AN OVERVIEW OF COMPLICATIONS IN PACEMAKER IMPLANTATION IN ELDERLY PATIENTS: A SCOPING REVIEW

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ABSTRACT

Introduction: Permanent pacemaker implantation in elderly patients is a critical procedure for managing various cardiac arrhythmias, but postoperative complications remain a significant concern. In the elderly population, the risk of complications increases due to age-related physiological changes, comorbidities, and declining functional status. This procedure is often associated with complications such as hematoma, infection, lead dislocation, and venous thrombosis. Despite this, research on complication rates in elderly patients remains limited, and there is a need for a deeper understanding of the determinants of complications as well as variability across healthcare settings. **Methods:** This scoping review examines relevant literature on the complication rates of pacemaker implantation in patients aged 65 and older, covering various clinical settings from January 2014 to December 2024. A literature search was conducted through the ProQuest, Wiley, and BMC databases, along with other sources. Of the 784 articles identified, 46 articles were screened for further review, and seven articles were selected for final analysis. **Results:** The studies reviewed indicate that while the overall complication rate following pacemaker implantation in elderly patients is low, there is variability depending on individual factors such as pacemaker type, underlying medical conditions, and the use of anticoagulant therapy. The most common complications found were hematoma, infection, and pacemaker lead dislocation. The dual-chamber pacemaker (DDD), more commonly used in elderly patients, showed a lower complication rate compared to other pacemaker types. Other risk factors, such as obesity and smoking history, also contribute to an increased likelihood of post-operative complications. **Conclusion:** Permanent pacemaker implantation in elderly patients is generally safe with a low complication rate. However, complications that do occur still affect the quality of life of elderly patients and require more attention in postoperative management. Further research is needed to explore the long-term impact of complications on the quality of life of elderly patients and to understand the influence of pacemaker type and risk factors in minimizing post-implantation complications.

Keywords: *Complications, Elderly patients, Risk factors, Scoping review, Permanent pacemaker implantation.*

Introduction

Permanent pacemaker implantation has become an essential intervention in the management of various arrhythmias, particularly in the elderly population. As global life expectancy increases, the demand for pacemaker implantation procedures among the elderly has also seen a significant rise (Lopez-Candales, 2021; Udo, 2020). A pacemaker helps maintain adequate heart rhythm, alleviate symptoms, and improve the quality of life for patients. While its clinical benefits are well recognized, pacemaker implantation is not without risks, which tend to be higher in elderly patients due to age-related physiological changes, multiple comorbidities, and declining functional status (Mulpuru, 2021).

Post-implantation complications in the elderly include infections, hematomas, lead dislocations, heart perforations, venous thrombosis, and pacemaker syndrome (Khan et al., 2022). These complications are further exacerbated by the anatomical challenges and specific medical conditions often found in geriatric patients. Data indicate that complication rates range from 3% to 12%, with variations depending on patient factors, procedural techniques, and operator experience (Tarvainen, 2022). In the context of modern healthcare systems that prioritize patient safety, understanding these complication patterns is critical for designing effective prevention strategies and improving clinical outcomes.

Healthcare systems worldwide are currently facing significant challenges in providing safe, effective, and sustainable cardiovascular services, especially for the growing elderly population. Therefore, a comprehensive understanding of pacemaker implantation complication rates in the elderly is crucial, not only for clinical purposes but also for the formulation of health policies and the development of post-implantation care protocols (Brignole, 2021). However, despite several primary studies on pacemaker implantation complications, no systematic or comprehensive scoping review has specifically mapped the complication rates in the elderly population globally.

Preliminary literature review reveals that studies on post-pacemaker implantation complications tend to focus on the general population without distinguishing the unique characteristics of elderly patients (Luthje, 2022). Some studies report complication data but often fail to classify results based on age groups, leading to a gap in critical information that hinders the implementation of evidence-based approaches specifically for the elderly group. Thus, there is a need for a systematic and comprehensive review that identifies, maps, and analyzes complication rates in pacemaker implantation among elderly patients.

