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WORLDWIDE ASSESSMENT OF NURSES' KNOWLEDGE IN CARDIAC ARRHYTHMIA INTERPRETATION AND MANAGEMENT

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Abstract. This study evaluates the knowledge of global registered nurses regarding the interpretation and management of cardiac arrhythmia. The research aims to identify strengths and gaps in nurses' electrocardiogram interpretation skills, emergency response decisions, and pharmacological competencies. We developed a structured 14-item questionnaire based on recent scientific literature and administered it to 30 registered nurses from diverse clinical settings. We analyzed the results using descriptive mathematical and graphical methods. Nurses demonstrate solid understanding of myocardial infarction recognition, asystole management, and anticoagulation in atrial fibrillation, but show major knowledge gaps in defibrillation energy levels, ventricular fibrillation recognition, and drug selection for bradycardia. These findings indicate inconsistent competency in managing life-threatening arrhythmia. The study concludes that nurses require regular electrocardiography training, simulation-based practice, and globally standardized educational programs to strengthen arrhythmia management skills. Improving these competencies supports safer clinical decision-making and enhances patient outcomes.

Keywords. nurses, cardiac arrhythmia, management

INTRODUCTION

Cardiovascular diseases remain the leading cause of morbidity and mortality worldwide, with cardiac arrhythmias representing one of the most urgent and potentially life-threatening clinical presentations requiring immediate recognition and treatment. Rapid interpretation of cardiac electrical activity through electrocardiography (ECG) is foundational for diagnosing arrhythmias, directing early management, preventing complications, and reducing mortality (Aljohani, 2022; Qaddumi et al., 2024). Because nurses serve as the first point of contact in emergency departments, intensive care units (ICU), and cardiac care units, they are often responsible for the initial assessment of ECG abnormalities, early rhythm identification, and timely activation of clinical interventions (Obied et al., 2024; Jamahari et al., 2023). Thus, ECG and arrhythmia interpretation competence is an essential component of safe nursing practice, directly influencing patient outcomes and survival rates.

Despite this central clinical role, extensive international evidence consistently demonstrates that nurses frequently lack sufficient knowledge and competency in ECG interpretation and arrhythmia management. Studies conducted in Palestine, Saudi Arabia, Jordan, Iran, Turkey, China, Pakistan, and Malaysia reveal widespread deficits in rhythm recognition, theoretical knowledge, and decision-making capabilities (Buluba et al., 2023; Ayasreh et al., 2024; Aljohani, 2022; Ros et al., 2022). For example, Qaddumi et al. (2024) found that only 17.1% of nurses in Palestine demonstrated adequate competency in ECG interpretation and arrhythmia management, whereas Obied et al. (2024) reported generally low competency levels among emergency nurses despite frequent exposure to cardiac emergencies. Similar gaps were observed in Saudi Arabia, where critical care nurses scored below optimal levels in both ECG interpretation and arrhythmia management (Aljohani, 2022). Even in specialized cardiac institutions, nurses often display insufficient understanding of lethal rhythms and struggle with accurate recognition of ventricular arrhythmias, atrioventricular blocks, or supraventricular tachyarrhythmias (Khan et al., 2024; Singh et al., 2022).

Theoretical models of clinical competence emphasize that arrhythmia interpretation requires the integration of foundational knowledge, psychomotor skills, pattern recognition, and rapid clinical reasoning (Tavan et al., 2020; Haridy et al., 2022). Several studies note that undergraduate education often provides limited ECG training, and competency declines without continuous reinforcement (Chen et al., 2024; Mohsenabadi et al., 2022). Research further shows that competency is influenced by a range of factors, including clinical setting, years of experience, previous ECG training, academic qualifications, frequency of ECG exposure, and self-confidence in clinical decision-making (Ayasreh et al., 2024; Qaddumi et al., 2024). Nurses working in ICU or coronary care units tend to achieve higher competency scores compared to those in emergency or general wards, although even these scores often remain below recommended proficiency thresholds (Buluba et al., 2023; Aljohani, 2022).

