The Nursing Response to Cardiac Arrest: A Review of Protocols

Fatimah Sulaiman Eid Alharbi[1], Samit Salem Ali Alrashdi[2], Fatimah Mohsen Zubayr Alanazi[3], Nadirah Mansour Humud Almas[4], Aeshah Muidh Huyay Alrashdi[5], Ibrahim Mfareh O Alreshidi[6], Ahad Khalid A Hakeem[7], Najla Saad Binali Alghamdi[8], Alruwaili, Reem Ghantan A[9], Mohammed Mqaed Mohammed Almutairi[10]

[1] Technician Nursing, Long-Term Care Hospital, Hafr Al-Batin, Eastern Region, Saudi Arabia.
[2] Technician Nursing, Al-Ma'arash Health Center, Hail, Hail Region, Saudi Arabia.
[3] Nursing technician, Long-Term Care Hospital, Hafar Al-Batin, Eastern Region, Saudi Arabia.
[4] Health Assistant-nursing, Al-Thaghr Hospital, Jeddah, Makkah Region, Saudi Arabia.
[5] Nursing technician, Al-Ma'arash Health Center, Hail, Hail Region, Saudi Arabia.
[6] Nursing technician, Al-Hulayfah Al-Sufla Health Center, Hail, Hail Region, Saudi Arabia.
[7] Technician Nursing, Umm Al Salam Primary Health Care Center (PHCC), Jeddah, Makkah Region, Saudi Arabia.
[8] Nursing technician, Al-Thaghr Hospital, Jeddah, Makkah Region, Saudi Arabia.
[9] Nursing technician, Prince Meteb bin Abdulaziz Hospital, Sakaka, Al-Jouf Region, Saudi Arabia.
[10] Health Assistant-Nursing, Zulfi General Hospital, Al-Zulfi, Riyadh Region, Saudi Arabia.

Abstract:

The nursing response to cardiac arrest is a critical component of the emergency intervention process. Prompt recognition of cardiac arrest and the initiation of cardiopulmonary resuscitation (CPR) can significantly impact patient outcomes. Protocols such as the American Heart Association's Advanced Cardiovascular Life Support (ACLS) provide detailed guidelines for nurses and healthcare providers. These protocols emphasize the importance of early defibrillation, high-quality chest compressions, and effective ventilation. Additionally, nurses play a vital role in teamwork during resuscitation efforts, coordinating actions with physicians and other healthcare team members while maintaining clear communication to ensure efficiency and efficacy in care delivery. In reviewing the nursing protocols associated with cardiac arrest, it is essential to consider pre-arrest interventions, such as patient assessment and recognition of risk factors, to help prevent cardiac events. Continuous training and simulation exercises for nurses can enhance preparedness and proficiency in implementing these protocols. The incorporation of evidence-based practices into routine nursing education can further promote a culture of excellence in emergency care. Overall, the nursing response during cardiac arrest involves not only the immediate technical skills required for resuscitation but also a comprehensive approach that incorporates teamwork, communication, and ongoing education.

Keywords: Cardiac Arrest, Nursing Response, Protocols, CPR, Advanced Cardiovascular Life Support (ACLS), Defibrillation, Chest Compressions, Teamwork, Pre-arrest Interventions, Evidence-Based Practice, Emergency Care.

Introduction:

Cardiac arrest remains one of the leading causes of morbidity and mortality globally, underscoring the urgent need for effective and timely interventions. In the United States alone, the incidence of out-of-hospital cardiac arrest is approximately 356,000 cases annually, with survival rates hovering around 10% in adults. These sobering statistics highlight the critical importance of immediate, high-quality cardiopulmonary resuscitation (CPR) combined with advanced cardiac life support (ACLS) protocols. In this context, nurses play an essential role in the healthcare response to cardiac arrest, leveraging their clinical expertise to implement established protocols that can significantly improve patient outcomes [1].

As frontline healthcare providers, nurses are often the first responders in acute medical emergencies, including cardiac arrest. Their actions during the initial moments can profoundly influence the trajectory of care for patients experiencing cardiac arrest. Consequently, the development and adherence to evidence-based protocols are paramount. Protocols, such as the American Heart

Association (AHA) guidelines, establish a framework for healthcare organizations, encompassing both systematic approaches to resuscitation and the roles of various healthcare professionals involved in the process. Through rigorous training and simulation, nurses are equipped to execute these protocols effectively, ensuring that critical interventions such as high-quality chest compressions, early defibrillation, and advanced airway management are delivered without delay [2].

The evolution of nursing protocols for cardiac arrest has been informed by continuous research and clinical practice developments. Historically, resuscitation efforts were characterized by a fragmented approach, with varying practices influenced by individual clinician experiences and institutional capabilities. However, with the establishment of standard guidelines, there has been a concerted effort to unify the response to cardiac arrest, promoting a collaborative team-based approach that emphasizes the integration of nursing roles. This shift is evidenced in the transition from traditional rescue techniques to contemporary methodologies incorporating cardiopulmonary resuscitation training, automated external defibrillator (AED) use, and post-resuscitation care [3].

Within hospitals, particularly in emergency departments and intensive care units, nurses are uniquely positioned to coordinate the response to cardiac arrest episodes. They serve as crucial links between medical providers and emergency care teams, managing communication, performing advanced assessments, and facilitating the administration of medications and interventions as dictated by established protocols. In addition to their clinical responsibilities, nurses also play a pivotal role in educating patients, families, and communities regarding the signs of cardiac arrest and the importance of bystander intervention, which is integral to reducing mortality rates. Community-wide efforts such as "Chain of Survival" highlight the significance of immediate CPR and AED application by bystanders, further emphasizing the need for comprehensive training that includes nursing professionals as co-participants in public health education [4].

Despite the well-documented effectiveness of standardized protocols, barriers to optimal nursing responses during cardiac arrest episodes persist. These barriers may include insufficient staffing, limited resources, and inadequate training, which can impede the timely execution of critical resuscitative measures. Moreover, variations in institutional policies and practices regarding emergency response can lead to significant discrepancies in patient outcomes. Addressing these challenges requires a commitment to ongoing education, simulation training, and interprofessional collaboration, fostering an environment where nurses are empowered to execute their roles confidently and competently during cardiac emergencies [5].

Overview of Nursing Roles in Emergency Situations:

Cardiac arrest is a critical medical emergency where the heart abruptly stops functioning, preventing the blood from circulating to vital organs. The timely and effective management of cardiac arrest can spell the difference between life and death. Nurses play a pivotal role in the emergency response to cardiac arrest, demonstrating a wide range of skills and competencies that are essential to patient survival and recovery [5].

