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The Nurse's Role in Enhancing In-Hospital Cardiac Arrest Management: Monitoring and Early Intervention

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Abstract
Cardiac arrest (CA) remains a leading cause of in-hospital mortality, with many patients exhibiting signs of clinical deterioration hours before the event. Early detection and timely intervention during this pre-arrest phase are crucial for improving survival outcomes. This paper explores various monitoring techniques, including non-invasive methods such as electrocardiography (ECG), pulse oximetry, and end-tidal carbon dioxide (ETCO2), as well as invasive methods such as central venous pressure (CVP) and pulmonary artery catheterization, which are integral in guiding resuscitation efforts. The role of the nursing staff in monitoring, identifying, and responding to early signs of instability is emphasized, as nurses often act as first responders in the hospital setting. The introduction of Early Warning Score (EWS) systems has shown promise in identifying patients at risk of CA and activating the Medical Emergency Team (MET) for prompt intervention. The importance of continued education and the use of algorithms to guide clinical decision-making in acute situations is also highlighted. This paper underscores the need for constant protocol updates and clinical research to optimize monitoring systems and improve patient outcomes following CA.
Keywords: nurses, Cardiac Arrest

Introduction
Cardiac arrest (CA) is defined as the cessation of the heart's mechanical activity, confirmed by the absence of any signs of circulation. It remains one of the leading causes of mortality in Europe, claiming approximately 700,000 lives annually, while in the United States, the

incidence of CA affects around 400,000 to 460,000 individuals each year. When examining these statistics as a global incidence among an unselected adult population, the overall rate is estimated at 1 to 2 cases per 1000 individuals (0.1%-0.2%) annually (Wong et al., 2019). The prognosis following CA and cardiopulmonary resuscitation (CPR) largely depends on the timely implementation of critical interventions, such as early defibrillation, effective chest compressions, and assisted ventilation. However, despite ongoing efforts to enhance CA outcomes, survival rates remain poor (Herlitz et al., 2011). Improving patient outcomes necessitates continuous monitoring during the peri-arrest phase, which is crucial not only for identifying and preventing CA but also for informing treatment decisions and guiding immediate interventions throughout and following CPR.

In order to assess the success of resuscitation efforts and monitor patient progress, it is essential to have appropriate invasive or non-invasive equipment in place, with electrocardiography (ECG) serving as the cornerstone of monitoring during CA (Hayes et al., 2013). Additional parameters such as pupil response, body temperature, systolic and diastolic blood pressure (BP), and end-tidal carbon dioxide (ETCO2) provide valuable insights and help guide clinical management. Furthermore, emerging monitoring technologies and physiological parameters are being increasingly explored, such as the bispectral index (BIS), sonography, and coronary perfusion pressure (CPP). These advancements are pivotal in enhancing the care provided during the critical moments of CA and CPR.

Nurses play a crucial role in the effective monitoring and management of patients during CPR and throughout the peri-arrest period. Their responsibilities extend beyond the operation of monitoring equipment to the active interpretation of data, identifying changes in patient status, and taking appropriate actions based on clinical findings. During CPR, nurses are instrumental in ensuring that interventions are timely and coordinated, including the administration of medications, maintaining the integrity of the airway, and ensuring effective ventilation and chest compressions. They must continuously assess the patient's response to resuscitation efforts and be prepared to adjust the approach based on real-time monitoring feedback.

In addition to technical skills, nurses must also be adept at communication and collaboration within the resuscitation team, as these cases require a unified, rapid response. The nurse's ability to swiftly recognize signs of deterioration or improvement, interpret physiological data, and relay critical information to other team members can significantly impact the patient's chances of survival. As new monitoring technologies continue to evolve, nurses must remain updated on the latest techniques and devices, integrating these tools into their practice to enhance patient outcomes during these high-stakes situations. Effective nursing care in the peri-arrest period not only contributes to immediate survival but also supports long-term recovery and neurological outcomes, underscoring the indispensable role nurses play in managing cardiac arrest situations.