A permanent pacemaker is defined as a small electronic device implanted subcutaneously to regulate the heart's

rhythm by providing electrical stimulation to the myocardium, typically through one or more leads connected to the heart (Kusumoto, 2019). In this context, the "complication rate" encompasses the occurrence of side effects or adverse medical incidents that occur as a direct or indirect consequence of the implantation procedure, either during the acute or chronic post-implantation period.

Inclusion criteria for this scoping review include studies reporting the incidence of complications related to permanent pacemaker implantation in patients aged ≥ 65, without restricting the type of device (single chamber, dual chamber, or biventricular pacemaker). Research from various clinical settings such as community hospitals, academic hospitals, and cardiac specialist clinics will be included to capture contextual variations that may influence complication rates (Hutten, 2020).

A scoping review was chosen as the method due to the broad and complex nature of the topic and the variability in methodology and findings across the available studies. This approach allows for comprehensive mapping of the evidence, identifying research gaps, and establishing a foundation for systematic studies or primary research in the future (Peters et al., 2020). Additionally, this method is expected to provide an in-depth understanding of the determinants of complications, variations across healthcare settings, and strategic recommendations to enhance the safety of pacemaker implantation procedures in the elderly.

An initial literature search through PubMed, Scopus, and Web of Science confirmed that there has yet to be a scoping review specifically exploring the complication rates of pacemaker implantation in the elderly population. This finding underscores the urgency of this review to fill the knowledge gap and support evidence-based clinical practices in the care of geriatric patients requiring pacemakers. The objective of this scoping review is to map and evaluate the complication rates of permanent pacemaker implantation in elderly patients and identify the factors contributing to variation in complications across healthcare settings.

Research question: "What are the complication rates and the factors contributing to complications in permanent pacemaker implantation among elderly patients across different healthcare settings?"

Methods

The development of this scoping review follows the latest methodology guidelines from the Joanna Briggs Institute (JBI) (Peters et al., 2020) and the PRISMA-ScR framework (Tricco, Lillie, & Zarin, 2018), which are designed to ensure a systematic, transparent, and credible review process. First, the research objectives and questions were formulated using the Population, Concept, Context (PCC) framework to clarify the focus and scope of this study (Peters et al., 2020). Second, the review protocol was developed by setting inclusion and exclusion criteria, search strategies, and data extraction methods to ensure transparency and replicability; the

development of the protocol is also aligned with recommendations for registration on platforms such as the Open Science Framework or JBI Evidence Synthesis (Peters et al., 2020; Tricco, Lillie, & Zarin, 2018). Third, a comprehensive literature search was conducted through academic databases such as PubMed, Scopus, and Web of Science, as well as grey literature sources, with the assistance of academic librarians to optimize search strategies and systematically record all steps (Tricco et al., 2018). Fourth, the article selection process was carried out in several stages, beginning with title and abstract screening, followed by full-text evaluation based on inclusion and exclusion criteria, using the PRISMA-ScR flow diagram to maintain transparency and accountability in the study selection process (Tricco, Lillie, & Zarin, 2018). Fifth, relevant data were extracted using pre-developed extraction forms and then analyzed descriptively to map key findings, research trends, and identify gaps in the available literature (Peters et al., 2020). This entire process is designed to produce a systematic, credible, and comprehensive scoping review, which aims to provide a mapping of the current scientific evidence regarding the complication rates of pacemaker implantation in elderly patients and inform evidence-based clinical practice and health policy.

Inclusion Criteria

The article search method applies the Population, Concept, Context (PCC) framework as follows:

Table 1. PCC Framework

Component	Deskription
Population	Patients aged ≥65 years who undergo permanent pacemaker implantation. This population includes individuals with various cardiovascular conditions, such as sinoatrial node dysfunction, atrioventricular block, and symptomatic bradycardia.
Concept	Complications evaluated include infection, hematoma, lead dislocation, heart perforation, venous thrombosis, and pacemaker syndrome. The focus is on incidence reports, risk factors, and the clinical impact of these complications.
Context	Including community hospitals, academic hospitals, specialized heart centers, and other healthcare facilities at both national and global levels, without restricting to high or low-resource settings. Studies from all geographic regions will be considered to

Component	Deskription
	explore variation in complications across different contexts..