Before exploring specific nursing roles, it is essential to acknowledge the gravity of cardiac arrest situations. According to statistics from the American Heart Association, approximately 350,000 out-of-hospital cardiac arrests occur annually in the United States, with only about 10% of victims surviving. The initiation of Cardiopulmonary Resuscitation (CPR) and the prompt use of automated external defibrillators (AEDs) can significantly enhance survival rates. As front-line responders, nurses are vital in these scenarios, often being the first healthcare professionals to arrive at the scene or respond within an emergency department [5].

Pre-Hospital Roles and Responsibilities

In many cases, nurses may operate within emergency medical services (EMS), participating in pre-hospital response teams. Their roles in this setting include:

1. Rapid Assessment and Triage

Nurses deployed in emergency services must execute swift and effective patient assessments. This involves recognizing the signs and symptoms of

cardiac arrest, as well as distinguishing it from other conditions that may mimic it. Speed is of the essence; the quicker a nurse can identify a patient in distress and initiate protocols, the better the outcome [6].

2. Application of CPR and AED

One of the primary responsibilities of a nurse during cardiac arrest is performing CPR, which includes chest compressions and rescue breaths. Nurses are also trained to apply and operate AEDs when available, as early defibrillation is critical in the advanced care of patients experiencing ventricular fibrillation or pulseless ventricular tachycardia [6].

3. Communication with EMS and Healthcare Teams

Effective communication is crucial in emergency situations. Nurses must be able to relay pertinent information to EMS personnel and subsequently to hospital teams, ensuring a seamless transition of care. This involves documenting the patient's condition, interventions performed, and the timeline of events.

In-Hospital Roles

Once a cardiac arrest patient arrives at the hospital, the role of nursing continues to be integral, particularly in the emergency department (ED) and intensive care settings [7].

1. **Advanced Cardiac Life Support (ACLS)

Nurses in the emergency department are typically ACLS-certified, which equips them with the advanced knowledge required to respond effectively to cardiac arrest situations. They are trained in the latest algorithms for managing arrhythmias, administering medications such as epinephrine and amiodarone, and understanding the importance of post-resuscitation care [7].

2. Collaboration in Code Blue Situations

When a cardiac arrest occurs in a hospital setting, it triggers a "Code Blue" response, mobilizing a specialized code team that includes physicians, nurses, respiratory therapists, and pharmacists. Nurses play a crucial role in this team-based approach, which includes performing life-saving interventions, medications administration, and coordinating with other team members to ensure the protocol is followed and actions executed efficiently [7].

3. Patient Monitoring and Evaluation

After initial resuscitation efforts, nurses are responsible for continuous monitoring of the patient's vital signs and ECG rhythms. This involves observing for return of spontaneous circulation (ROSC) and assessing for any neurological changes that may indicate complications. Prompt identification of changes can result in timely interventions, which are vital for patient recovery [8].

Specialized Roles in Cardiac Care

In addition to their immediate response roles, nurses can take on specialized positions that focus on cardiac care, including:

1. Cardiac Care Unit (CCU) Nurses

Nurses working in the CCU play a critical role in post-resuscitation care. They are responsible for patients following cardiac procedures, offering comprehensive assessments, managing complex medications, and educating patients and families about recovery protocols. Their role includes facilitating continuity of care and ensuring long-term cardiac rehabilitation [8].

2. Nurse Educators and Trainers

Experienced nurses may also transition into educator positions, delivering training on CPR, ACLS, and emergency response protocols to other healthcare professionals. They play a crucial part in ensuring that their colleagues remain up-to-date with the latest guidelines and techniques, fostering a culture of preparedness in the healthcare setting [9].

Skills and Competencies Required

To effectively manage cardiac arrest situations, nurses must have a strong foundation of medical knowledge, clinical skills, and emotional resilience. Key competencies include:

- **Critical Thinking**: The ability to quickly analyze situations, identify problems, and make rapid decisions is essential in cardiac arrest management.

- **Technical Proficiency**: Knowledge of advanced life support techniques and skills

such as intubation and intravenous catheter placement is often required.

- **Emotional Intelligence**: Cardiac arrest situations can be highly stressful for both healthcare providers and families. Nurses must possess the emotional strength to manage their own stress while providing support and reassurance to patients' families.

- **Teamwork and Collaboration**: Nurses must be adept at working within interdisciplinary teams, understanding their roles clearly, and communicating effectively to achieve the best patient outcomes [9].

Evidence-Based Protocols for Cardiac Arrest Management:

Cardiac arrest is a critical medical emergency characterized by a sudden loss of heart function, breathing, and consciousness. It represents one of the leading causes of mortality worldwide, with survival rates heavily influenced by the promptness and appropriateness of medical interventions. The establishment of evidence-based protocols for cardiac arrest management has been pivotal in improving outcomes for patients. These protocols are integral to resuscitation practices, guiding healthcare professionals in delivering effective interventions based on the most current scientific evidence [10].

To appreciate the importance of structured protocols in managing cardiac arrest, one must first comprehend the underlying mechanisms. Cardiac arrest occurs primarily due to two types of arrhythmias: **ventricular fibrillation (VF)** and **pulseless ventricular tachycardia (pVT)**. Both conditions disrupt the heart's ability to pump blood effectively, leading to inadequate blood flow to vital organs, ultimately resulting in death if not promptly treated. The brain is particularly sensitive to a lack of oxygen, with irreversible damage occurring within minutes of cardiac arrest. Therefore, immediate intervention is crucial for survival [10].

The Chain of Survival

The concept of the "Chain of Survival" is foundational in understanding the management of cardiac arrest. Formulated by the American Heart Association (AHA), the Chain of Survival comprises five critical links:

1. **Early Recognition and Call for Help**: Rapid identification of cardiac arrest by bystanders or emergency responders is essential. Early activation of emergency medical services (EMS) ensures that advanced interventions can commence as soon as possible.

2. **Early Cardiopulmonary Resuscitation (CPR)**: High-quality CPR is vital in maintaining blood flow to the heart and brain until advanced care can be provided. CPR should commence within a few seconds of recognizing cardiac arrest, emphasizing chest compressions at a rate of 100 to 120 compressions per minute and allowing complete chest recoil [11].

3. **Early Defibrillation**: For victims of VF or pVT, defibrillation is the most effective method for restoring a normal heart rhythm. Automated External Defibrillators (AEDs) have revolutionized this aspect, allowing laypersons to administer life-saving shocks without extensive training.

4. **Effective Advanced Life Support (ALS)**: Once EMS personnel arrive, advanced interventions such as airway management, intravenous medication administration, and advanced monitoring techniques are employed according to established guidelines.

5. **Integrated Post-Cardiac Arrest Care**: Survivors of cardiac arrest require comprehensive care to address the underlying causes of the arrest, optimize neurological recovery, and prevent future cardiovascular events [11].

Guidelines and Protocol Development

The establishment of guidelines and protocols for cardiac arrest management has undergone significant developments over the years, driven by research, clinical trials, and expert consensus. The AHA and other organizations continuously update their guidelines to incorporate emerging evidence.