Non-invasive Monitoring

Non-invasive monitoring refers to the use of methods and equipment that do not require access to arterial (e.g., radial or femoral) or intravenous (IV) pathways. This type of monitoring is typically employed first when a nurse encounters an emergency. Many non-invasive monitoring devices are designed to be portable, making them suitable for use in a variety of clinical settings and environments.

Absence of Respiration: Pulse Palpation

When responding to a presumed cardiac arrest (CA), the initial step is to assess for unresponsiveness, absence of respiration, and lack of circulation. The absence of a pulse does not require specialized equipment, but it is not always quick or easy to detect, particularly for individuals who are not healthcare professionals.(Bahr et al., 2017) For this reason, the European Resuscitation Council (ERC) recommends initiating CPR if there are no signs of life (such as movement, normal breathing, or coughing) until more experienced help arrives or the patient shows signs of life. In contrast, the American Heart Association (AHA) advises healthcare providers to check for a pulse for no longer than 10 seconds. Nurses with clinical experience in assessment should palpate the carotid pulse while simultaneously observing for signs of life within this 10-second timeframe (Nolan et al., 2015). However, carotid pulsations during CPR do not indicate the effectiveness of coronary blood flow or the perfusion of the myocardium or brain.9 As such, checking for carotid pulsations during CPR does not provide valuable prognostic information and is not recommended.9 Other studies indicate that assessing for breathing can also be prone to error, with agonal gasps often misinterpreted as normal breathing. Nevertheless, the absence of breathing in an unresponsive individual remains a key sign of CA, as per the 2005 ERC guidelines. Additionally, recognizing agonal gasps is another indicator to begin CPR.

Patients in intensive care units (ICUs) require regular monitoring of vital signs, including heart rate, respiratory rate, blood pressure, and peripheral oxygen saturation (SpO2), to evaluate their response to medications, nursing procedures, and other therapeutic interventions. Early identification of clinical deterioration can serve as a warning for potential CA.

Pulse Oximetry

Pulse oximetry is a quick and useful tool for assessing oxygenation and evaluating the adequacy of perfusion at the site of the probe. However, pulse oximeters may fail to provide accurate readings even before the onset of CA, particularly when there is decreased local blood flow. Pulse oximetry should thus be viewed as a real-time "warning system" for patients at risk of arterial desaturation, such as those in the pre- or post-arrest periods, and for monitoring the effectiveness of therapeutic interventions or diagnostic procedures (Valdez-Lowe et al., 2009). The American Association of Critical-Care Nurses recommends evaluating the prospective site for signs such as cyanosis, weak peripheral pulses, and low temperature, as these could signal reduced blood flow and lead to inaccurate SpO2 measurements. Additionally, factors such as humidity and nail morphology can affect pulse oximetry readings. During CPR, pulse oximetry may not provide reliable data, as the blood flow supported by effective chest compressions is redirected primarily to vital organs, including the brain and heart.8 After the return of spontaneous circulation (ROSC), pulse oximetry can be useful in determining peripheral oxygenation and assessing perfusion adequacy.

Electrocardiographic Monitoring

Electrocardiographic (ECG) monitoring is considered the most important tool for monitoring during CA. The initial cardiac rhythm is one of the most critical factors influencing patient survival.6 ECG can help identify four main rhythms during CA: asystole, pulseless electrical activity, ventricular fibrillation (VF), and pulseless ventricular tachycardia. These rhythms are categorized into two groups: non-shockable and shockable rhythms. Non-shockable rhythms include asystole and pulseless electrical activity, while shockable rhythms include VF and pulseless ventricular tachycardia (Deakin et al., 2010).

ECG monitoring and interpretation are essential for determining whether the rhythm is shockable. Before administering a shock for VF, the nurse must confirm that the rhythm is not due to artifact by checking two leads. Similarly, asystole must be confirmed in two leads.9 Defibrillation is the definitive treatment for VF, and its success diminishes with the duration of VF. In cases of prolonged VF, the timing of defibrillation plays a significant role in determining the success of the shock and the likelihood of survival. An automatic external defibrillator (AED) can identify a shockable rhythm when chest compressions are paused, enabling nurses to safely perform early defibrillation with the device (Handley et al., 2015). However, the optimal criteria for determining the timing of defibrillation attempts remain uncertain.

