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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 device implanted under the skin of the chest or abdomen to help control abnormal heart rhythms. This device sends electrical impulses to the heart muscle to maintain a suitable rhythm and heart rate.

Introduction: Patients undergoing implantation of cardiac pacemakers require specialized medical care. Nurses play a key role in the care of patients with cardiac pacemakers, especially 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

A cardiac pacemaker (CP) is a medical device implanted under the skin of the chest or abdomen, designed to help regulate abnormal heart rhythms [1]. This implantable medical device sends electrical impulses 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 widely used in clinical practice and are an indispensable part of the treatment for patients with conduction and rhythm disorders.

The cardiac pacemaker, also known as an electrical stimulator or artificial pacemaker, was first implanted in 1958. Since then, this device has significantly evolved in appearance thanks to advancements in electronics, and the implantation

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procedure is now considered routine [3]. The design and indications for pacemaker use have changed with the system's development. The purpose of stimulating the heart muscle is to stabilize the heart rhythm, which is why the device is called a pacemaker. If the heart has preserved pumping function but experiences conduction disturbances in impulse transmission and myocardial activation, it can be artificially stimulated and regulated, allowing the patient to lead a normal life. A very low stimulation current is required for its operation.

In recent decades, therapy with cardiac pacemakers has become increasingly important in the treatment of complex cardiac patients, with broader indications and more patients receiving this treatment [2]. This has been achieved through better diagnostics, improved training of medical personnel, and increased life expectancy in the general population. The care of patients before and after pacemaker implantation depends on the professional assessment of the patient by the nurse, who is part of the cardiology team. As the healthcare professional closest to the patient, the nurse plays a significant role in providing quality care and education to these patients.

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]. Continuous support and explanations from the medical staff 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.

1.1. Preoperative Assessment Before Pacemaker Implantation

The preoperative assessment before pacemaker implantation is a basic stage in patient care. It involves a detailed review of the patient's medical history, physical examination, and additional tests that may be necessary to assess the patient's health and suitability for 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].

For most patients monitored at the center, previous examination records are available from regular follow-ups. 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]. The nurse plays a crucial role in the perioperative care of these patients. They must monitor the patient's condition, assess painful symptoms, and provide appropriate analgesia if necessary. Additionally, the nurse should be familiar with the specific instructions for managing the pacemaker and be able to offer educational support to the patient and their family regarding care and safety concerns. 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 positioning requiring repositioning, or improper fixation 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 priorities of nursing care for patients with a pacemaker include:

- **Monitoring Heart Rhythm and Pacemaker Function:** Regular assessment of the patient's heart rhythm and pacemaker function is essential to ensure optimal cardiac function and effectiveness of pacemaker therapy.
- **Proper Wound Care:** Maintaining a clean and sterile environment for the wound promotes healing, reduces the risk of wound-related complications, and ensures that the pacemaker continues to function optimally without interruption or need for additional interventions.
- **Monitoring for Pacemaker-Related Complications:** Complications related to the pacemaker may include infection at the implantation site, electrode displacement or fracture, hematoma formation, pneumothorax, thrombosis or embolism, device malfunction or electrical issues, and allergic reactions or interference with other devices.
- **Providing Emotional Support:** This includes actively listening to the patient's concerns and fears, validating their emotions, and offering reassurance and empathy.
- **Patient and Family Education:** Providing education and support to the patient and their family regarding the pacemaker's function, activity restrictions, and signs of complications.

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. Such complications include:

- **Pneumothorax:** Accumulation of air in the pleural cavity.
- **Hemothorax:** Accumulation 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 apex of the right ventricle or the right atrial appendage, 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]. The most common complication is electrode displacement (with atrial electrodes being displaced more frequently than ventricular ones), followed by pneumothorax, infection, hematoma, and myocardial perforation.

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.

Management of Pneumothorax:

- Partial Pneumothorax: If localized to the apex, conservative management is generally employed.
- Total or Subtotal Pneumothorax: Requires drainage.

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.

Hemothorax is an extremely rare complication associated with pacemaker implantation, typically resulting from puncture of the subclavian artery, especially in patients on anticoagulant therapy. Hemothorax is usually treated with drainage, although in rare cases, decortication may be required [29].

Air embolism is a complication related to the use of the Seldinger technique for percutaneous puncture [30]. Deep inhalation during the use of venous access can lead to air entering the venous system due to the physiological negative pressure. To prevent this complication, it is recommended to adequately hydrate the patient and place them in the Trendelenburg position. However, the most important step in preventing air embolism is well-trained medical staff, particularly the operator. 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 dilator from the introducer.

