

The role of the nurse in patients with pacemakers: Practices and interventions in preoperative and postoperative intensive care

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Abstract

Background: The pacemaker is a medical device placed beneath the skin in the chest or abdominal area, designed to regulate irregular heart rhythms. By delivering electrical signals to the heart muscle, it ensures the heart maintains an appropriate rate and rhythm.

Introduction: Patients undergoing implantation of cardiac pacemakers require specialized medical care. Nurses play a key role in the care of patients with cardiac pacemakers, particularly in the preoperative and postoperative periods. This review focuses on the practices and interventions performed by nurses to improve outcomes and care in managing and monitoring patients with pacemakers.

Methods: This article presents the fundamental aspects of caring for patients with pacemakers in the preoperative and postoperative periods. The review covers processes of assessment, observation, and interventions related to patient status, pacemaker function, and associated complications. **Results:** Nurses play a key role in monitoring patients with pacemakers, including monitoring device function and identifying potential problems or complications. Nursing interventions include pain management, infection control, educational programs for patients and their families, and support for the psychological well-being of patients.

Conclusion: Care for patients with pacemakers in the preoperative and postoperative periods requires specialized knowledge and skills from nurses. Understanding the practices and interventions in this area can improve outcomes and the quality of care for these patients.

Keywords: Nurse; Pacemaker Patients; Preoperative Care; Postoperative Care; Intensive Care; Patient Management; Complications

1. Introduction

1.1. Review

A cardiac pacemaker (CP) is a medical device implanted beneath the chest's skin or abdomen, designed to help regulate abnormal heart rhythms [1]. Electrical impulses are being sent from this implantable medical device to the heart muscle, which helps maintain an appropriate rhythm and heart rate. Pacemakers are essential for patients with cardiac arrhythmias, providing the necessary stimulation to stabilize the heart's rhythm and prevent or interrupt dangerous arrhythmias [2]. They play a substantial role in maintaining optimal heart function and reducing the risk of severe events such as cardiac arrest or stroke. Cardiac pacemakers are commonly utilized in medical practice and play a crucial role in managing patients with conduction and rhythm abnormalities.

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The cardiac pacemaker, also known as an electrical stimulator or artificial pacemaker, was first implanted in 1958. Over time, advancements in electronics have greatly transformed the design of this device, and the implantation process has become a standard medical procedure [3]. Its primary function is to stabilize the heart's rhythm by stimulating the heart muscle. In modern practice, the use of cardiac pacemakers has gained greater significance in managing complex cardiac conditions. Advancements in medical technologies, population aging, and the expansion of indications have increased the number of patients receiving this therapy [2].

The importance of specialized medical care for patients undergoing pacemaker implantation is crucial for the successful outcome of the procedure and achieving optimal patient results. Pacemaker implantation is a serious and invasive procedure that requires specific training and care from the medical staff. Specialized medical care provides the necessary support and monitoring of patients before, during, and after the pacemaker implantation procedure. This includes preoperative preparation and assessment, selection of the appropriate pacemaker type, the implantation procedure itself, as well as postoperative care and monitoring. Specialized care offers not only physical but also emotional support for patients, who often feel stressed and anxious before and after the implantation [3]. The nurse plays an active role in managing cardiac care, with responsibilities ranging from direct medical interventions to psychological support and team coordination. Effective nursing care is based on proper assessment and support for patients undergoing pacemaker implantation, both before and after the procedure. Continuous support and information help patients cope with the situation more easily and feel confident in their treatment. Furthermore, specialized medical care includes monitoring for potential complications after pacemaker implantation, as well as managing any problems or side effects that may arise. This ensures the safety and well-being of patients undergoing the procedure [4]. Ultimately, specialized medical care is essential for the successful treatment and recovery of patients who need pacemaker implantation. It plays a key role in providing quality healthcare and improving the quality of life for these patients.