In ICU settings, continuous ECG monitoring provides valuable information even before the onset of CA. Changes in heart rate, arrhythmias, and signs of myocardial ischemia may indicate impending cardiac failure, prompting timely interventions by nurses to prevent CA.

End-Tidal Carbon Dioxide Monitoring

ETCO2 monitoring serves as a valuable tool in evaluating the effectiveness of chest compressions. A rapid decline in ETCO2 at the onset of cardiac arrest (CA), followed by a subsequent rise with the initiation of resuscitation efforts, indicates that ETCO2 can be used to assess the success of these efforts. When ventilation is steady, as in controlled mechanical ventilation, the expired CO2 accurately reflects lung perfusion and, by extension, cardiac output. The simultaneous monitoring of arterial blood pressure and ETCO2 can provide a comprehensive evaluation of the quality and efficacy of resuscitative measures, including the depth, rate, and placement of chest compressions. Following the return of spontaneous circulation (ROSC), patients may experience increased oxygen demands, necessitating mechanical ventilation. Ventilator settings are typically adjusted based on the patient's arterial blood gas (ABG) results, respiratory rate, and work of breathing.

Non-invasive Blood Pressure Measurement

Although measuring blood pressure with a cuff is not recommended during resuscitation efforts, non-invasive blood pressure measurement after ROSC can offer an initial, approximate assessment of a patient's hemodynamic status until more reliable invasive blood pressure measurements are obtained via arterial catheters. Despite the limited number of randomized trials assessing the role of blood pressure in CA outcomes, the nurse—who has been shown to be more diligent in measuring blood pressure than physicians—should target the mean arterial pressure to achieve sufficient urine output, considering the patient's baseline blood pressure (Padfield, 2009).

Pupillary Diameter

Pupillary size, symmetry, and response to light are essential indicators when assessing potential brain injuries following CA. While most individuals exhibit equal pupil sizes, approximately one in five patients may present with anisocoria without an underlying pathology. During cardiopulmonary resuscitation (CPR), dilated pupils may result from atropine administration. The presence of bilateral pupillary dilation coupled with the absence of pupillary light reflexes is considered a late sign of ischemic brain injury (Dawes et al., 2007). No neurologic signs can predict outcomes during the early hours post-ROSC. According to the European Resuscitation Council (ERC) guidelines, the absence of the pupillary light reflex on the third day after CA is highly specific in predicting a poor outcome (e.g., death or a vegetative state). The American Heart Association (AHA) further asserts that an absent pupillary response 24 hours post-resuscitation is a strong indicator of a poor neurological outcome. The absence of pupillary response has become such a significant negative predictor that both the American College of Surgeons and the National Association of Emergency Medical Services Physicians advocate for withholding resuscitation in cases of traumatic CA. The role of pupillary response to therapeutic interventions during CPR has received limited attention in the literature.

Temperature Monitoring

Recent studies suggest that maintaining hypothermia (core temperature between 33°C and 36°C) in patients post-CA can improve neurological recovery. Continuous temperature monitoring is strongly recommended, and a thermometer should be used to track this parameter. Nurses can apply traditional cooling methods, such as cold fluids, extracorporeal circuits, body cavity lavage, whole-body ice water immersion, continuous veno-venous hemofiltration, and air-conduction hypothermia, or opt for modern cooling devices (commercial surface and intravascular cooling systems), which offer advantages in terms of ease of use, patient safety, target temperature maintenance, and control over rewarming (Seder & Van der Kloot, 2009). It is currently advised that post-arrest patients should not be rewarmed unless their core temperature falls below 33°C, in which case they should be gradually rewarmed to 34°C. A controlled trial with six months of follow-up involving 275 patients demonstrated that mild hypothermia was more effective than standard normothermia in improving neurological outcomes in patients after CA caused by ventricular fibrillation (VF).