1. Cardiopulmonary Resuscitation (CPR)

The 2020 AHA Guidelines for Cardiopulmonary Resuscitation emphasize the importance of high-quality CPR. Key recommendations include:

- **Compression Depth and Rate**: Compressions should be delivered at a depth of 5-6 cm in adults, with a rate of 100-120 compressions per minute. Allowing full chest recoil between compressions is critical to maximize blood flow [12].

- **Minimize Interruptions**: Interruptions in CPR should be minimized to enhance perfusion during resuscitation. The focus should remain on continuous compressions, with minimal interruptions only for rhythm checks or defibrillation [12].

2. Defibrillation

The guidelines advocate for early defibrillation in witnessed cardiac arrests with VF or pVT. The timeline is crucial; survival rates diminish by approximately 10% with each passing minute without defibrillation. Thus, utilizing an AED within the vicinity can drastically enhance the likelihood of a successful outcome.

3. Advanced Life Support (ALS)

For Advanced Life Support, the AHA guidelines recommend streamlined protocols, including:

- **Airway Management**: Utilize advanced airway devices like endotracheal tubes or supraglottic airway devices, accompanied by appropriate ventilation strategies [13].

- **Medication Administration**: Epinephrine is recommended for adult victims of cardiac arrest in a 1 mg dose every 3-5 minutes. Antiarrhythmic agents like Amiodarone may also be administered during refractory VF/pVT [13].

4. Post-Cardiac Arrest Care

Post-resuscitation care is vital for improving outcomes. The guidelines recommend targeted temperature management (TTM) for comatose survivors of cardiac arrest with a shockable rhythm. Cooling the body to 32-36°C for 24 hours can reduce neuronal injury and enhance neurological recovery [14].

Training and Implementation

Successful implementation of evidence-based protocols requires ongoing training and education for healthcare providers. Simulation-based training and regular drills are effective in preparing both laypersons and professionals to respond to cardiac arrest emergencies. Public awareness campaigns also play a key role in educating communities about the Chain of Survival, the importance of CPR, and defibrillator accessibility [14].

Barriers to Effective Management

Despite the availability of evidence-based protocols, several barriers still hamper effective cardiac arrest management. These include:

- **Lack of Knowledge**: A significant portion of the population is not trained in CPR or defibrillation techniques. Efforts must be directed toward educating the public and healthcare providers on these life-saving skills [15].

- **Access to AEDs**: In many communities, public access to AEDs remains limited. Policies must encourage the placement of AEDs in high-traffic areas, coupled with community education on how to use them.

- **Disparities in Emergency Response**: Variable response times from EMS and different practices among healthcare providers can affect the consistency of treatment delivery across regions [15].

The Importance of Rapid Recognition and Early Intervention:

Cardiac arrest is among the leading causes of sudden death worldwide, with profound implications for individuals, families, and healthcare systems. Each year, hundreds of thousands of people experience this acute medical emergency, often without warning. However, the likelihood of survival dramatically increases with the immediate recognition of the condition and prompt intervention [16].

Cardiac arrest occurs when the heart suddenly stops beating, leading to a cessation of blood flow to vital organs. This condition can arise from various

causes, including heart attacks, arrhythmias, trauma, and respiratory failure. The underlying pathological processes often involve a disruption in the heart's electrical activity, resulting in the heart's inability to pump blood effectively. The immediate consequences of cardiac arrest are fatal, with studies indicating that brain damage can occur within minutes, and survival chances diminish significantly with each passing minute [16].

One of the most crucial factors in the successful management of cardiac arrest is the role of bystanders. According to the American Heart Association, immediate action from bystanders can double or triple a victim's chances of survival. However, timely recognition of the signs of cardiac arrest is imperative. Many individuals may struggle to differentiate between a heart attack and cardiac arrest. Cardiac arrest is marked by a sudden collapse, loss of consciousness, and absence of breathing, while heart attacks may present with chest discomfort and other symptoms over several minutes to hours.

Public awareness campaigns that educate communities about the signs of cardiac arrest and the importance of responding quickly can significantly improve outcomes. Effective training programs in basic life support (BLS), which include techniques for recognizing cardiac arrest and performing CPR, empower citizens to act swiftly and confidently in emergency situations [17].

Cardiopulmonary resuscitation (CPR) is a life-saving technique that combines chest compressions with artificial ventilation in an effort to restore blood circulation and breathing in a person whose heart has stopped beating. The primary goal of CPR is to maintain vital blood flow to the heart and brain until professional medical help arrives. Properly executed CPR can maintain a degree of blood flow to vital organs, prolonging the window of viability for resuscitation [17].

The effectiveness of CPR diminishes rapidly without early intervention. Studies indicate that the likelihood of survival decreases by approximately 7-10% for every minute that passes without CPR or defibrillation. Thus, immediate initiation of CPR is essential. The significance of high-quality CPR is underscored by research indicating that compressions should be performed at a rate of at least 100 to 120 per minute, with a depth of about two inches for adult victims. Bystander-initiated CPR can be a decisive factor in bridging the gap until emergency medical services (EMS) can intervene [18].

The integration of Automated External Defibrillators (AEDs) into public spaces has transformed the landscape of emergency cardiac care. AEDs are portable devices that analyze the heart's rhythm and, if necessary, deliver an electrical shock to restore a normal heartbeat. The use of AEDs is critical, as many cases of cardiac arrest are due to shockable rhythms, such as ventricular fibrillation [18].

The availability of AEDs in public locations, such as schools, airports, malls, and sports arenas, significantly enhances the chances of survival. Research shows that the combination of immediate CPR and rapid defibrillation can increase the survival rate of cardiac arrest victims to as high as 50-70%. Encouraging public familiarity with AED operation and promoting a culture of readiness can further improve outcomes. Training programs that equip individuals with the skills to operate AEDs during emergencies can empower communities and ensure that lifesaving resources are utilized effectively [18].

Despite the clear benefits of rapid recognition and early intervention in cardiac arrest situations, several barriers exist. Though education programs proliferate, a lack of awareness and hesitation among bystanders can impede action. Many individuals may lack training or fear causing harm, leading to delays in starting CPR. Therefore, the normalization of viewing such emergencies as a societal responsibility is vital. Emphasizing the importance of action, even if uncertain about the severity of the condition, can encourage bystanders to engage rather than hesitate.

Furthermore, disparate access to emergency medical services can exacerbate the situation. In rural or less populated areas, response times for professional help can be prolonged, increasing reliance on those present at the scene. Training programs must focus on providing effective techniques and confidence to individuals in these communities [19].