Types of sources

This scoping review will include a variety of source types to comprehensively answer the research question that has been formulated. Studies with experimental and quasi-experimental designs will be considered, including randomized controlled trials (RCTs), non-randomized controlled trials, before-and-after studies, and interrupted time-series studies.

Analytical observational studies such as prospective and retrospective cohort studies, case-control studies, and analytical cross-sectional studies will also be included to enrich the analysis of complication rates in pacemaker implantation in elderly patients.

Additionally, descriptive observational studies, including individual case reports, case series, and descriptive cross-sectional studies, will be considered to provide additional context and broader insights into the variation of complications.

Furthermore, qualitative studies focusing on the collection and analysis of qualitative data, including but not limited to phenomenological approaches, grounded theory, ethnography, qualitative descriptions, action research, and feminist research, will be included to capture the perspectives of patient and healthcare provider experiences.

By incorporating a range of study designs and sources of evidence, this scoping review aims to comprehensively map the available literature, identify research gaps, and illustrate the scope of knowledge related to the complication rates of pacemaker implantation across different healthcare settings (Peters et al., 2020; Tricco, Lillie, & Zarin, 2018).

Eligibility Criteria

The inclusion and exclusion criteria for this literature review were meticulously established to ensure the relevance and quality of the articles analyzed. The inclusion criteria encompass articles that report findings on the complication rates of permanent pacemaker implantation in patients aged ≥ 65 years; studies utilizing quantitative, qualitative, or mixed-methods designs; studies involving elderly patients who have received permanent pacemaker implantation, without limiting the type of device (single-chamber, dual-chamber, or biventricular pacemaker); articles available in full-text format; articles published between January 2014 and December 2024; and articles written in English. Conversely, the exclusion criteria include articles categorized as literature reviews, systematic reviews, or scoping reviews, as well as duplicate publications appearing in two or more journals, to maintain the integrity and uniqueness of the findings. The establishment of these criteria is designed to uphold the accuracy of the literature mapping and ensure that only relevant, high-quality evidence is included in this scoping review, in line with the methodological principles recommended

by the Joanna Briggs Institute and PRISMA-ScR (Peters et al., 2020; Peters & al., 2020).

Databases

The literature search for this scoping review was conducted using three main databases: Proquest, Wiley, BMC (BioMed Central), and other sources. The selection of these databases was intended to access high-quality scholarly publications relevant to the topic of pacemaker implantation complications in elderly patients. All databases were accessed on April 20, 2025, to ensure the timeliness of the data and the reliability of the sources used in the literature review.

Search Strategy

In the literature search, a combination of keywords with Boolean operators was used to achieve more specific results and facilitate the selection of relevant articles. The keywords used in the search were ("complications" OR "complication rates" OR "postoperative complications") AND ("pacemaker implantation" OR "permanent pacemaker") AND ("elderly patients" OR "geriatric patients" OR "older adults" OR "patients ≥65 years") AND ("overview" OR "review" OR "summary") AND ("health outcomes" OR "post-surgery outcomes") AND ("aging" OR "elderly population"). By utilizing this combination of keywords across three major databases Proquest, Wiley, BMC (BioMed Central), and other sources along with the assistance of Boolean operators, the researchers successfully identified 784 articles that met the search criteria.

Article Screening

This study employed the PRISMA flow diagram, which includes the stages of identification, screening, eligibility, and inclusion of articles. The screening process began with the removal of duplicate articles and the filtering of articles based on titles and abstracts relevant to the topic of pacemaker implantation complications in elderly patients. Articles with designs categorized as literature reviews, scoping reviews, and systematic reviews were excluded from the analysis. Additionally, articles with identical titles and authors, or those categorized under the same type, either within a single database or across databases, were also eliminated. Subsequently, full-text articles were screened to assess their relevance and alignment with the inclusion criteria for this study (Tricco, Lillie, & Zarin, 2018).