A transient period of hyperthermia (body temperature >37°C) is commonly observed within the first 48 hours after CA. The risk of poor neurological outcomes rises with each degree of body temperature above 37°C. Hyperthermia during the initial 72 hours post-CA can be managed with antipyretics or active cooling methods. The optimal target temperature, rate of cooling, duration of hypothermia, and rewarming protocols have yet to be fully established. Various cooling techniques, including gastric, peritoneal, pleural, or bladder lavage with cold water, and intravascular cooling via cold intravenous fluids, cooling catheters, and extracorporeal circuits, can help lower the core temperature (Soar et al., 2016). Nurses should be educated on the cooling methods available in their healthcare facilities.

During resuscitation efforts, continuous temperature monitoring can provide critical insights, as both hypothermia and hyperthermia may be encountered (e.g., following drug overdoses). In cases of severe hypothermia, defibrillation should be limited to three attempts, and intravenous drugs should be withheld until the core body temperature exceeds 30°C. Cardiopulmonary bypass, though optimal for internal rewarming because it facilitates circulation, oxygenation, and ventilation, is not the preferred method due to the availability of less invasive alternatives, such as forced-air warming with heating blankets, ventilator adjustments for airway warming, and heated irrigation (e.g., gastric and bladder lavage with warm fluids, peritoneal dialysis, and thoracic lavage) (Lasater, 2008). It is essential to maintain consistency in temperature measurement methods (esophageal, bladder, rectal, or tympanic) throughout both resuscitation and rewarming phases.

Other Monitoring Techniques: Sonography and Bispectral Index Monitoring

Sonography is increasingly being used to assess resuscitation efforts. While transesophageal echocardiography (TEE) is challenging to perform during resuscitation, it can be done after the return of spontaneous circulation (ROSC). Transthoracic echocardiography, which is non-invasive, can be used during resuscitation but not during cardiopulmonary resuscitation (CPR). TEE is effective in diagnosing specific cardiovascular abnormalities associated with cardiac arrest (CA). A sudden reduction in aortic blood flow, followed by a decrease in end-tidal carbon dioxide (ETCO2), suggests the onset of CA, despite the persistence of an ECG signal. Initiating CPR leads to improvements in both aortic blood flow and ETCO2 levels, which indicates the effectiveness of resuscitation efforts (Kolar et al., 2008). In patients who experience intraoperative CA, TEE can continuously measure aortic blood flow, diameter, and velocity, providing vital diagnostic data along with the identification of cardiac pathology (e.g., ischemia), which may guide targeted, potentially lifesaving therapies.

Cardiac sonography is a sensitive tool for monitoring post-CA contractile dysfunction. Within the first 24 hours after CA, sonography is useful for guiding ongoing management, as it can document myocardial dysfunction and low cardiac output. Persistent and worsening hemodynamic instability is a clear indication for sonography. This technique can be taught to medical and nursing staff with limited experience. The involvement of nursing personnel in sonographic practice has enhanced the assessment and diagnosis of cardiovascular disease. Studies show that TEE imaging by critical care nurses is a safe method for measuring cardiac index and estimating intravascular volume in patients requiring hemodynamic monitoring in medical and surgical intensive care units (ICUs), with Doppler-derived measurements correlating well with those obtained via pulmonary artery catheterization.

The Bispectral Index (BIS) has the potential to provide information about cerebral blood flow

and oxygenation, although BIS readings may lag behind changes in arterial pressures. BIS is widely used in anesthesiology to measure the effects of anesthetic drugs on the brain and to track changes in a patient's level of sedation or hypnosis. BIS is calculated using a statistical algorithm that analyzes a patient's electroencephalogram during surgery (Johansen, 2018). When BIS monitoring is applied during CPR, it can serve as a potential predictor of cerebral perfusion, assisting the resuscitation team in evaluating cerebral response to CPR. A high BIS value reflects cerebral activity and may encourage the team to continue CPR. However, some studies indicate that BIS does not predict ROSC or survival after ICU admission (Chollet-Xémard et al., 2009).
BIS is of limited value during the early stages of post-resuscitative care. BIS values of zero can predict a poor neurologic outcome after CA and induced hypothermia. However, a non-zero BIS value alone is insufficient as a sole predictor of favorable neurologic survival (Leary et al., 2010; Stammet et al., 2009).