In the preoperative and postoperative care of patients undergoing pacemaker implantation, nurses play an essential and indispensable role. They not only provide physical care and medical monitoring but also offer emotional support and information to the patients and their families. Preoperative care involves a comprehensive assessment of the patient's health, preparation for the procedure, and explanation of the procedure itself [2]. Postoperative care includes monitoring for reactions and complications following pacemaker implantation, pain management, and support for the patient's recovery. All these aspects are carried out under the guidance and care of nurses, who are essential for the successful treatment and healthy recovery of the patients.

1.2. Preoperative Assessment Before Pacemaker Implantation

The preoperative assessment before pacemaker implantation is a basic stage in patient care. This process includes a thorough analysis of the patient's medical history, an evaluation of their condition, and an assessment of additional tests essential for making a decision regarding the procedure. During the preoperative evaluation, a thorough assessment of the patient's cardiac function is conducted, including an evaluation of the electrocardiogram (ECG) and echocardiography, to rule out any serious cardiac issues that could affect the pacemaker implantation [4].

Additionally, the patient's current medication list is reviewed to assess potential interactions with anaesthesia and their impact on the implantation procedure [5]. An important part of the preoperative assessment is discussing the procedure with the patient, explaining the expected outcomes, risks, and alternatives. This provides an opportunity for the patient to ask questions, express concerns, and feel reassured about the benefits of pacemaker implantation. Overall, the preoperative assessment is crucial for preparing the patient and ensuring the successful execution of the pacemaker implantation procedure, as it establishes the necessary conditions for safety and effectiveness.

Before performing scheduled procedures for implantation or reimplantation, the preoperative assessment includes consultations with the cardiology team from the cardiac pacing department of the relevant institution, as well as with the anaesthesiologist and the operating physician [6,7]. The evaluation will determine the type of device to be implanted (Cardiac Implantable Electronic Devices), the manufacturer, serial number, and the current settings required for its proper functioning.

Patients undergoing reimplantation usually carry an identification card for their current pacemaker, which provides information about the brand, model, and manufacturer. This allows for the pre-selection of the correct model to replace the old device. In the absence of this information, an evaluation of the device must be performed to answer several key questions: What is the patient's underlying rhythm? Is the device functioning properly? Are the electrode parameters optimal? This allows for proper planning of the reimplantation procedure [8,9].

According to the recommendations of the EHRA (European Heart Rhythm Association) and ASA (American Society of Anaesthesiology), follow-up for implanted devices should be conducted periodically—every 12 months for conventional pacemakers, every 6 months for ICDs, and every 3 to 6 months for CRT devices [10,11]. In the absence of prior history, it is mandatory to conduct an examination and gather all necessary data using the appropriate equipment. This stage of surgical procedure planning is essential for minimizing the risk of complications [12,13].

According to leading guidelines for monitoring and implantation of cardiac devices, it is important to address several key questions [14,15]:

- Is the patient dependent on the cardiac pacemaker? Patients with a pacemaker may be dependent on it, meaning that if the stimulation from the device is stopped, they could experience asystole and cardiac arrest. Such patients may have had severe bradycardia before implantation or have undergone His bundle ablation for some reason. Electromagnetic interference (EMI) can inhibit the pacemaker, posing an immediate life threat to the patient [16]. Therefore, EMI should be avoided, or if necessary, the existing device should be programmed to asynchronous pacing mode to minimize the risk of complications.
- Does the patient have an ICD (Implantable Cardioverter-Defibrillator)? When reimplanting a defibrillating device such as an ICD, it is crucial to deactivate the anti-tachycardia therapy. This is necessary due to the risk of delivering a shock during the procedure, which could adversely affect the patient and the surgical team.

There are several types of CP, but they are mainly categorized into external (temporary) and internal (permanent) pacemakers [17]. In some patients, a temporary external pacemaker may be required to stabilize their condition until a permanent pacemaker can be implanted. The temporary electrode is introduced through a different peripheral vein than the one used for the future permanent pacemaker, to minimize the risk of infection and complications. The role of the specialized medical staff is to explain to the patient that they must adhere to the prescribed regimen and avoid moving the limb through which the temporary electrode is placed. This ensures that the implantation procedure proceeds smoothly for both the patient and the surgical team.