Data Extraction

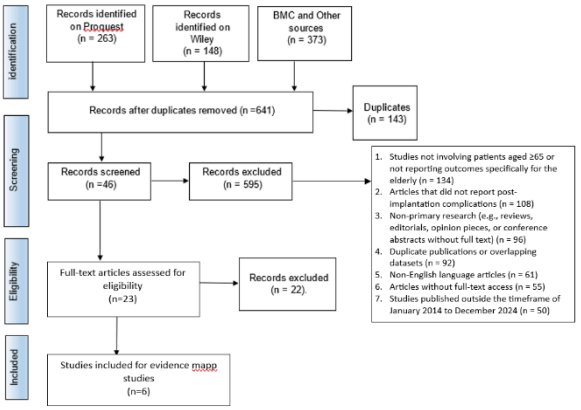
Data extraction will be performed based on a pre-designed template, including key details such as study design, population, concept, context, and reported outcomes. The data extraction process will be conducted independently by two reviewers to minimize potential bias and ensure the accuracy of the collected data (Peters et al., 2020).

Results

The researchers used three main search platforms in this study: PubMed, BMC (BioMed Central), and ProQuest. In the identification phase, a total of 784 articles were retrieved from all databases. Subsequently, articles were filtered based

on the publication criteria between 2014 and 2024, availability in full-text format, and written in English. This initial screening process resulted in 46 articles that met the criteria.

Further screening was conducted based on titles and abstracts to ensure the relevance of the articles to the research topic. Articles using designs such as literature reviews, systematic reviews, and scoping reviews were excluded. Additionally, duplicate articles found across the databases were removed at this stage. After this further screening, 23 articles were selected for more in-depth review to ensure alignment with the inclusion criteria. Ultimately, six articles were included in the final analysis of this scoping review. The entire PRISMA procedure is visualized in the flow diagram below.



Picture 1. PRISMA Flowchart

Critical Appraisal Results

The initial assessment of article quality was conducted independently by two reviewers, with discussions held to resolve any discrepancies in evaluations before reaching a final justification. In this used to assess various types of studies, including the JBI Checklist for Cohort Studies (n=4), JBI RCT (n=1), and JBI Checklist for Case Reports (n=1). This assessment aims to ensure that the articles included in this review meet adequate methodological quality and are relevant to the research objectives, in line with the evidence-based critical appraisal standards recommended in recent literature (Munn et al., 2020).

Articles Included in the Literature Review

The results of the initial analysis, further review, and identification ultimately included 6 articles. The following table provides detailed information about each article:

Table 3. Accumulated Critical Assessment of Articles

ID	Title	Criteria													Mark
		1	2	3	4	5	6	7	8	9	10	11	12	13	
JBI Checklist for Cohort Studies															
CE 4	Aging and Cardiac Implantable Electronic Device	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓			81%

ID	Title	Criteria												Mark
		1	2	3	4	5	6	7	8	9	10	11	12	13	
	Complications: Is the Procedure Safe in Older Patients?														
CE 5	Periprocedural Complications of Cardiac Implantable Electronic Device Implantation in Very Elderly Patients with Cognitive Impairment: A Prospective Study	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			100%
CE 6	Analysis of Postoperative Complications and Risk Factors in Patients with Permanent Pacemaker Implantation	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-			81%
CE1	Patients Characteristic, Indications, and Complications of Permanent Pacemaker Implantation: A Prospective Single-Center Study	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-			81%
JBI RCT															
CE 3	The Pacemaker Implantation in Elderly Patients: Safety of Various Regimens of Anticoagulant Therapy	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	80%
JBI Checklist for Case Reports															
CE 5	*A Pacemaker Lead Infection as a Complication of Discitis Post-Fall in an Elderly: A Case Report*	✓	✓	✓	✓	✓	✓	✓	✓						100%