Invasive Monitoring

Invasive monitoring involves methods and equipment that require endarterial or intravenous (IV) access. This is typically performed after non-invasive monitoring techniques are in place, as setting up the equipment and securing sensors can be time-consuming. Once established, invasive monitoring provides continuous and precise data on a patient's condition, allowing for timely adjustments to therapeutic interventions. After ROSC, invasive monitoring becomes even more crucial due to the metabolic changes and the injured heart's tendency to develop arrhythmias. While physicians typically place catheters, it is the nurses who interpret the readings from such monitoring and manage the catheters. Invasive monitoring is particularly valuable for assessing a patient's response to therapy during and after CA in the ICU. Catheters used for invasive monitoring can be placed in central veins (e.g., jugular or subclavian veins) or peripheral arteries (e.g., radial or femoral arteries). Invasive monitoring may be required to measure blood pressure (BP) accurately and to determine the appropriate combination of medications to optimize blood flow.

A central venous catheter is useful for measuring central venous pressure (CVP), ensuring venous access when peripheral veins are unavailable, and providing access for administering medications that cannot be delivered peripherally. CVP measurements help estimate circulatory function, especially cardiac function and blood volume. While the absolute CVP value is less important than serial measurements and changes in response to therapy, a normal value for a spontaneously breathing patient ranges from 5 to 10 cmH2O (3.7–7.4 mm Hg). The flow-directed balloon-tipped pulmonary artery catheter, also known as the Swan-Ganz catheter, is another diagnostic tool used for bedside monitoring, such as measuring pulmonary artery resistance and right ventricular function (Maragiannis et al., 2010).

Hemodynamic optimization can be achieved during both the pre- and post-arrest periods using central venous oxygen saturation (ScvO2) as a surrogate measure via a fiberoptic pulmonary artery catheter. Continuous ScvO2 monitoring alerts the nurse to significant derangements in oxygen balance, allowing for the timely implementation of appropriate interventions. ScvO2 indirectly reflects the amount of oxygen consumed by the tissues. Poor ScvO2 measurements are strongly correlated with poor patient outcomes. Minimally invasive continuous near-infrared spectroscopy can measure intracellular oxygen levels, quantify intracellular function, and identify conditions affecting intracellular work.

Cerebral perfusion pressure (CPP), the only reliable prognostic indicator for successful resuscitation, can guide therapeutic interventions during CA if arterial and central venous monitoring are available. Calculating CPP can be useful when invasive monitoring of systemic BP is in place, as it may help improve the effectiveness of chest compressions, though it should not delay basic or advanced resuscitation efforts.
When necessary, arterial and central venous catheters can be used to obtain blood samples for

assessing a patient's biochemical status. For CA patients, it is strongly recommended to send blood samples for arterial blood gas (ABG) analysis and electrolytes. Monitoring both arterial and mixed venous blood gases and pH levels during CA is invaluable for evaluating acid-base equilibrium changes and guiding appropriate therapy to correct these imbalances. It is recommended to repeat ABG, acid-base values, and potassium levels every 10 to 15 minutes. ABG readings alone cannot provide a complete picture of the patient's condition and are not a reliable indicator of the severity of tissue hypoxemia, hypercarbia, or acidosis. While no data support targeting a specific arterial Pco2 after resuscitation, it is reasonable to adjust ventilation to achieve normocarbia, monitored via Pco2 and ABG values.

Monitoring blood glucose levels is crucial during and after resuscitation efforts. Frequent blood glucose checks are necessary, and any hypoglycemia or hyperglycemia should be corrected cautiously. Hyperglycemia should be avoided, as it exacerbates osmotic diuresis. Additionally, hyperglycemia increases the impact of hypoxia on ischemia, intensifies central nervous system damage, and reduces survival rates in CA patients. Further studies are needed to identify the optimal blood glucose target range and determine the impact of tight glucose control on outcomes after CA.

Urinary bladder catheterization is essential for monitoring hourly urinary output, which reflects both cardiac output and renal function. A significant decrease in urinary output may be an early sign of compromised cardiac and renal function, requiring prompt attention from healthcare providers.