2. Nursing Interventions During and in the Early Postoperative Period Following Permanent Pacemaker Implantation

Perioperative care for patients undergoing pacemaker implantation is crucial for the successful outcome of the procedure. These patients often require specialized and individualized medical care due to their specific needs and potential risks. Due to the risk of developing various complications following the implantation of a permanent pacemaker, such as arm swelling on the side of the surgical intervention and signs of cardiac dysfunction, the patient must be actively monitored [18]. Immediately after the surgery, the medical team observes the patient for any painful or unusual symptoms. Regular examinations and monitoring are essential to ensure that the pacemaker is functioning properly and that no complications arise [19]. Perioperative nursing care includes monitoring the patient's vital signs, assessing pain, and carrying out the physician's orders. The nurse must be familiar with the guidelines for pacemaker care and participate in patient's safety education and support. The nurse's responsibilities also include monitoring the implantation site for any signs of infection and assisting the patient in their recovery. They need to be prepared to respond to unforeseen circumstances and provide the necessary help and support to the patient throughout the postoperative period. The pacemaker implantation procedure encompasses the preoperative period, the actual implantation in the operating room, and postoperative follow-up. The specialized nurse plays an active role in each stage. During the procedure itself, the nurse must prepare the operating room and instruments, and be ready to respond promptly to any potential complications [20].

Early postoperative complications are often diagnosed in the operating room, such as suboptimal electrode placement necessitating repositioning or inadequate attachment of the electrodes to the pulse generator. Although these complications are rare, they can be life-threatening in the following days or weeks if not promptly identified [21]. Continuous ECG monitoring throughout the procedure is absolutely essential, and the nurse, as part of the team, must be trained to recognize pathological deviations and alert the operator. This helps to minimize complications during the surgical intervention [22]. After the pacemaker implantation is completed, the nurse applies a sterile dressing. They should inspect the surgical wound to monitor it as needed in the early postoperative period.

Each stage of pacemaker implantation is of utmost importance, and the trained nurse plays a crucial role in patient monitoring. In addition to the technical aspects, the psychological state of the patient should not be underestimated. A primary task of the nurse is to comfort the patient and ensure their comfort during the procedure [23]. After the operation is completed, the implanted device requires programming to accommodate the individual characteristics and

needs of the patient. Programming may involve adjusting the base pacing rate as well as changing the atrioventricular delay. These parameters depend on the physical capacity and specific needs of the patient.

The role of the nurse in providing care for patients with pacemaker was examined through a standardized interview conducted among medical professionals directly involved in the processes of coordination and organization (n=125). The study provides valuable information about daily practices, the role of the nurse, and opportunities for improvement in the management of cardiology care. A significant proportion of the surveyed respondents perceive their role as extremely important (66.4%). The results highlight the importance of their professional contribution to providing high-quality care and support for patients (Figure 1).