In response to persistent deficits, recent research has explored innovative educational interventions to strengthen competence. Studies have demonstrated the effectiveness of simulation-based training, e-learning platforms, mobile learning, video-supported instruction, clinical teammate approaches, and structured modular programs in improving rhythm interpretation accuracy and knowledge retention (Tourdeh et al., 2025; Kılıç et al., 2025; de Lima et al., 2025). For instance, Kılıç et al. (2025) reported significant improvements in ICU and emergency nurses' interpretation skills after an online educational program, while Ardekani et al. (2023) found substantial gains in arrhythmia recognition following simulation-based instruction. Nonetheless, despite the demonstrated efficacy of such programs, the literature

highlights a lack of standardization across healthcare systems, insufficient integration of competency-based ECG curricula, and limited long-term evaluation of training outcomes.

Across countries and healthcare settings, the existing evidence portrays a fragmented and inconsistent landscape of ECG interpretation competency among nurses, underscoring an urgent need for global assessment and harmonized educational strategies. Although individual studies provide valuable insights, most are limited to single institutions or national contexts, lack cross-cultural comparisons, and rarely connect theoretical foundations with real-world competency gaps. Furthermore, no study to date has synthesized the global empirical findings to examine how theoretical, educational, and contextual factors collectively shape nurses' arrhythmia interpretation competencies.

The object of research: the knowledge of registered nurses worldwide.

The aim of the research: to assess the knowledge of registered nurses worldwide regarding the interpretation and management of cardiac arrhythmias.

The tasks of the research:

1. To analyze the theoretical foundations of cardiac arrhythmia interpretation and management, examining the role of registered nurses in arrhythmia care, and identifying key factors influencing their knowledge and competencies worldwide.
2. Assess the knowledge and decision-making of registered nurses regarding emergency management of life-threatening arrhythmias
3. Evaluate the gaps in electrocardiography interpretation skills among registered nurses, focusing on recognition of arrhythmias and related indicators changes.
4. Investigate the impact of continuing education and clinical experience on nurses' competency in pharmacological and procedural management of arrhythmias.

Research methods: Scientific Literature Analysis; Structured Survey; Mathematical Calculation and Graphical Descriptive Analysis of the Obtained Data.

SCIENTIFIC LITERATURE ANALYSIS

Cardiac arrhythmia interpretation and management are grounded in well-established theoretical principles of cardiovascular electrophysiology, ECG waveform analysis, and clinical decision-making frameworks. The theoretical foundation emphasizes understanding cardiac conduction pathways, recognizing deviations from normal sinus rhythm, and linking arrhythmic patterns to appropriate interventions. Several studies highlight that accurate arrhythmia interpretation requires the integration of conceptual knowledge, practical pattern recognition skills, and rapid clinical reasoning (Mohsenabadi et al., 2022; Tavan et al., 2020). As these competencies underpin early recognition of ischemia, life-threatening dysrhythmias, and conduction blocks, ECG interpretation is viewed as an essential clinical competency and a critical element of patient safety (Aljohani, 2022; Khan et al., 2024).

The literature consistently affirms that registered nurses play a central role in arrhythmia care due to their proximity to patients, continuous rhythm monitoring responsibilities, and primary involvement in the early stages of emergency response. Nurses in emergency departments, ICU, and coronary care units are typically the first to observe ECG changes and must rapidly interpret rhythm disturbances to activate clinical interventions, prevent deterioration, or administer first-line management when protocols allow (Obied et al., 2024; Ayasreh et al., 2024). Studies emphasize that the speed and accuracy of nurses' arrhythmia recognition significantly influence patient outcomes, especially in cases such as ventricular tachycardia, atrial fibrillation with rapid ventricular response, or third-degree heart block (Haridy et al., 2022; Qaddumi et al., 2024). Moreover, nurses' ability to differentiate between benign and potentially fatal dysrhythmias is essential for preventing unnecessary alarms, facilitating efficient teamwork, and ensuring appropriate escalation of care (Chen et al., 2024)

Despite the theoretical importance of arrhythmia interpretation competence, empirical evidence from the 18 analyzed studies reveals consistently insufficient knowledge and skills among nurses worldwide. Competency scores are frequently below recommended thresholds. For example, Qaddumi et al. (2024) found that only 17.1% of Palestinian nurses demonstrated adequate competency in both arrhythmia interpretation and management, while Aljohani (2022) reported low competency scores among Saudi critical care nurses despite nearly all having completed ECG training. Similar deficiencies have been described in China, Malaysia, Jordan, Iran, Turkey, and Pakistan, indicating a widespread global challenge (Buluba et al., 2023; Jamahari et al., 2023; Khan et al., 2024). Even in tertiary cardiac hospitals, nurses often demonstrate difficulty identifying lethal rhythms or linking arrhythmic patterns to correct clinical responses. Ros et al. (2022) and Singh et al. (2022) highlight that nurses frequently misinterpret supraventricular tachyarrhythmias, atrioventricular blocks, or ventricular ectopy - patterns that require immediate recognition to ensure patient safety.