Discussion

A substantial body of evidence indicates that many hospitalized patients exhibit signs of clinical deterioration prior to experiencing cardiac arrest (CA), including altered levels of consciousness, changes in oxygenation status, and trends in systolic blood pressure. In-hospital CA is linked with higher mortality rates, and it is generally assumed that timely intervention during the pre-arrest period can improve patient survival. Studies have shown that 60% to 76% of patients experience instability or deterioration in the 1 to 8 hours leading up to CA (Gazarian et al., 2010).

Patients hospitalized with CA or requiring emergency transfer to the intensive care unit (ICU) often have abnormal physiological values recorded in the hours before the event. However, numerous studies have documented that vital physiological measurements are frequently either not made or not recorded during this critical period of clinical decline. Such abnormalities are strongly associated with poor outcomes. Therefore, accurate and frequent recording of physiological measurements, including temperature, pulse rate, blood pressure, respiratory rate, hemoglobin, oxygen saturation, and mental status deterioration, is essential in any system designed for the early detection of physiological instability. At a minimum, these measurements must be recorded with sufficient frequency and accuracy. A system that can detect significantly abnormal values and trigger an immediate, appropriate clinical response is critical. As patients often have increased metabolic demands (such as blood and fluid loss, pain, infection, and trauma) post-CA, frequent monitoring—sometimes hourly or more—becomes essential.

Following resuscitation, nursing staff must assess the patient's electrocardiogram (ECG), radiographs, and laboratory analyses of serum electrolytes and cardiac biomarkers.

Nurses play a pivotal role in the management and monitoring of in-hospital CA, as they are typically the first responders in the hospital setting. As a result, they are often the first to initiate resuscitation, even before the arrival of the medical emergency team (MET). Traditionally, responses to CA have been reactive, with hospital staff attending to the patient only after the event has occurred. However, the presence of a CA team has been shown to improve survival rates in hospitals that previously lacked such a team. In some institutions, the CA team has been replaced by a MET, which responds not only to patients in CA but also to those exhibiting acute physiological deterioration. The MET typically consists of medical and nursing staff from both intensive care and general medicine and is activated based on specific clinical criteria.

In most hospitals, patient monitoring is primarily the responsibility of nursing staff, as they are typically the ones who apply the Early Warning Score (EWS) system or call the MET. The clinical signs of acute illness—such as respiratory, cardiovascular, and neurological failure—are similar regardless of the underlying condition. Despite the frequent occurrence of abnormal physiology in clinical departments, vital physiological observations of acutely ill patients are often not recorded as frequently as they should be. To aid in the early detection of critical illness, many hospitals now use EWS systems. These systems allocate points based on routine vital signs measurements and have been instrumental in identifying risk factors for CA. Through statistical analysis, it has been determined that an EWS score of 4 corresponds to 89% sensitivity and 77% specificity for predicting CA, while an EWS score of 8 offers 52% sensitivity and 99% specificity. Notably, all patients with an EWS score greater than 10 experienced CA. The weighted EWS score, based on the observation of vital signs, is utilized to guide decisions on increasing the frequency of monitoring or calling the MET.

A highly skilled nurse is an essential member of the MET. Nurses must recognize when a patient is clinically unstable and alert the appropriate personnel to initiate treatment. Traditional monitoring methods may fall short in assessing unstable patients, as heart rate may not adequately reflect the degree of compromise, and blood pressure reflects cardiac output and systemic vascular resistance rather than tissue perfusion. Similarly, urine output can be unreliable as a guide for resuscitation, body temperature is often impacted by shock, and pulmonary artery catheterization, while useful, also has its limitations.

To improve the clinical response of novice nurses, educators must develop teaching strategies that promote critical thinking and quick decision-making. Nursing students, especially those just starting in clinical environments, face many challenges, including acquiring vital signs, interpreting them to assess their clinical significance, and determining appropriate interventions. Nursing education typically begins with foundational courses, such as Basic Principles, Foundations, and Fundamentals of Nursing, which provide theoretical knowledge, followed by skill demonstrations in clinical simulation laboratories and real-world clinical settings. Educators need to prepare nurses for unexpected situations. Through the use of human patient simulators, educators can create complex clinical scenarios, allowing nurses to make decisions under pressure, simulating real-world situations without risk to patients. Additionally, algorithms are effective tools in guiding nurses through evaluation, decision-making, and intervention, promoting critical thinking. While algorithms themselves do not guarantee positive outcomes, they provide a standard of care that can be tailored to the needs of individual patients, emphasizing the importance of thorough monitoring (Rathbun & Ruth-Sahd, 2009).