Skills and Competencies Required for Effective Resuscitation:

Cardiac arrest, a critical medical emergency wherein the heart unexpectedly stops beating, poses a significant threat to life. It is essential to grasp that the effectiveness of resuscitation efforts largely hinges on the specific skills and competencies of the responder. Factors such as prompt recognition of the arrest, immediate initiation of cardiopulmonary resuscitation (CPR), and the availability of advanced life support interventions play pivotal roles in improving survival conditions and outcomes [19].

Core Skills for Basic Life Support (BLS)

The foundation of effective resuscitation lies in the execution of Basic Life Support (BLS), which primarily encompasses high-quality CPR. CPR involves two vital components: chest compressions and rescue breaths [19].

1. **Chest Compressions**: The foremost skill required in BLS is the ability to perform adequate chest compressions effectively. This involves positioning the hands correctly on the center of the victim's chest and using the heel of one hand and the other hand on top to apply firm pressure. Rescuers should compress at a depth of at least two inches and a rate of 100 to 120 compressions per minute, allowing complete chest recoil between compressions. A key competency is recognizing the importance of minimizing interruptions to compressions, as this directly correlates with the victim's chance of survival [20].

2. **Rescue Breaths**: While chest compressions are paramount, the provision of rescue breaths completes the cycle of effective CPR. Rescuers need to be trained in utilizing the correct method to deliver rescue breaths. This includes using a head-tilt-chin-lift maneuver to maintain an open airway and creating an effective seal over the victim's mouth. It's crucial to deliver two breaths after every 30 compressions in a typical adult rescue scenario [20].

3. **Use of Automated External Defibrillators (AEDs)**: Knowledge of how to use an AED is also critical in the BLS domain. AEDs are portable devices that analyze the heart's rhythm and can deliver an electric shock if necessary. Rescuers must be able to turn on the AED, follow the spoken prompts, and attach pads securely to the patient to administer shocks effectively [20].

Advanced Life Support (ALS) Competencies

When basic CPR has been initiated, advanced life support interventions become necessary, especially in a hospital setting, where healthcare professionals may be involved.

1. **Airway Management**: In advanced life support, the ability to establish and maintain a patent airway is imperative. Competencies include recognizing the need for advanced airway devices, such as orotracheal intubation or supraglottic airway devices, and understanding the indications and contraindications for each method. Management of potential airway complications, such as aspiration and obstructed airways, further requires critical skills [21].

2. **Cardiac Rhythm Monitoring and Drug Administration**: Advanced practitioners should demonstrate proficiency in interpreting cardiac rhythms. This requires training in identifying life-threatening arrhythmias and knowing the appropriate pharmacological interventions for rhythm stabilization, such as administering epinephrine, amiodarone, or other antiarrhythmics, based on established guidelines.

3. **Invasive Procedures**: Competence in performing additional invasive procedures, such as intraosseous access or central line placement, can be crucial in situations where intravenous access is challenging. These advanced interventions allow for quicker drug delivery and infusion of fluids in life-threatening scenarios [21].

Communication and Team Dynamics

Effective communication is a cornerstone of successful resuscitation efforts. The high-pressure environment of cardiac arrest demands clear,

concise, and assertive communication within the resuscitation team. Key components include:

1. **Role Assignment**: Efficient team dynamics rely on predefined roles among team members. Each responder must know their responsibilities, whether as a team leader, compressor, airway manager, or AED operator. This clarity minimizes confusion and enhances coordination, leading to optimized performance during resuscitation [22].

2. **Feedback Mechanisms**: Continuous, constructive feedback among team members is essential. Effective rescuers should learn to give and receive feedback regarding technique and performance without disrupting the flow of resuscitation efforts. Debriefing post-resuscitation can also foster improvement in future incidents.

3. **Leadership**: The ability to lead a resuscitation team effectively can significantly impact the outcomes. A competent leader must demonstrate decisiveness, distribute responsibilities, and adapt to ongoing developments as the situation evolves [22].

Continuous Education and Practice

To maintain and enhance the skills required for effective resuscitation, continuous education and regular practice are indispensable. Professional training programs, such as those offered by the American Heart Association (AHA) and similar organizations, provide up-to-date knowledge on BLS and ALS protocols. Participating in hands-on simulation training allows medical personnel and lay responders alike to practice their skills in a controlled environment, reinforcing their competencies and boosting confidence in real-life scenarios [23].

Furthermore, advancements in medical research and technology necessitate an ongoing commitment to education. Staying informed on new innovations, guidelines, and recommendations ensures that responders can provide the highest standard of care [23].

Interprofessional Collaboration during Cardiac Arrest Response:

Cardiac arrest is a critical medical emergency that poses a significant challenge to healthcare systems worldwide. It necessitates immediate intervention and coordinated action among various healthcare professionals to optimize patient outcomes. Interprofessional collaboration, defined as the process by which professionals from different disciplines work together to achieve shared goals, plays a crucial role in enhancing the effectiveness of responses to cardiac arrest [24].

Cardiac arrest occurs when the heart suddenly stops beating, leading to an abrupt cessation of blood flow to vital organs, including the brain. The most common underlying causes include coronary artery disease, arrhythmias, and respiratory failure. The immediate response to cardiac arrest is crucial, as the window for successful resuscitation is limited; brain damage can start within minutes, and survival chances decrease rapidly without intervention. Consequently, guidelines, such as those provided by the American Heart Association, emphasize the importance of the "Chain of Survival," comprising early recognition, activation of emergency response systems, early CPR, rapid defibrillation, and post-cardiac arrest care. For these steps to be executed efficiently, effective interprofessional collaboration is essential [24].

The Importance of Interprofessional Collaboration

In the context of cardiac arrest response, interprofessional collaboration involves a diverse team of healthcare professionals, including paramedics, physicians, nurses, respiratory therapists, and pharmacists, each contributing their unique expertise to the situation. This collaboration enhances patient care through multiple avenues:

1. **Improved Communication:** Successful resuscitation efforts rely on clear and concise communication among team members. During cardiac arrest events, every second counts; thus, the ability to relay critical information swiftly can significantly affect outcomes. Interprofessional collaboration fosters a culture where open lines of communication are established, allowing for immediate feedback and adaptability [25].

2. **Shared Expertise:** Each professional brings specific skills and knowledge to the table. For example, while paramedics are trained in immediate emergency response techniques, physicians provide clinical decision-making and advanced life support. Nurses facilitate patient management and monitoring, while respiratory therapists ensure airway management and ventilation. By leveraging each member's strengths, the team can effectively address the multifaceted nature of cardiac arrest [26].

3. **Team-Based Decision-Making:** In high-stress situations like cardiac arrest, collective decision-making that considers diverse perspectives leads to more comprehensive care strategies. Research indicates that teams that engage multiple disciplines produce better clinical outcomes compared to isolated responses.

4. **Emotional and Psychological Support:** Cardiac arrest situations can be distressing for both patients and providers. An interprofessional team can offer emotional support, not only to the patient but also to each other, fostering resilience in the face of high-pressure scenarios [26].