Table 4. Analysis of Literature Results

ID Number	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Results
CE 1	Author: Mousa Haji Ahmed. Journal Identity: *Med J Babylon*, 2022 (Ahmed, 2022).	Patients' Characteristics, Indications, and Complications of Permanent Pacemaker Implantation: A Prospective Single-Center Study	To determine the characteristics, indications, and complications of permanent pacemaker implantation	396 patients (average age 65 years) undergoing pacemaker implantation	Prospective single-center study	4.25% of patients developed complications. Early complications included pocket hematoma and pneumothorax, while late complications involved shoulder pain. Dual-chamber pacemakers (DDD) were the most commonly used.
CE 2	Authors: Cima Hamieh, Rania Sakr, Mahmoud El Hussein. Journal Identity: *J Family Med Prim Care*, 2023 (Hamieh, C., Sakr, R., & El Hussein, 2023).	A Pacemaker Lead Infection as a Complication of Discitis Post-Fall in an Elderly: A Case Report	To report a rare case of pacemaker lead infection as a complication of spondylodiscitis in an elderly patient post-fall	1 elderly female patient (78 years) with ischemic cardiomyopathy and a pacemaker	Case report	The patient developed spondylodiscitis after a fall and subsequently developed a pacemaker lead infection. Despite treatment, the patient died from septic shock 6 weeks later.
CE 3	Authors: Denis Terekhov, Valeriy Agapov,	Pacemaker Implantation in Elderly Patients: Safety of Various	To evaluate the complication rates of pacemaker implantation in	126 elderly patients (average age 83) receiving continuous	Non-randomized prospective study	No significant difference in hematoma formation between the warfarin (5%) and dabigatran

ID Number	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Results
	Kirill Kulikov, et al. Journal Identity: *J Atrial Fibrillation*, 2017 (Terekhov, D., Agapov, V., Kulikov, K., 2017)	Regimens of Anticoagulant Therapy	elderly patients using warfarin or dabigatran	anticoagulant therapy		(6.5%) groups. Hematoma formation was more common in pacemaker muscle fixation.
CE 4	Author: Tuncay Güzel et al. Journal Identity: *Aging Clinical and Experimental Research*, August 2023 (Güzel et al., 2023).	Aging and Cardiac Implantable Electronic Device Complications: Is the Procedure Safe in Older Patients?	To investigate whether complications associated with CIED procedures are more frequent in patients aged ≥75 years compared to those aged <75 years	1923 patients (504 aged ≥75 years; 1419 aged <75 years) undergoing CIED procedures at two heart centers in Turkey	Multicenter retrospective cohort study	No significant difference was found in cumulative complications (3.5% vs. 4.4%, p=0.393). Device-related infections were higher in the ≥75 years group (3.4% vs. 1.8%, p=0.034), but this was not significant in multivariate analysis. No significant difference was observed in clinically significant hematoma or pneumothorax.
CE 5	Author: Fu Guan et al. Journal Identity: *Medicine (Baltimore)*,	Periprocedural Complications of Cardiac Implantable Electronic Device Implantation in	To evaluate the association between cognitive impairment and periprocedural complications	180 patients aged ≥80 years (90 with cognitive impairment, 90 without	Prospective observational study	Complications were significantly higher in patients with cognitive impairment (34% vs. 15%, p<0.001). Pocket hematomas,

ID Number	Author and Journal Identity	Journal Title	Objective	Population and Sample	Method	Summary of Results
	2021 (Guan et al., 2021).	Very Elderly Patients with Cognitive Impairment: A Prospective Study	of CIED implantation in very elderly patients	cognitive impairment)		thrombotic events, and lead dislodgements were more frequent. Cognitive impairment was significantly associated with an increased risk of periprocedural complications in multivariate analysis.
CE 6	Authors: Songbo Jing, Shan Hu, Shuai Ma. Journal Identity: *J Thorac Dis*, 2020 (Jing, S., Hu, S., & Ma et al., n.d., 2020)	Analysis of Postoperative Complications and Risk Factors in Patients with Permanent Pacemaker Implantation	To investigate postoperative complications and risk factors in patients with permanent pacemaker implantation	124 patients (ages 30–86 years) undergoing permanent pacemaker implantation	Retrospective analysis	8.06% of patients experienced complications, including capsular hematoma, capsular tear, capsular infection, and venous thrombosis. Risk factors included older age, high BMI, smoking history, poor nutritional status, and decreased platelet count.