Protocols regarding the management of CA require continuous updates to ensure they incorporate internationally accepted algorithms for therapeutic interventions and decision-making. Beyond basic research, clinical studies should focus on comparing different monitoring strategies and their correlation with treatment outcomes. These studies will help fill gaps in evidence and provide a more robust clinical algorithm for managing in- and out-of-hospital CA, ultimately improving patient survival rates following CA.

Conclusion

Effective monitoring and early detection of clinical deterioration are crucial in managing in-hospital cardiac arrest (CA). A range of non-invasive and invasive monitoring techniques, including electrocardiography (ECG), end-tidal carbon dioxide (ETCO2), sonography, and bispectral index (BIS) monitoring, play an essential role in guiding resuscitation efforts and improving patient outcomes. Nurses, as frontline responders, are pivotal in identifying early signs of clinical instability and initiating appropriate interventions. The integration of Early

Warning Score (EWS) systems into clinical practice has shown promise in predicting and averting CA, highlighting the importance of timely intervention. Furthermore, the use of critical care teams, such as the Medical Emergency Team (MET), contributes to improved survival rates when activated promptly. However, the success of these interventions relies heavily on the continuous education and training of nursing staff to foster quick decision-making and critical thinking in acute situations. Ongoing research is necessary to refine monitoring protocols and treatment strategies to bridge gaps in current evidence and ensure better clinical outcomes for patients experiencing CA.

References

Bahr, J., Klingler, H., Panzer, W., Rode, H., & Kettler, D. (2017). Skills of lay people in checking the carotid pulse. *Resuscitation*, *35*(1), 23–26. https://doi.org/10.1016/s0300-9572(96)01092-1

Chollet-Xémard, C., Combes, X., Soupizet, F., Jabre, P., Penet, C., Bertrand, C., Margenet, A., & Marty, J. (2009). Bispectral index monitoring is useless during cardiac arrest patients' resuscitation. *Resuscitation*, *80*(2), 213–216. https://doi.org/10.1016/j.resuscitation.2008.10.011

Dawes, E., Lloyd, H., & Durham, L. (2007). Monitoring and recording patients' neurological observations. *Nursing Standard*, *22*(10), 40–45. https://doi.org/10.7748/ns2007.11.22.10.40.c6237

Deakin, C. D., Nolan, J. P., Soar, J., Sunde, K., Koster, R. W., Smith, G. B., & Perkins, G. D. (2010). European Resuscitation Council Guidelines for Resuscitation 2010 Section 4. Adult advanced life support. *Resuscitation*, *81*(10), 1305–1352. https://doi.org/10.1016/j.resuscitation.2010.08.017

Gazarian, P. K., Henneman, E. A., & Chandler, G. E. (2010). Nurse decision making in the prearrest period. *Clinical Nursing Research*, *19*(1), 21–37. https://doi.org/10.1177/1054773809353161

Handley, A. J., Koster, R., Monsieurs, K., Perkins, G. D., Davies, S., Bossaert, L., & European Resuscitation Council. (2015). European Resuscitation Council guidelines for resuscitation 2015. Section 2. Adult basic life support and use of automated external defibrillators. *Resuscitation*, *67 Suppl 1*, S7-23. https://doi.org/10.1016/j.resuscitation.2005.10.007

Hayes, M. M., Berg, R. A., & Otto, C. W. (2013). Monitoring during cardiac arrest: Are we there yet? *Current Opinion in Critical Care*, *9*(3), 211–217. https://doi.org/10.1097/00075198-200306000-00007