Challenges to Interprofessional Collaboration

Despite its many benefits, interprofessional collaboration in cardiac arrest responses is fraught with challenges. Some of these include:

1. **Hierarchical Structures:** Traditional healthcare settings often maintain strict hierarchies that can hinder communication and collaboration. In high-pressure situations like cardiac arrest, junior team members may hesitate to speak up due to fear of disrespecting senior professionals [27].

2. **Role Clarity:** Ambiguities concerning roles and responsibilities can lead to confusion during emergencies. Team members must have a clear understanding of their designated tasks to avoid overlaps or omissions that could jeopardize patient safety.

3. **Variability in Training and Protocols:** Different disciplines may have varying training backgrounds, skill sets, and protocols for cardiac arrest response. These disparities can create barriers to effective collaboration if team members are not only unfamiliar with each other's practices but also lack brief shared training experiences or guidelines [27].

Strategies for Effective Interprofessional Collaboration

To overcome these challenges and enhance collaboration during cardiac arrest responses, several strategies can be implemented:

1. **Simulation-Based Training:** Engaging in joint simulation exercises that replicate cardiac arrest scenarios allows team members from different disciplines to practice working together in a risk-free environment. Such simulation training fosters team dynamics, role clarity, and crisis resource management [28].

2. **Interprofessional Education (IPE):** Integrating IPE into medical and nursing curricula promotes mutual respect and understanding among healthcare professionals. IPE can improve collaborative skills and highlight the importance of teamwork well before individuals enter the workforce.

3. **Standardizing Roles and Protocols:** Developing and implementing organizational protocols that clearly define roles and responsibilities for cardiac arrest responses can help establish a shared understanding among team members. Simultaneously, regular interprofessional team meetings can reinforce these roles and provide a platform for feedback and discussion [28].

4. **Crisis Management Training:** Incorporating crisis management training into regular professional development for all team members can cultivate resilience and adaptability. Such training prepares healthcare professionals to respond

effectively under the stress of emergencies [28].

Implications for Policy and Future Research

The significance of interprofessional collaboration during cardiac arrest response underscores the need for systemic changes within healthcare policies. Institutions should prioritize creating environments conducive to teamwork, which includes recognition of collaborative efforts in performance evaluations and incentivizing healthy team dynamics.

Furthermore, future research should investigate the effectiveness of different interprofessional training models, evaluate outcomes from collaborative responses compared to isolated efforts, and analyze cultural factors influencing team dynamics during cardiac arrest situations. Continuous inquiry will enhance our understanding of best practices and foster innovations in interprofessional collaboration [29].

Training and Simulation in Nursing Education for Cardiac Arrest:

Cardiac arrest stands as a critical healthcare challenge, marking a significant global health concern with a high mortality rate. In the United States alone, approximately 610,000 people die of heart disease annually, with sudden cardiac arrest accounting for a substantial proportion of these fatalities. The imperative for healthcare professionals, particularly nurses, to be proficient in responding to cardiac arrest situations is vital, as timely intervention can lead to improved survival rates and better patient outcomes. In light of this, training and simulation have emerged as indispensable components in nursing education, particularly in fostering the competencies required for effective management of cardiac arrest scenarios [30].

Training in cardiac arrest response equips nursing professionals with the necessary knowledge, technical skills, and critical thinking abilities needed to act promptly in life-threatening situations. Nurses frequently serve as frontline providers in hospitals and community settings and are often the first responders in cardiac arrest cases. As such, it is crucial for nursing education programs to integrate comprehensive training frameworks that emphasize the importance of the rapid assessment, recognition,

and initiation of advanced life support (ALS) measures.

The American Heart Association (AHA) delineates a systematic approach to cardiopulmonary resuscitation (CPR) through its guidelines, which underscore the "Chain of Survival" concept. This includes early recognition and activation of the emergency response system, early CPR, rapid defibrillation, effective advanced life support, and integrated post-cardiac arrest care. To effectively implement these elements, nursing education must employ training programs that reflect these guidelines [30].

Historically, nursing education relied on traditional methods such as didactic lectures and textbook readings to convey knowledge about cardiac arrest. While these methods are essential for foundational knowledge, they often lack the practical experience required for health professionals to develop the confidence and skills necessary for high-pressure situations. Real-life scenarios in clinical settings may not always provide the opportunity for nursing students to encounter cardiac arrest cases, resulting in a gap between theory and practice [31].

Simulation-Based Learning

In response to the shortcomings of traditional training, simulation-based learning has gained traction as an innovative and effective educational tool. Simulation can be defined as a reflective training modality that replicates real-life clinical scenarios in a controlled environment, allowing nurses to practice and hone their clinical skills without risking patient safety. This experiential learning strategy fosters the effective acquisition of skills and knowledge while promoting teamwork, communication, and decision-making abilities [32].

1. **Types of Simulation**: Various forms of simulation are used in nursing education, including high-fidelity simulation, part-task trainers, standardized patients, and virtual reality. High-fidelity simulators are sophisticated mannequins equipped with realistic physiological responses, such as pulse, breath sounds, and even vocalizations. These simulators can mimic various cardiac arrest scenarios, enabling nurses to practice assessment, airway management, CPR, and defibrillation techniques. Part-task trainers focus on

specific skills, like intubation or intravenous access, while standardized patients provide a human element to build rapport and communication skills. Virtual reality has also started to make its mark in nursing education by immersing learners in lifelike environments to practice their clinical responses [33].

2. **Benefits of Simulation**: Research highlights the numerous advantages of simulation-based training in nursing education. One of the most significant benefits is the enhancement of clinical skills and knowledge retention. Numerous studies have demonstrated that nursing students who engage in simulation training display higher levels of competency in executing CPR techniques compared to those who receive traditional education alone. Additionally, simulation provides immediate feedback, allowing students to recognize their strengths and weaknesses and adjust their learning strategies accordingly [34].

Moreover, simulation promotes a safe learning environment where mistakes can be viewed as valuable learning opportunities rather than failures. This approach cultivates a culture of safety, encouraging nursing students to develop resilience and confidence in their clinical decision-making skills. Simulation can also improve interpersonal skills, as team-based learning scenarios enable students to collaborate with peers, enhancing their communication and team dynamics—essential elements during real-life emergencies [34].

Implementation in Nursing Curricula

To successfully integrate simulation training into nursing education for cardiac arrest, institutions must consider a multifaceted approach. Nursing curricula should incorporate simulation training as a core component in both foundational and advanced practice courses. This means that undergraduate programs should span basic CPR techniques, gradually progressing to more complex scenarios, while graduate programs may encompass specialized resuscitation techniques and leadership in crisis management [35].

Faculty development is paramount to ensure that educators are equipped with the skills and knowledge to effectively facilitate simulation training. By participating in train-the-trainer programs, educators can learn various simulation methodologies, debriefing techniques, and assessment strategies to enhance the learning experience for nursing students [36].