Venous thrombosis is a rare but potentially dangerous complication of pacemaker implantation. It can manifest at various intervals following the procedure [31]. According to clinical studies, the incidence of venous thrombosis ranges from 30% to 45%, but most cases remain asymptomatic due to the development of adequate collateral circulation [32]. The exact pathogenesis is not fully understood, but literature identifies several risk factors that may contribute to severe occlusion, including the presence of multiple electrodes (compared to single-electrode systems), use of hormone therapy, a history of previous venous thrombosis, previous electrophysiological therapy, endothelial trauma caused by electrode placement, and postoperative hypercoagulable states [33]. Although only 1-3% of patients with venous thrombosis develop symptoms, routine follow-up and attention to the potential development of this complication are crucial, as early diagnosis can reduce potential morbidity and mortality. The clinical presentation depends on the location and size of the thrombosis.

Haematoma is a relatively common complication of pacemaker implantation, particularly in patients undergoing oral anticoagulant or antithrombotic therapy. The decision to use perioperative anticoagulant therapy poses a dilemma for physicians, especially for individuals at moderate to high risk of thromboembolic events [34]. Until recently, guidelines recommended discontinuing oral anticoagulant therapy and using "bridging" therapy with heparin. However, this strategy of transitioning from one anticoagulant to another is associated with an increased incidence of pocket haematoma (up to 20%). Recent observational studies suggest that continuing oral anticoagulant therapy is safe and does not significantly increase the incidence of hematoma.

Wound erosion and dehiscence are subacute complications associated with pacemaker implantation, resulting from progressive erosion of the skin. If the pocket prepared for the pulse generator during implantation is too small for the device, excessive tension on the overlying skin can gradually cause erosion of the subcutaneous tissue and eventually the skin. Erosion can also occur if the pocket is made too superficial, rather than between the pectoral fascia and the pectoral muscle. In cases of erosion, there is a high risk of infection, and it is often recommended to extract the entire system [35]. As the number of implanted devices increases, so does the frequency of infections related to pacemaker implantation. This complication can affect any structure, including the pacemaker pocket and electrodes, as well as endocardial structures, the latter being associated with extremely high mortality. Multiple and prolonged hospitalizations are common, and attempts to salvage infected devices frequently fail. According to literature, the incidence of infections as a complication of implanting all types of cardiac electronic devices ranges from 0.5% to 2.2%,

with slightly lower rates for conventional pacemakers compared to implantable cardioverter-defibrillators, and slightly higher rates for re-implantation compared to primary implantation.

Improper placement of the ventricular electrode is an extremely rare complication. Literature describes cases where the implanted electrode was positioned in the left ventricle, coronary sinus, cardiac veins, or pulmonary vessels [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.

Electrode dislocation is a clinically significant and potentially dangerous complication. It typically occurs in the early post-implantation period (within 24-48 hours). Literature indicates that 88% of dislocations occur within the first 3 months [37]. Displacement of atrial electrodes is more common (1.6-4.4%) than ventricular electrodes (0.5-1.9%) [38]. Possible risk factors for electrode dislocation 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 haematoma, 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. Observing for symptoms such as dyspnea, chest pain, pallor, cyanosis, diminished or absent breath sounds, tracheal deviation, and a patient's sense of impending doom.

These signs may indicate a developing tension pneumothorax, which is an emergency condition requiring immediate treatment.

- **Monitoring for muscle twitching and hiccups.** This may suggest perforation of the heart with pacing towards the chest wall or diaphragm.
- **Watching for signs and symptoms of cardiac tamponade.** This could indicate myocardial perforation and accumulation of blood in the pericardial sac, leading to cardiac tamponade. This is a potentially life-threatening complication that necessitates prompt medical intervention.
- **Tracking vital signs,** including observing for diaphoresis, dyspnea, anxiety, and hypotension. These signs may indicate the development of a hemothorax due to potential puncture of the subclavian artery during the implantation procedure.
- **Advising the patient to avoid exposure to high electromagnetic energy fields,** which could lead to device dysfunction.
- **Educating the patient and their family about activity restrictions** to minimize the risk of complications. This includes avoiding heavy physical labor with the arm on the side of the implanted device and limiting circular movements of the shoulder joint on the side of the pacemaker. This helps reduce the risk of electrode fracture and related late 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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