Herlitz, J., Bång, A., Aune, S., Ekström, L., Lundström, G., & Holmberg, S. (2011). Characteristics and outcome among patients suffering in-hospital cardiac arrest in monitored and non-monitored areas. *Resuscitation*, *48*(2), 125–135. https://doi.org/10.1016/s0300-9572(00)00249-5

Johansen, J. W. (2018). Update on bispectral index monitoring. *Best Practice & Research. Clinical Anaesthesiology*, *20*(1), 81–99. https://doi.org/10.1016/j.bpa.2005.08.004

Kolar, M., Križmarić, M., Klemen2, P., & Grmec, Š. (2008). Partial pressure of end-tidal carbon dioxide successful predicts cardiopulmonary resuscitation in the field: A prospective observational study. *Critical Care*, *12*(5), R115. https://doi.org/10.1186/cc7009

Lasater, M. (2008). Treatment of severe hypothermia with intravascular temperature modulation. *Critical Care Nurse*, *28*(6), 24–29; quiz 31.

Leary, M., Fried, D. A., Gaieski, D. F., Merchant, R. M., Fuchs, B. D., Kolansky, D. M., Edelson, D. P., & Abella, B. S. (2010). Neurologic prognostication and bispectral index monitoring after resuscitation from cardiac arrest. *Resuscitation*, *81*(9), 1133–1137. https://doi.org/10.1016/j.resuscitation.2010.04.021

Maragiannis, D., Lazaros, G., Aloizos, S., Vavouranakis, E., & Stefanadis, C. (2010). Pulmonary artery catheter (PAC) under attack? *Hellenic Journal of Cardiology: HJC = Hellenike Kardiologike Epitheorese*, *51*(1), 49–54.

Nolan, J. P., Deakin, C. D., Soar, J., Böttiger, B. W., Smith, G., & European Resuscitation Council. (2015). European Resuscitation Council guidelines for resuscitation 2015. Section 4. Adult advanced life support. *Resuscitation*, *67 Suppl 1*, S39-86. https://doi.org/10.1016/j.resuscitation.2005.10.009

Padfield, P. L. (2009). Measuring blood pressure: Who and how? *Journal of Hypertension*, *27*(2), 216–218. https://doi.org/10.1097/HJH.0b013e32831fda4e

Rathbun, M. C., & Ruth-Sahd, L. A. (2009). Algorithmic tools for interpreting vital signs. *The Journal of Nursing Education*, *48*(7), 395–400. https://doi.org/10.3928/01484834-20090615-07

Seder, D. B., & Van der Kloot, T. E. (2009). Methods of cooling: Practical aspects of therapeutic temperature management. *Critical Care Medicine*, *37*(7 Suppl), S211-222. https://doi.org/10.1097/CCM.0b013e3181aa5bad

Soar, J., Deakin, C. D., Nolan, J. P., Abbas, G., Alfonzo, A., Handley, A. J., Lockey, D., Perkins, G. D., Thies, K., & European Resuscitation Council. (2016). European Resuscitation Council guidelines for resuscitation 2016. Section 7. Cardiac arrest in special circumstances. *Resuscitation*, *67 Suppl 1*, S135-170. https://doi.org/10.1016/j.resuscitation.2005.10.004

Stammet, P., Werer, C., Mertens, L., Lorang, C., & Hemmer, M. (2009). Bispectral index (BIS) helps predicting bad neurological outcome in comatose survivors after cardiac arrest and induced therapeutic hypothermia. *Resuscitation*, *80*(4), 437–442. https://doi.org/10.1016/j.resuscitation.2009.01.008

Valdez-Lowe, C., Ghareeb, S. A., & Artinian, N. T. (2009). Pulse oximetry in adults. *The American Journal of Nursing*, *109*(6), 52–59; quiz 60. https://doi.org/10.1097/01.NAJ.0000352474.55746.81

Wong, C. X., Brown, A., Lau, D. H., Chugh, S. S., Albert, C. M., Kalman, J. M., & Sanders, P. (2019). Epidemiology of Sudden Cardiac Death: Global and Regional Perspectives. *Heart, Lung & Circulation*, *28*(1), 6–14. https://doi.org/10.1016/j.hlc.2018.08.026