Literature identifies multiple factors contributing to these global competency gaps. One major determinant is the level and quality of formal education. Studies note that undergraduate nursing curricula often provide insufficient training in ECG interpretation or rely heavily on theoretical instruction without opportunities for practical pattern recognition or simulation (Chen et al., 2024; Mohsenabadi et al., 2022). Consequently, knowledge retention is weak, and newly graduated nurses may enter clinical practice with limited rhythm interpretation skills. Clinical experience is another influential factor, with several studies showing that nurses working in intensive or coronary care units tend to perform better than those in emergency or general units - though even among ICU nurses, competency often remains suboptimal (Buluba et al., 2023; Aljohani, 2022).

Prior ECG-related training also influences competency, yet findings across studies are mixed. While some research reports performance improvements following participation in ECG courses or advanced cardiovascular life support (ACLS). ACLS certification (Jamahari et al., 2023), others show no clear association, suggesting that traditional training programs may be insufficiently rigorous or lacking practical application (Qaddumi et al., 2024; Aljohani, 2022). This supports the need for educational models emphasizing active learning. Indeed, experimental studies provide strong evidence that simulation, online modules, clinical teammate approaches, and mobile learning substantially enhance competency (Tourdeh et al., 2025; Kılıç et al., 2025; de Lima et al., 2025). For example, Kılıç et al. (2025) demonstrated significant ECG knowledge improvement following online education, while Ardekani et al. (2023) reported that simulation-based training improved rhythm recognition accuracy and confidence. These findings highlight the potential for modern pedagogical methods to strengthen the theoretical and practical foundations of arrhythmia interpretation.

Additional factors influencing competency include professional experience, academic qualification, unit type, workload, exposure frequency to ECG abnormalities, and self-perceived confidence (Ayasreh et al., 2024; Qaddumi et al., 2024). Nurses with higher education levels, more years of clinical experience, or frequent rhythm-monitoring responsibilities generally score better, although not uniformly across contexts. Conversely, heavy workloads, limited clinical mentoring, and lack of institutional guidelines contribute to errors and reduced confidence in interpretation (Haridy et al., 2022; Singh et al., 2022).

Across all reviewed studies, consistent theoretical knowledge alone emerges is insufficient. Competency requires continuous, structured, and practice-oriented education reinforced through technology-enhanced learning and real-world clinical exposure. Yet globally, educational systems and clinical institutions lack harmonized standards for ECG competency, resulting in uneven preparedness among nurses and continuing risks to patient safety.

THE RESEARCH METHOD

In this research there were used 3 main methods to conduct a study:

1. **Scientific Literature Analysis** - the research process began with a comprehensive review of existing scientific literature. A total of 17 peer-reviewed articles published between 2020 and 2025 were analyzed to identify prevailing trends, methodological approaches, and knowledge gaps related to cardiac arrhythmia interpretation and clinical management. This synthesis of evidence served as the conceptual foundation for the development of the survey instrument and the overall study design. The review focused on arrhythmia recognition accuracy, response strategies in emergency scenarios, pharmacological competencies, and educational needs among nursing populations across various healthcare systems.

2. **Survey** - based on the insights derived from the literature review, a structured, closed-ended questionnaire was designed to evaluate participants' knowledge in three major domains: ECG interpretation, emergency arrhythmia management, and pharmacological and procedural competencies. The instrument consisted of 14 items formulated to measure both factual knowledge and the consistency of understanding across related concepts. Control questions were intentionally included to assess depth of comprehension rather than simple recall, enabling a more nuanced evaluation of participants' readiness for real-world clinical decision-making.

3. **Mathematical Calculation and Graphical Descriptive Analysis of the Obtained Data** - upon completion of data collection, the responses were subjected to descriptive mathematical analysis. Microsoft Excel 2021 was used to calculate frequencies, percentages, and other quantitative indicators required to evaluate knowledge levels within the identified domains. To present the findings clearly and visually, Microsoft Word 2021 was utilized to generate graphical representations, including charts and tables that illustrate the distribution of responses, patterns of strengths, and areas requiring improvement.