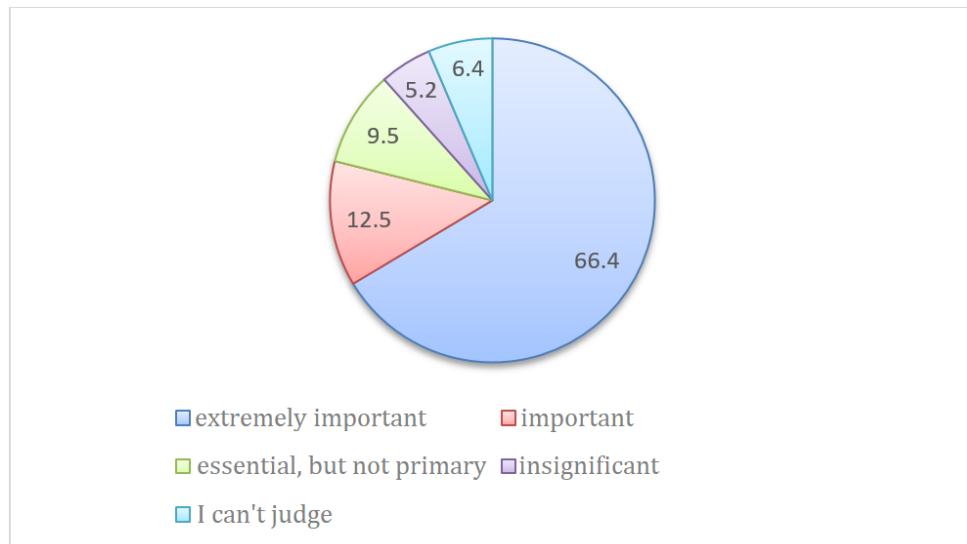


Figure 1 The role of the nurse in patients with pacemakers

Motivation and development of an optimal behavioral model for patients with a pacemaker are also found in the responses related to the stages of intervention planning. Detailed care planning encompasses both physical recovery and the psychological adaptation of the patient. A statistically significant strong positive correlation is established between physical recovery and successful adaptation ($r=0.88$). Patients who receive psychological support and guidance for adaptation demonstrate significantly better outcomes in coping with their new lifestyle (Figure 2).

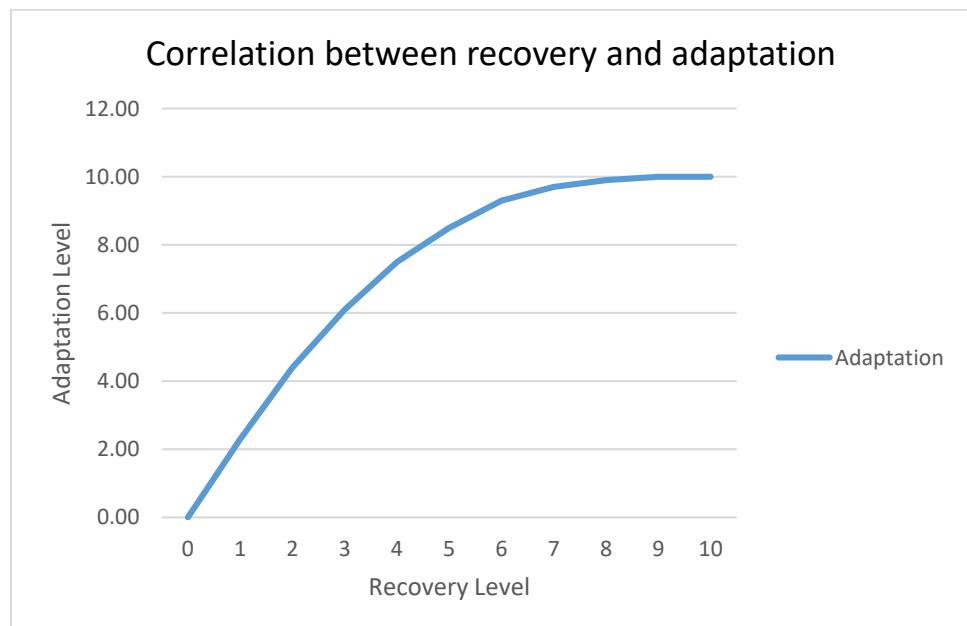


Figure 2 Correlation Between Recovery and Adaptation

The nurse in the cardiology clinic monitors the patient's overall condition on a daily basis, tracking vital signs, assessing the health dynamics, and applying care standards within the scope of her competencies. The main nursing activities and care for patients are focused on:

- continuous monitoring of the heart rate
- monitoring and early recognition of potential issues related to pacemaker function
- wound care and ensuring patient safety
- encouraging patient independence and awareness
- emotional support for the patient and their family
- guidance and psychological support for the patient and their family in living with a pacemaker

3. Types of Complications in Pacemaker Implantation and the Role of the Nurse in Early Detection and Minimization

3.1. Complications related to pacemaker implantation can be categorized into early and late complications.

Early Complications: These typically occur during the implantation procedure and are associated with venous access for electrode placement. The medical literature identifies complications that include:

- Pneumothorax: The presence of air in the pleural cavity.
- Hemothorax: The collection of blood in the pleural cavity.
- Air Embolism: Entry of air into the bloodstream, potentially leading to serious complications.