Table 5. Key issues emerging.

Key Issues	Specific Aspects	Sources	Quotations
Complication Rates	General complication rates in elderly patients	Özcan et al. (2021); Dönmez et al. (2013)	"Complication rates were low, at 3%, with hematoma and infection being the most common." Özcan et al. (2021);
Infection Rates	Higher rates of infection in elderly patients	Terekhov et al. (2017);	"Device-related infections were higher in the ≥75 years group (3.4% vs. 1.8%, p=0.034)." (Güzel et al., 2023, p. 6)

Key Issues	Specific Aspects	Sources	Quotations
		Güzel et al. (2023)	
Lead Dislodgement	Lead dislodgement rates in elderly versus younger patients	Haji Ahmed (2022); Guan et al. (2021)	"Lead dislodgement occurred in 4% of elderly patients, more frequently in those with cognitive impairment." (Guan et al., 2021, p. 10)
Risk Factors	Factors contributing to increased complications	Jing et al. (2020); Terekhov et al. (2017)	"Risk factors include older age, high BMI, smoking, and poor nutritional status." (Jing et al., 2020, p. 5)
Postoperative Management	Variability in management strategies and outcomes	Hamieh et al. (2023);	"Effective postoperative care, including the management of hematomas and pneumothorax, is crucial for minimizing complications." (Hamieh et al., 2023, p. 2)

Discussion

Post-Implantation Pacemaker Complication Rates in Elderly Patients

Permanent pacemaker implantation in elderly patients is generally considered a safe procedure with a relatively low complication rate. Based on the analysis of various studies, the complication rate in elderly patients ranges from 3% to 8%. Conversely, Hamieh, C., Sakr, R., & El Hussein, (2023) reported a rare but fatal case of pacemaker lead infection following a fall in an elderly patient, which led to death due to septic shock. This demonstrates that while complications are infrequent, their impact can be extremely dangerous for elderly patients with pre-existing health conditions.

Additionally, Terekhov, D., Agapov, V., Kulikov, K., (2017) found that although the use of warfarin or dabigatran did not show a significant difference in hematoma formation, complications related to anticoagulant therapy remain a concern. This highlights the importance of selecting the appropriate anticoagulant therapy and conducting strict post-operative monitoring to minimize the risk of further complications in elderly patients.

Risk Factors for Complications. Several risk factors contribute to an increased likelihood of complications in elderly patients undergoing permanent pacemaker implantation. Özcan et al., (2021) found that although elderly patients had a lower complication rate (7.6%) compared to younger patients (15.1%), complications such as hematoma, infection, and pacemaker lead dislocation were still observed in both groups. Jing, S., Hu, S., & Ma et al., n.d., (2020) highlighted additional risk factors such as obesity (high BMI), smoking, and reduced platelet count, which contribute to an increase in post-implantation complications. These factors demonstrate that underlying medical conditions, as well as lifestyle factors, play a significant role

in complication rates in elderly patients. Therefore, a more personalized and coordinated approach in managing elderly patients with these risk factors is necessary.

Additionally, technical factors, such as pacemaker type, also play an important role in determining the complication rate. Ahmed, (2022) found that dual-chamber pacemakers (DDD) are more frequently used in elderly patients and show a lower complication rate (4.25%) compared to other types of pacemakers. This finding underscores the importance of selecting the appropriate pacemaker type based on the medical needs and physical condition of elderly patients, especially those with multiple risk factors.