Partnerships with local hospitals and emergency services can further enhance the training experience, as real-world insights and expertise can provide context to the simulation scenarios. Engaging with experienced clinicians can benefit nursing students by bringing real-life experiences into the learning environment, bridging the gap between theory and practice [37].

While simulation-based training is a promising approach in nursing education for cardiac arrest, certain challenges persist. Funding for simulation labs, access to high-fidelity simulators, and time constraints within already packed curricula can pose significant hurdles. Furthermore, standardizing simulation assessments and measuring the outcomes can be complex, as skills may vary among students [38].

Efforts to address these challenges include advocating for increased funding and resources, establishing partnerships to share simulation facilities, and embracing technological advancements to create more accessible training opportunities. Future research is needed to further investigate the long-term effects of simulation training on clinical practice, especially regarding real-life confidence and competence in managing cardiac arrest situations [39].

Future Directions and Recommendations for Nursing Practice in Cardiac Arrest Care:

Cardiac arrest remains a critical healthcare issue that poses significant challenges to medical professionals, particularly nurses who play a pivotal role in emergency care. With advancements in technology and an ever-evolving understanding of cardiovascular health, the future of nursing practice in cardiac arrest care is an area ripe for exploration and improvement [40].

The Current Landscape of Cardiac Arrest Management

Cardiac arrest occurs when the heart abruptly stops beating, resulting in the cessation of blood flow to vital organs. According to the American Heart

Association, approximately 356,000 out-of-hospital cardiac arrests occur annually in the United States, with survival rates remaining alarmingly low. Nursing roles in the management of cardiac arrest include early recognition of symptoms, initiation of cardiopulmonary resuscitation (CPR), and coordination of emergency interventions. However, despite commendable efforts, various limitations in current practices necessitate a reassessment of nursing interventions, professional education, and healthcare system protocols [41].

Embracing Technology in Cardiac Arrest Care

One of the most significant future directions in cardiac arrest management revolves around the integration of technology. Advances in telemedicine, wearable devices, and artificial intelligence are promising tools that can enhance nursing practice. Telemedicine can provide real-time guidance and support for nurses during cardiac events, especially in remote or resource-limited settings. For example, remote monitoring systems can alert healthcare providers to early signs of cardiac distress, allowing for timely intervention before a full arrest occurs.

Moreover, the use of mobile applications that provide CPR instructions and automated external defibrillator (AED) locations can empower bystanders and healthcare professionals alike. Increased access to such resources can lead to quicker responses during emergencies, significantly improving survival rates. Training programs should incorporate these technologies, ensuring that nurses are proficient in utilizing them effectively during cardiac arrest care [42].

Enhanced Training and Education

Another imperative recommendation for the future of nursing practice in cardiac arrest care is the evolution of training and education programs. Traditional CPR training often relies on static methods and periodic refreshers, which may not be sufficient in preparing nurses for fast-paced emergency situations. Therefore, there is a critical need for simulation-based training that mimics real-life scenarios where nurses can practice their skills in a risk-free environment [43].

Resuscitation training should be a continuous process rather than a one-time event. Incorporating high-fidelity simulation, debriefing, and evaluation will facilitate the development of critical thinking and crisis management skills essential for cardiac arrest interventions. Nursing curricula must adapt to include advanced life support systems, personalized patient assessment, and emerging cardiac technologies.

Furthermore, the inclusion of interdisciplinary education in nursing training is key. Collaborative learning opportunities among nurses, physicians, paramedics, and respiratory therapists will foster comprehensive understanding and team dynamics that enhance patient outcomes during cardiac emergencies [44].

Interdisciplinary Collaboration

Future nursing practice in cardiac arrest care should prioritize enhancing collaboration among healthcare team members. Effective communication and coordination during a cardiac arrest are critical factors influencing survival rates. Implementing structured handoff protocols and interdisciplinary training initiatives can help establish roles and ensure clarity of action plans during emergencies [45].

The development of standardized protocols that involve nurses as primary decision-makers in resuscitation efforts can empower nurses to take decisive action, especially in critical settings where time is of the essence. Nurses should participate actively in interdisciplinary rounds to contribute their insights based on patient assessments, thereby enhancing holistic patient care.

In addition, fostering relationships with community organizations and fire departments can further enhance collaboration. Educating non-medical personnel on the importance of CPR and the use of AEDs can create a network of trained laypersons ready to assist in emergencies, thus increasing the chances of survival for cardiac arrest patients [45].

Focus on Patient-Centered Approaches

Moving forward, a patient-centered approach to cardiac arrest care should dominate nursing practice. This involves not only focused attention on the person experiencing cardiac arrest but also on the families and bystanders who may be emotionally impacted during the event. Understanding the psychosocial needs of the cardiac arrest patient and their families is paramount in providing compassionate and holistic care [46].

Implementing family-centered care strategies can ease the anxiety of family members, providing them with vital information during resuscitation efforts and coordinating post-resuscitation care discussions. Educating families about the value of timely bystander CPR can also encourage community-wide engagement in emergency cardiac care initiatives [47].

Moreover, nurses should advocate for post-arrest care—addressing not only the immediate aftermath of a cardiac arrest but also the rehabilitation and emotional support needed for patients and families. Integrating follow-up care programs, including counseling and support groups, can help facilitate recovery and foster greater connections between healthcare providers and patients [48].

Conclusion:

The nursing response to cardiac arrest is a vital element of the emergency care landscape, directly influencing patient survival and recovery outcomes. This review highlights the significance of adhering to established protocols, such as those outlined by the American Heart Association, which guide nurses in delivering effective cardiopulmonary resuscitation (CPR) and other lifesaving interventions. Additionally, the importance of rapid recognition of cardiac arrest, timely action, and clear communication within the healthcare team cannot be overstated; these factors are critical to the success of resuscitation efforts.

Furthermore, ongoing education and regular simulation training are essential in enhancing nurses' skills and confidence in emergency situations. As the landscape of healthcare evolves, it is imperative that nursing practice continues to integrate the latest evidence-based protocols and fosters collaboration among healthcare professionals. By embracing these strategies, nurses can ensure they are well-prepared to respond effectively to cardiac arrest, ultimately improving outcomes for patients in critical situations. Future research should focus on refining these protocols and exploring innovative training methods to sustain and elevate nursing responses to cardiac emergencies.

