolan JP, Monsieurs KG, L. Bossaert, Böttiger BW, Greif R, Lott C, et al. (2020) European Resuscitation Council COVID-19 guidelines executive summary. Resuscitation 153:45–55. https://doi.org/10.1016/J.RESUSCITATION.2020.06.001

[16] Kimblad H, Marklund J, Riva G, Rawshani A, Lauridsen KG, Djärv T. (2022) Adult cardiac arrest in the emergency department – A Swedish cohort study. Resuscitation 175:105–12. https://doi.org/10.1016/j.resuscitation.2022.03.015.

[17] Perman SM, Stanton E, Soar J, Berg RA, Donnino MW, Mikkelsen ME, et al. (2016) Location of in-hospital cardiac arrest in the United States-variability in event rate and outcomes. J Am Heart Assoc 5. https://doi.org/10.1161/JAHA.116.003638.

[18] Guetterman TC, Kellenberg JE, Krein SL, Harrod M, Lehrich JL, Iwashyna TJ, et al. (2019) Nursing roles for in-hospital cardiac arrest response: higher versus lower performing hospitals. BMJ Qual Saf 28:916–24. https://doi.org/10.1136/BMJQS-2019-009487.

[19] Pettersen TR, group on behalf of the UNITE (UNITE) research, Mårtensson J, group on behalf of the UNITE (UNITE) research, Axelsson Å, group on behalf of the UNITE (UNITE) research, et al. (2018) European cardiovascular nurses' and allied professionals' knowledge and practical skills regarding cardiopulmonary resuscitation. European Journal of Cardiovascular Nursing 17:336–44. https://doi.org/10.1177/1474515117745298.

[20] Rajeswaran L, Ehlers VJ. (2014) Cardiopulmonary resuscitation knowledge and skills of registered nurses in Botswana. Curationis 37:1259. https://doi.org/10.4102/CURATIONIS.V37I1.1259.

[21] Rajeswaran L, Cox M, Moeng S, Tsima BM. (2018) Assessment of nurses' cardiopulmonary resuscitation knowledge and skills within three district hospitals in Botswana. Afr J Prim Health Care Fam Med 10:1633. https://doi.org/10.4102/PHCFM.V10I1.1633.

[22] Kuchaki Z, Taheri M, Esfahani H, Erfanifam T. (2022) The effect of CPR educational package on knowledge and performance of nurses working in intensive care units: A review study. J Family Med Prim Care 11:1677. https://doi.org/10.4103/JFMPC.JFMPC_1938_21.

[23] Gabbard ER, Klein D, Vollman K, Chamblee TB, Soltis LM, Zellinger M. (2021) Clinical Nurse Specialist: A Critical Member of the ICU Team. Crit Care Med 49:E634–41. https://doi.org/10.1097/CCM.0000000000005004.

[24] Saramma PP, Raj L, Dash PK, Sarma PS. (2016) Assessment of long-term impact of formal certified cardiopulmonary resuscitation training program among nurses. Indian J Crit Care Med 20:226–32. https://doi.org/10.4103/0972-5229.180043.

[25] Lima SG de, Macedo LA de, Vidal M de L, Sá MPB de O. (2009) Permanent Education in BLS and ACLS: impact on the knowledge of nursing professionals. Arq Bras Cardiol 93:630–6. https://doi.org/10.1590/S0066-782X2009001200012.

[26] Tíscar-González V, Blanco-Blanco J, Gea-Sánchez M, Molinuevo AR, Moreno-Casbas T. (2019) Nursing knowledge of and attitude in cardiopulmonary arrest: Cross-sectional survey analysis. PeerJ 2019. https://doi.org/10.7717/PEERJ.6410/SUPP-2.