Early complications may also involve the placement of the electrode in the right atrial appendage or the apex of the right ventricle, including:

Myocardial perforation or micro-perforation: Penetration of the myocardium, potentially leading to acute or subacute pericardial effusion. Additionally, potentially life-threatening cardiac tachyarrhythmias can occur during the implantation. Timely recognition and management of these arrhythmias are critical for the patient's survival. In these scenarios, the nurse plays a crucial role by monitoring the patient's haemodynamic parameters closely.

Late complications occur days or months after the implantation procedure. The initial two months are critical for stabilizing the electrodes, during which the patient must adhere to certain physical activity restrictions to minimize the risk of electrode displacement [24]. Regular follow-up visits to monitor the function of the implanted device are extremely important. During these visits, the pacing threshold and electrode impedance are measured, and other potential complications that may develop over time are checked. These late complications may include:

- Increased Pacing Threshold: This may occur even if the electrode has not displaced, due to fibrosis at the electrode site.
- Decubitus Ulcer: Formation of a small pocket above the pulse generator, potentially leading to skin breakdown.
- Infection at the Implantation Site: Risk of infection at the site where the device was implanted. Monitoring and early detection of these issues are essential for ensuring the long-term effectiveness and safety of the pacemaker.

Mortality from complications is rare, with rates ranging from 0.08% to 1.1% [25].

Pneumothorax is a serious complication associated with pacemaker implantation and most commonly occurs during the puncture of the subclavian vein through which the electrodes are inserted [26]. Literature reports varying frequencies of this complication, with some institutions reporting rates from 0.6% to 1%, while others indicate a rate of 5.2%, largely depending on the experience and workload of the center. On average, the frequency of complications ranges from 1% to 3% [27]. Pneumothorax typically presents ipsilaterally and may vary in severity.

In such cases, the patient may need to be placed on continuous aspiration [28]. The immediate care provided by the nurse is crucial for the psychological comfort of the patient.

The possibility of developing **hemothorax** during pacemaker implantation is a rare complication, typically occurring during puncture of the subclavian artery, especially in patients receiving antiplatelet therapy [29]. The nurse identifies the early signs of the complication. Patient management includes timely recognition of clinical symptoms, providing

respiratory support, monitoring hemodynamic parameters, assisting in diagnostic procedures and drainage, as well as providing necessary education.

Several authors define **air embolism** as a potential complication [30]. The at-risk groups for developing air embolism include elderly patients and those who are dehydrated, with the highest risk occurring during the removal of the introducer's dilator. Nursing intervention in ensuring adequate hydration and positioning the patient in a safe Trendelenburg position is significant for improving the patient's overall condition. The interventions are focused on assessing the hydration level and providing the necessary amount of fluids, including intravenous administration.

Results from conducted studies show that the incidence of **venous thrombosis** after pacemaker implantation can range from 30% to 45%, with most cases being asymptomatic, as the body compensates by forming alternative blood vessels [31, 32]. Early identification can significantly reduce risks of further health problems and even death [33]. The nurse must be attentive to the early signs of venous thrombosis, which may include:

- pain, swelling, and redness at the implantation site or along the venous pathway
- shortness of breath, chest pain, and tachycardia
- local inflammation or signs of infection, including elevated temperature.

A fairly frequent problem after pacemaker implantation is **haematomas**. In cardiology practice, the use of perioperative anticoagulant therapy is a challenge [34]. The nurse monitors the patient for signs of hematoma, such as swelling, pain, changes in skin color around the implantation site, and difficulty moving the arm. The patient is informed about the behavior to follow—avoiding physical exertion, pressure, or injury at the intervention site. The wound is kept clean and dry to prevent infection, which could increase the risk of complications and hematoma formation.

The **risk of infection** is significantly increased in erosion cases and it is often recommended to extract the entire system [35]. The incidence of pacemaker-related infections is dependent on the number of implanted devices. The more the number increases, the greater the risk of infections. This complication can affect any structure, including the pacemaker pocket and electrodes, as well as endocardial structures, which is being linked by high percentage of mortality rates. Research indicates that the rate of infections associated with the implantation of various cardiac electronic devices ranges from 0.5% to 2.2% [35]. The nurse must regularly inspect the implantation site for signs of wound dehiscence or erosion. Proper wound care, infection prevention, and early recognition of problems can significantly reduce the risk of complications and support the patient's successful recovery.