References:

1. Stiell IG, Hébert PC, Wells GA, et al. Vasopressin versus epinephrine for inhospital cardiac arrest: a randomised controlled trial. Lancet. 2001;358(9276):105–109. doi: 10.1016/S0140-6736(01)05328-4

2. Weidman EK, Bell G, Walsh D, Small S, Edelson DP. Assessing the impact of immersive simulation on clinical performance during actual in-hospital cardiac arrest with CPR-sensing technology: a randomized feasibility study. Resuscitation. 2010;81(11):1556–1561. doi: 10.1016/j.resuscitation.2010.05.021

3. Neumar RW, Shuster M, Callaway CW, et al. Part 1: Executive Summary: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18)(suppl 2):S315–S367. doi: 10.1161/CIR.0000000000000252

4. Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS; American Heart Association Get with the Guidelines–Resuscitation Investigators. Trends in survival after in-hospital cardiac arrest. N Engl J Med. 2012;367(20):1912–1920. doi: 10.1056/NEJMoa1109148

5. Cohen TJ, Goldner BG, Maccaro PC, et al. A comparison of active compression-decompression cardiopulmonary resuscitation with standard cardiopulmonary resuscitation for cardiac arrests occurring in the hospital. N Engl J Med. 1993;329(26):1918–1921. doi: 10.1056/NEJM199312233292603

6. Woodhouse SP, Cox S, Boyd P, Case C, Weber M. High dose and standard dose adrenaline do not alter survival, compared with placebo, in cardiac arrest. Resuscitation. 1995;30(3):243–249. doi: 10.1016/0300-9572(95)00890-X

7. Sinha SS, Sukul D, Lazarus JJ, et al. Identifying important gaps in randomized controlled trials of adult cardiac arrest treatments: a systematic review of the published literature. Circ Cardiovasc Qual Outcomes. 2016;9(6):749–756. doi: 10.1161/CIRCOUTCOMES.116.002916

8. Mentzelopoulos SD, Zakynthinos SG, Tzoufi M, et al. Vasopressin, epinephrine, and corticosteroids for in-hospital cardiac arrest.

Arch Intern Med. 2009;169(1):15–24. doi: 10.1001/archinternmed.2008.509

9. Thel MC, Armstrong AL, McNulty SE, Califf RM, O'Connor CM; Duke Internal Medicine Housestaff. Randomised trial of magnesium in in-hospital cardiac arrest. Lancet. 1997;350(9087):1272–1276. doi: 10.1016/S0140-6736(97)05048-4

10. Sack JB, Kesselbrenner MB, Jarrad A. Interposed abdominal compression-cardiopulmonary resuscitation and resuscitation outcome during asystole and electromechanical dissociation. Circulation. 1992;86(6):1692–1700. doi: 10.1161/01.CIR.86.6.1692

11. Patrick WD, Freedman J, McEwen T, Light RB, Ludwig L, Roberts D. A randomized, double-blind comparison of methoxamine and epinephrine in human cardiopulmonary arrest. Am J Respir Crit Care Med. 1995;152(2):519–523. doi: 10.1164/ajrccm.152.2.7633701

12. Sack JB, Kesselbrenner MB, Bregman D. Survival from in-hospital cardiac arrest with interposed abdominal counterpulsation during cardiopulmonary resuscitation. JAMA. 1992;267(3):379–385. doi: 10.1001/jama.1992.03480030057037

13. Stiell IG, Hébert PC, Wells GA, et al. The Ontario trial of active compression-decompression cardiopulmonary resuscitation for in-hospital and prehospital cardiac arrest. JAMA. 1996;275(18):1417–1423. doi: 10.1001/jama.1996.03530420045034

14. Benjamin EJ, Virani SS, Callaway CW, et al. ; American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2018 Update: a report from the American Heart Association. Circulation. 2018;137(12):e67–e492. doi: 10.1161/CIR.0000000000000558

15. Pittl U, Schratter A, Desch S, et al. Invasive versus non-invasive cooling after in- and out-of-hospital cardiac arrest: a randomized trial. Clin Res Cardiol. 2013;102(8):607–614. doi: 10.1007/s00392-013-0572-3

16. Anderson TM, Secrest K, Krein SL, Schildhouse R, Guetterman TC, Harrod M, Trumpower B, Kronick SL, Pribble J, Chan PS, et al. Best practices for education and training of resuscitation teams for in-hospital cardiac arrest. Circ Cardiovasc Qual Outcomes. 2021;14:e008587. doi: 10.1161/CIRCOUTCOMES.121.008587

17. Nolan JP, Soar J, Smith GB, Gwinnutt C, Parrott F, Power S, Harrison DA, Nixon E, Rowan K; National Cardiac Arrest Audit. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation. 2014;85:987–992. doi: 10.1016/j.resuscitation.2014.04.002

18. Chan PS, Nallamothu BK. Improving outcomes following in-hospital cardiac arrest: life after death. JAMA. 2012;307:1917–1918. doi: 10.1001/jama.2012.3504

19. Holmberg MJ, Ross CE, Fitzmaurice GM, Chan PS, Duval-Arnould J, Grossestreuer AV, Yankama T, Donnino MW, Andersen LW; American Heart Association's Get With The Guidelines–Resuscitation Investigators. Annual incidence of adult and pediatric in-hospital cardiac arrest in the United States. Circ Cardiovasc Qual Outcomes. 2019;12:e005580. doi: 10.1161/CIRCOUTCOMES.119.005580

20. Wang C, Zheng W, Zheng J, Shao F, Zhu Y, Li C, Ma Y, Tan H, Yan S, Han X, et al. A national effort to improve outcomes for in-hospital cardiac arrest in China: the Baseline Investigation of Cardiac Arrest (BASIC-IHCA). Resusc Plus. 2022;11:100259. doi: 10.1016/j.resplu.2022.10025

21. Ocen D, Kalungi S, Ejoku J, Luggya T, Wabule A, Tumukunde J, Kwizera A. Prevalence, outcomes and factors associated with adult in hospital cardiac arrests in a low-income country tertiary hospital: a prospective observational study. BMC Emerg Med. 2015;15:23. doi: 10.1186/s12873-015-0047-0

22. Ohbe H, Tagami T, Uda K, Matsui H, Yasunaga H. Incidence and outcomes of in-hospital cardiac arrest in Japan 2011-2017: a nationwide inpatient database study. J

Intensive Care. 2022;10:10. doi: 10.1186/s40560-022-00601-y

23. Semeraro F, Greif R, Bottiger BW, Burkart R, Cimpoesu D, Georgiou M, Yeung J, Lippert F, Lockey A, Olasveengen TM, et al. European Resuscitation Council guidelines 2021: systems saving lives. Resuscitation. 2021;161:80–97. doi: 10.1016/j.resuscitation.2021.02.008

24. Penketh J, Nolan JP. In-hospital cardiac arrest: the state of the art. Crit Care. 2022;26:376. doi: 10.1186/s13054-022-04247-y

25. Kronick SL, Kurz MC, Lin S, Edelson DP, Berg RA, Billi JE, Cabanas JG, Cone DC, Diercks DB, Foster JJ, et al. Part 4: systems of care and continuous quality improvement: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2015;132(18 suppl 2):S397–S413. doi: 10.1161/CIR.0000000000000258

26. Andersen LW, Holmberg MJ, Berg KM, Donnino MW, Granfeldt A. In-hospital cardiac arrest: a review. JAMA. 2019;321:1200–1210. doi: 10.1001/jama.2019.1696

27. Nolan JP, Maconochie I, Soar J, Olasveengen TM, Greif R, Wyckoff MH, Singletary EM, Aickin R, Berg KM, Mancini ME, et al. Executive summary 2020 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Resuscitation. 2020;156:A1–A22. doi: 10.1016/j.resuscitation.2020.09.