Post-Operative Complications and Their Impact on Elderly Patients' Quality of Life. Post-implantation complications, such as hematoma, pneumothorax, infection, and pacemaker lead dislocation, can significantly increase morbidity and reduce the quality of life in elderly patients. Jing, S., Hu, S., & Ma et al., n.d., (2020) reported a post-implantation complication rate of 8.06%, with additional risk factors including advanced age, high BMI, and poor nutritional status. This study emphasizes the importance of strict post-operative monitoring, particularly for elderly patients with multiple risk factors, to detect and address complications early.

Complications Based on Care Type and Anticoagulant Therapy. The use of anticoagulant therapy post-pacemaker implantation is an important factor to consider, particularly for elderly patients who are more susceptible to hematoma formation. Terekhov et al. (2017) found that the use of warfarin and dabigatran did not show significant differences in hematoma formation, although anticoagulant therapy remains an important risk factor that needs to be closely monitored during pacemaker implantation procedures. Anticoagulant therapy must be carefully selected, balancing the prevention of blood clotting with the risk of bleeding complications.

Research Gaps and Recommendations. Although the complication rate in elderly patients post-pacemaker implantation is generally low, the long-term impact of these complications on patients' quality of life remains underexplored. Ventura-Silva et al., (2024) emphasize the importance of longitudinal research to assess the long-term effects of these complications, including their impact on the quality of life of elderly patients. Further research is also needed to better understand the variation in complications based on pacemaker type, individual patient risk factors, and the impact of anticoagulant therapy in preventing further complications.

Overall, while post-pacemaker implantation complications in elderly patients are generally low, careful monitoring and a more cautious approach in the care of elderly patients undergoing this procedure are still required. Further research focusing on long-term aspects and variations in complications based on individual risk factors is essential to

improve the quality of care and clinical outcomes in elderly patients.

The relatively low complication rates suggest that permanent pacemaker implantation remains a viable and safe option for elderly patients. However, the findings also highlight the need for tailored perioperative management strategies that address modifiable risk factors such as obesity and anticoagulant use, especially in resource-limited settings.

Despite the growing number of studies on pacemaker complications, there remains a paucity of data specifically addressing outcomes among frail elderly subgroups, such as those with multimorbidity, cognitive impairment, or socioeconomic disadvantage. Additionally, few studies explored the long-term impact of post-implantation complications on quality of life, particularly from a nursing or rehabilitative perspective. These gaps warrant longitudinal, multidisciplinary investigations in future research.

This scoping review has several limitations. First, the inclusion was limited to English-language articles, which may introduce language bias. Second, the heterogeneity of study designs and outcome measures across included studies limited direct comparisons or quantitative synthesis. Third, although a systematic approach was employed, the lack of protocol registration may reduce methodological transparency. Lastly, most included studies were observational, which limits the ability to infer causal relationships between risk factors and complications.

CONCLUSION

Permanent pacemaker implantation in elderly patients is a relatively safe procedure with a low complication rate. Nevertheless, complications such as hematoma, infection, and pacemaker lead dislocation can still have a substantial impact on patients' quality of life. Factors such as advanced age, underlying medical conditions, pacemaker type, and the use of anticoagulant therapy significantly influence complication rates. The reviewed studies indicate that post-implantation complication rates range from 3 to 8 percent, with variations depending on patients' clinical conditions, procedural techniques, and risk factors including obesity, smoking history, and decreased platelet count.

Dual-chamber pacemakers (DDD) are more commonly used in elderly patients and have demonstrated a lower complication rate compared to other types. However, considerable research gaps remain, particularly concerning the long-term effects of complications on the quality of life of elderly patients, the variability of complications across different pacemaker types and patient risk profiles, and the impact of anticoagulant therapy on postoperative outcomes. Vulnerable groups, such as elderly individuals with complex comorbidities or those from socioeconomically disadvantaged backgrounds, also require greater attention to ensure equitable access to optimal care. Further longitudinal and context-specific research is essential to strengthen evidence-based clinical practice and expand inclusive healthcare services.

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