Improper placement of the ventricular electrode is an exceedingly uncommon complication. Literature describes cases where the implanted electrode was positioned in cardiac veins, coronary sinus, pulmonary vessels, or the left ventricle [36]. Identifying incorrect electrode placement during the implantation procedure is crucial for making necessary adjustments and avoiding subsequent complications, such as embolic events or pericardial effusion.

Clinical studies indicate that **electrode dislocation** is a potentially dangerous and significant complication in practice. It usually develops during the initial post-implantation phase, typically within the first 24 to 48 hours. Studies show that 88% of electrode displacements take place within the first three months [37]. Displacement of atrial electrodes is more common (1.6-4.4%) than ventricular electrodes (0.5-1.9%) [38]. There are several potential risk factors for electrode dislocation and they include advanced heart failure with enlargement of cardiac chambers, the onset of atrial fibrillation, and lack of adequate experience in the center performing the procedure. When dislocated, the electrode usually remains intracardiac but may migrate back to the pulse generator, especially in the presence of Twiddler's syndrome [39].

Specific strategies for managing various complications vary depending on the particular issue. For a hematoma, manual compression and a prophylactic course of prolonged antibiotics are applied to prevent infection; revision and repositioning of the electrodes may be necessary [40]. In cases of pneumothorax or hemothorax, consultation with a thoracic surgeon is required, and if a perforation of a cardiac chamber is present, cardiothoracic surgical support should be sought [41]. The nurse plays an essential role in monitoring the patient and is often the first member of the team to detect complications. Key responsibilities of the specialized nurse include:

Monitoring the electrocardiogram and looking for clinical signs of device dysfunction, such as a low heart rate or evidence of incorrect electrode positioning. Various medications used in the intensive cardiology unit, such as corticosteroids, sympathomimetics, and anesthetics, may elevate the pacing threshold of the pacemaker and lead to extreme bradycardia.

3.2. Coordinated Care for Key Symptoms of Critical Conditions.

Timely assessment of the patient's condition and identification of signs of serious and life-threatening conditions support the urgent and effective treatment of critically ill patients. The nurse must be attentive not only to changes in the patient's condition but also to potential issues with the device itself. Clinical experience and judgment can be directed toward the following priorities in nursing care:

- monitoring vital signs, including observation of heart rhythm and pacemaker function
- monitoring and assessing chest pain
- observing respiratory function
- evaluating the underlying cause and ensuring immediate and appropriate interventions for dyspnea
- analyzing subjective and objective data for impaired gas exchange
- monitoring for symptoms of arrhythmias
- observing for signs of cardiac tamponade and providing timely reporting
- noting signs of anxiety and restlessness
- preventing and controlling infections
- informing the patient and their family about the influence of external factors, limiting physical activity, and avoiding areas with strong magnetic or electrical fields
- ensuring patient safety

Coordinated care for patients with pacemakers encompasses a wide range of activities, including not only monitoring cardiac function and preventing infections but also supporting the patient's psycho-emotional state and ensuring safety during daily activities. These aspects are interconnected and require exceptional precision, attentiveness, and skills from the nurse, whose active involvement is crucial for successful recovery and reducing the risk of complications.

4. Conclusion

In conclusion, the role of nurses in the care of patients with cardiac pacemakers is crucial for achieving successful outcomes and improving quality of life. The specialized knowledge and skills they demonstrate during the preoperative and postoperative periods not only ensure the effective functioning of the devices but also provide essential support and information to patients and their families. Understanding and implementing best practices by nurses not only helps to address potential risks and complications but also provides reassurance and comfort to patients whose lives depend on the functioning of their cardiac pacemakers. It is important to continue the education and development of nurses in this field to ensure ongoing improvement in patient care.

Compliance with ethical standards

Disclosure of conflict of interest.

The author declares that there is no conflict of interest regarding the publication of this paper

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