The research process began with a systematic review of scientific articles to establish the existing knowledge base regarding the interpretation and management of cardiac arrhythmia. A total of 18 peer-reviewed scientific articles published between 2018 and 2025 were analyzed. The purpose of this review was to: identify recurrent themes in arrhythmia interpretation and emergency management; detect gaps in global nursing knowledge; understand educational strategies used worldwide; and ground the survey instrument in evidence-based practice.

Following the literature review, a 14-item closed-end questionnaire was created to evaluate nurses' knowledge of cardiac arrhythmia interpretation and management. The survey was structured around three core areas: ECG interpretation skills; emergency management of life-threatening arrhythmia; and pharmacological and procedural competencies. Importantly, the questionnaire also included control questions, which were intentionally designed to test the consistency and depth of participants' knowledge rather than just memorized facts. These questions helped determine whether respondents demonstrated coherent understanding across related concepts.

The inclusion criteria required participants to be registered nurses or final-year nursing students; be 18 years of age or older; represent different countries and healthcare environments; and voluntarily agree to participate. The study targeted nurses working in various clinical settings, including ICU, emergency departments, cardiology units, and general medical wards. A total of 30 respondents were recruited, representing diverse educational backgrounds, specialized training and years of experience. Their demographic profile allowed the researchers to compare knowledge across different professional levels.

The survey was distributed and completed virtually, allowing participants from different countries to take part. Respondents completed the questionnaire independently within the provided time frame. A total of 30 complete

questionnaires were received, constituting the final sample used for analysis. The virtual format ensured high accessibility, minimized time constraints, and supported participation across geographic locations. After data collection, all responses were organized and prepared for analysis. Each questionnaire was reviewed for completeness, and the answers were entered into a digital dataset.

Mathematical analysis consisted of calculation of correct and incorrect response frequencies, identification of knowledge strengths and weaknesses, comparison of responses across different survey sections and evaluation of consistency through the control questions. Using Microsoft Excel 2021 and Microsoft Word 2021, the following graphical elements were produced: bar charts for demographic distributions (age, gender, experience, qualifications); charts depicting percentages of correct vs. incorrect answers for each knowledge domain and summary tables illustrating overall performance patterns. These visual tools allowed for a clear and accessible representation of the results and facilitated interpretation during later stages of the study (Figure).