28. Vahedian-Azimi A, Hajiesmaeili M, Amirsavadkouhi A, et al. Effect of the Cardio First Angel device on CPR indices: a randomized controlled clinical trial. Crit Care. 2016;20(1):147. doi: 10.1186/s13054-016-1296-3

29. Zhang Q, Li C, Shao F, Zhao L, Wang M, Fang Y. Efficacy and safety of combination therapy of shenfu injection and postresuscitation bundle in patients with return of spontaneous circulation after in-hospital cardiac arrest: a randomized, assessor-blinded, controlled trial. Crit Care Med. 2017;45(10):1587–1595. doi: 10.1097/CCM.0000000000002570

30. Chan PS, Nallamothu BK, Krumholz HM, et al. ; American Heart Association Get with the Guidelines–Resuscitation Investigators. Long-term outcomes in elderly survivors of in-hospital cardiac arrest. N Engl J Med. 2013;368(11):1019–1026. doi: 10.1056/NEJMoa1200657

31. Koster RW, Beenen LF, van der Boom EB, et al. Safety of mechanical chest compression devices AutoPulse and LUCAS in cardiac arrest: a randomized clinical trial for non-inferiority. Eur Heart J. 2017;38(40):3006–3013. doi: 10.1093/eurheartj/ehx318

32. Mentzelopoulos SD, Malachias S, Chamos C, et al. Vasopressin, steroids, and epinephrine and neurologically favorable survival after in-hospital cardiac arrest: a randomized clinical trial. JAMA. 2013;310(3):270–279. doi: 10.1001/jama.2013.7832

33. Morrison LJ, Neumar RW, Zimmerman JL, et al. ; American Heart Association Emergency Cardiovascular Care Committee, Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on P. Strategies for improving survival after in-hospital cardiac arrest in the United States: 2013 consensus recommendations: a consensus statement from the American Heart Association. Circulation. 2013;127(14):1538–1563. doi: 10.1161/CIR.0b013e31828b2770

34. Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. Intensive Care Med. 2007;33(2):237–245. doi: 10.1007/s00134-006-0326-z

35. Eastwood GM, Schneider AG, Suzuki S, et al. Targeted therapeutic mild hypercapnia after cardiac arrest: A phase II multi-centre randomised controlled trial (the CCC trial). Resuscitation. 2016;104:83–90. doi: 10.1016/j.resuscitation.2016.03.023

36. Movahedi A, Mirhafez SR, Behnam-Voshani H, et al. A comparison of the effect of interposed abdominal compression cardiopulmonary resuscitation and standard cardiopulmonary resuscitation methods on

end-tidal CO2 and the return of spontaneous circulation following cardiac arrest: a clinical trial. Acad Emerg Med. 2016;23(4):448–454. doi: 10.1111/acem.12903

37. Wallmuller C, Meron G, Kurkciyan I, Schober A, Stratil P, Sterz F. Causes of in-hospital cardiac arrest and influence on outcome. Resuscitation. 2012;83(10):1206–1211. doi: 10.1016/j.resuscitation.2012.05.001

38. Perman SM, Stanton E, Soar J, et al. ; American Heart Association's Get With the Guidelines®—Resuscitation Investigators. Location of in-hospital cardiac arrest in the United States: variability in event rate and outcomes. J Am Heart Assoc. 2016;5(10):e003638. doi: 10.1161/JAHA.116.003638

39. Nolan JP, Soar J, Smith GB, et al. ; National Cardiac Arrest Audit. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation. 2014;85(8):987–992. doi: 10.1016/j.resuscitation.2014.04.002

40. Radeschi G, Mina A, Berta G, et al. ; Piedmont IHCA Registry Initiative. Incidence and outcome of in-hospital cardiac arrest in Italy: a multicentre observational study in the Piedmont Region. Resuscitation. 2017;119:48–55. doi: 10.1016/j.resuscitation.2017.06.020

41. Chan PS, Krumholz HM, Nichol G, Nallamothu BK; American Heart Association National Registry of Cardiopulmonary Resuscitation Investigators. Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med. 2008;358:9–17. doi: 10.1056/NEJMoa0706467

42. Nolan JP, Berg RA, Andersen LW, Bhanji F, Chan PS, Donnino MW, Lim SH, Ma MH, Nadkarni VM, Starks MA, et al. 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 ILCOR. Circulation. 2019;140:e746–e757. doi: 10.1161/CIR.0000000000000710

43. Elgohary M, Palazzo FS, Breckwoldt J, Cheng A, Pellegrino J, Schnaubelt S, Greif R, Lockey A. Blended learning for accredited life support courses - a systematic review. Resusc Plus. 2022;10:100240. doi: 10.1016/j.resplu.2022.100240

44. O'Leary A, Butler P, Fine JR. Dedicated chest compressor team: a quality improvement initiative to improve chest compression performance at in-hospital cardiac arrest events through quarterly training. Resusc Plus. 2023;13:100361. doi: 10.1016/j.resplu.2023.100361

45. Sutton RM, Niles D, Meaney PA, Aplenc R, French B, Abella BS, Lengetti EL, Berg RA, Helfaer MA, Nadkarni V. Low-dose, high-frequency CPR training improves skill retention of in-hospital pediatric providers. Pediatrics. 2011;128:e145–e151. doi: 10.1542/peds.2010-2105

46. Chan PS, Kennedy KF, Girotra S; American Heart Association's Get With The Guidelines®-Resuscitation Investigators. Updating the model for risk-standardizing survival for in-hospital cardiac arrest to facilitate hospital comparisons. Resuscitation. 2023;183:109686. doi: 10.1016/j.resuscitation.2022.109686

47. Anderson R, Sebaldt A, Lin Y, Cheng A. Optimal training frequency for acquisition and retention of high-quality CPR skills: a randomized trial. Resuscitation. 2019;135:153–161. doi: 10.1016/j.resuscitation.2018.10.033

48. Niles D, Sutton RM, Donoghue A, Kalsi MS, Roberts K, Boyle L, Nishisaki A, Arbogast KB, Helfaer M, Nadkarni V. "Rolling refreshers": a novel approach to maintain CPR psychomotor skill competence. Resuscitation. 2009;80:909–912. doi: 10.1016/j.resuscitation.2009.04.021