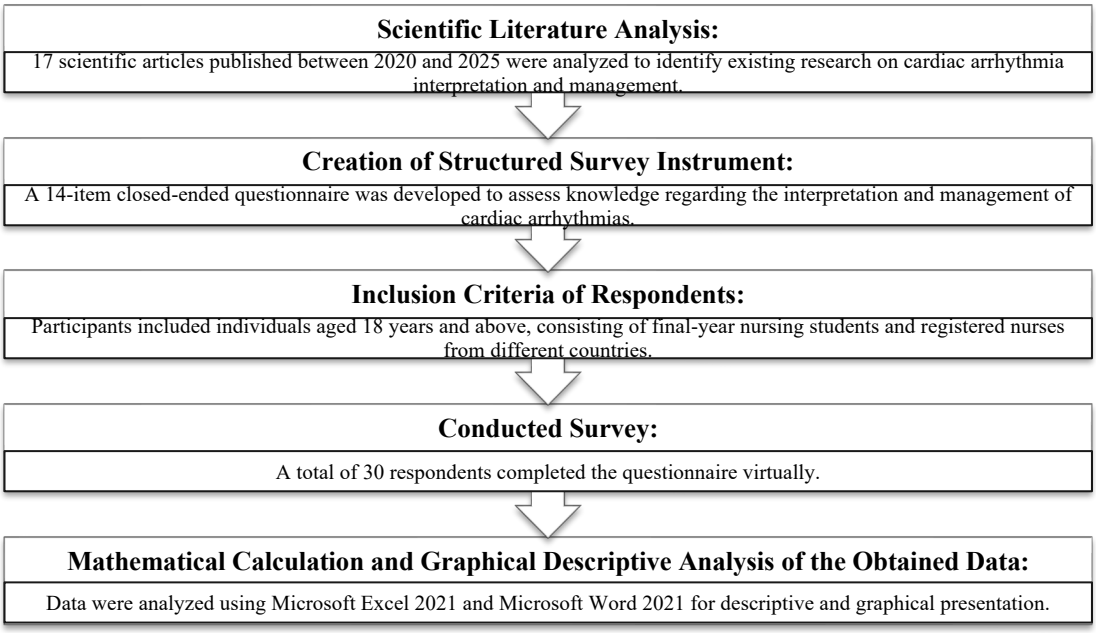

Figure. **Research Organization Chart**

This study was conducted following a clearly defined and systematically structured methodology. The combination of evidence-based literature analysis, a purposefully developed questionnaire, defined inclusion criteria, virtual data collection, and descriptive mathematical analysis ensured the reliability and clarity of the research process. Throughout all stages of the study, participants' anonymity and confidentiality were strictly maintained, with all collected data handled securely and used solely for research purposes. This structured and ethically grounded approach allowed for the accurate identification of knowledge levels and competency gaps among global registered nurses in the interpretation and management of cardiac arrhythmias.

THE RESEARCH METHOD

First, it is necessary to examine the distribution of correct and incorrect responses related to nurses' electrocardiogram interpretation skills. The highest accuracy was observed in identifying myocardial infarction ECG changes (73.3%), followed by recognition of bradycardia (63.3%) and normal sinus rhythm (66.7%). Moderate knowledge was demonstrated in interpreting atrial fibrillation (60%). However, recognition of PR interval lengthening showed equal correct and incorrect responses (50% each), indicating a significant inconsistency in understanding conduction abnormalities (Table 1). Overall, the results reveal that while participants performed well in basic ECG interpretation, more advanced rhythm analysis remains an area requiring improvement.

Table 1

Results of Electrocardiogram Interpretation Skills

Question	Correct answer (%)	Wrong answer (%)
Understanding of Normal Sinus Rhythm	66.7	33.3
Knowledge of Atrial Fibrillation	60	40
Recognition of PR Interval Lengthening	50	50
Bradycardia identification	63.3	36.7
Electrocardiogram Findings for Myocardial Infarction	73.3	26.7

Next, the focus is directed to nurses' knowledge of emergency arrhythmia management. Respondents showed strong competency in identifying the immediate action required in asystole, with 80% answering correctly. Management of ventricular fibrillation was also well understood (70%). However, knowledge of ventricular fibrillation recognition itself was weaker, with only 53.3% answering correctly. The largest knowledge gap was observed in defibrillation energy level selection, where only 46.7% responded correctly (Table 2). These findings highlight that although nurses demonstrate good awareness of emergency protocols, critical procedural knowledge - especially defibrillation parameters - requires further reinforcement.

Table 2

Results of Emergency Cardiac Arrhythmia Management

Question	Correct answer (%)	Wrong answer (%)
Ventricular Fibrillation Responses	53.3	46.7
Management of Ventricular Fibrillation	70	30
Defibrillation Energy Levels	46.7	53.3
Immediate Action in Asystole	80	20

Finally, it is important to discuss the results related to pharmacological and procedural decision-making in arrhythmia management. The strongest performance was seen in anticoagulation awareness for atrial fibrillation (76.7%), followed by pharmacological treatment of ventricular tachycardia (66.7%). Knowledge of supraventricular tachycardia treatment was moderate, with 60% providing the correct response. The weakest result in this category was drug selection for bradycardia, where only 56.7% answered correctly (Table 3). Collectively, these results show that while participants demonstrate acceptable pharmacological knowledge, important treatment decisions - particularly concerning bradyarrhythmia - would benefit from additional education and clinical simulation practice.

Table 3

Results of Pharmacological and Procedural Competency in Arrhythmia Management

Question	Correct answer (%)	Wrong answer (%)
Drug Choice for Bradycardia	56.7	43.3
Supraventricular Tachycardia Treatment Knowledge	60	40
Anticoagulation Awareness	76.7	23.3
Pharmacological Treatment of Ventricular Tachycardia	66.7	33.3

The findings of this study reflect global trends in nurses' competency in cardiac arrhythmia interpretation and management, demonstrating a consistent pattern of strong foundational knowledge paired with significant gaps in advanced clinical skills. Similar to research conducted in different countries, our participants showed competence in identifying common rhythms such as myocardial infarction changes, bradycardia, and atrial fibrillation: areas where numerous studies also report moderate to high performance (Buluba et al., 2023; Jamahari et al., 2023; Ros et al., 2022; Khan et al., 2024). The ability of 73.3% of respondents to recognize myocardial infarction parallels findings from Jamahari et al. (2023), where nurses demonstrated strong interpretation skills in a specialized cardiac environment, suggesting that frequent exposure to cardiac cases reinforces essential pattern-recognition abilities.

However, our results also reveal critical weaknesses in interpreting more complex arrhythmia and performing advanced procedural tasks. Only 53.3% of nurses correctly identified ventricular fibrillation, and fewer than half selected correct defibrillation energy levels: findings that closely mirror the competency deficits reported in studies from Palestine (Qaddumi et al., 2024) and Saudi Arabia (Aljohani, 2022). These difficulties indicate that while theoretical knowledge may be present, practical skills involving recognition of shockable rhythms and defibrillation protocols remain insufficient without ongoing simulation-based reinforcement. Similar conclusions were drawn by Haridy et al. (2022) and Singh et al. (2022), who found that nurses frequently misinterpreted lethal arrhythmias or struggled with conduction abnormalities.

Pharmacological competency in our study also showed mixed results. Strong performance in anticoagulation for atrial fibrillation (76.7%) aligns with global research highlighting good conceptual understanding of high-risk arrhythmias. However, insufficient knowledge of drug selection for bradycardia is consistent with international findings demonstrating that less commonly encountered arrhythmias, and their associated medications, are often poorly understood (Ayasreh et al., 2024; Mohsenabadi et al., 2022). This disparity supports the argument that clinical exposure and targeted case-based education play essential roles in ensuring accurate pharmacological decision-making.

The overall pattern in our study: strong basic knowledge but inconsistent advanced competencies - is highly consistent with the broader international literature. Studies evaluating educational interventions provide insight into potential solutions: simulation-based learning (Ardekani et al., 2023; Tavan et al., 2020), online programs (Kılıç et al., 2025), mobile learning (Mohsenabadi et al., 2022), and self-directed digital modules (de Lima et al., 2025) all demonstrated significant improvements in arrhythmia recognition and emergency management skills. These results support the conclusion that standardized, practice-oriented education, rather than solely theoretical instruction, is critical for developing and maintaining high levels of nurses' clinical competency. In summary, our findings align closely with global research, reinforcing that nurses worldwide possess basic arrhythmia knowledge but require continuous, structured,

and simulation-enhanced training to effectively recognize and manage life-threatening cardiac rhythms. This comparison highlights the need for internationally harmonized competency standards and regular refresher programs to ensure optimal patient safety and clinical outcomes.

CONCLUSIONS

Considering the previously formulated tasks, the following conclusions were reached:

1. Registered nurses play a critical role in the early recognition and management of cardiac arrhythmias, yet global evidence shows that their competency is limited by gaps in theoretical knowledge, practical training, and clinical exposure. Strengthening standardized, practice-oriented electrocardiography education and ensuring ongoing professional development are essential to improve nurses' arrhythmia interpretation skills and enhance patient safety worldwide.
2. Although most nurses demonstrate good knowledge of immediate actions in critical situations like asystole, inconsistencies in managing ventricular fibrillation and selecting appropriate drugs for bradycardia reveal that emergency response knowledge is not yet optimal.
3. Nurses have a moderate level of knowledge in interpreting electrocardiogram findings, with clear weaknesses in recognizing prolonged intervals and identifying ventricular fibrillation patterns.
4. Nurses show fair understanding of pharmacological and procedural aspects of arrhythmia management, but variability in knowledge across topics such as supraventricular tachycardia treatment and drug selection highlights the importance of ongoing professional education and simulation-based practice.

This study shows that the knowledge of registered nurses worldwide regarding the interpretation and management of cardiac arrhythmias remains uneven across key competency areas. Nurses demonstrate strong understanding of common and high-risk conditions, such as myocardial infarction, asystole, and anticoagulation in atrial fibrillation, which indicates that foundational clinical training is effective. At the same time, clear gaps persist in advanced ECG interpretation, defibrillation practices, and specific pharmacological decision-making, particularly in situations that require rapid and precise clinical judgment. These findings underscore the broader implication that global healthcare systems still differ substantially in access to standardized cardiovascular education, simulation-based training, and ongoing professional development. Improving these areas is essential, as nurses frequently serve as the first clinicians to recognize arrhythmia and initiate lifesaving interventions. The study highlights the importance of investing in continuous, evidence-based educational programs that reinforce practical skills and support clinical confidence. It also invites a more strategic, global perspective on cardiac education: one that encourages collaboration across countries, integration of digital learning tools, and adoption of uniform competency standards.

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