International Journal of Scientific Advances
ISSN: 2708-7972
Volume: 5 | Issue: 6 | Nov – Dec 2024 Available Online: www.ijscia.com
DOI: 10.51542/ijscia.v5i6.92

Quality of Life in Bradycardia Patients: Insights into Short-Term and Long-Term Effects of Permanent Pacemaker Implantation

Valiant Ezekiel[1], Rerdin Julario[2*]

[1]Medical Study Program, Faculty of Medicine, Airlangga University, Surabaya, Indonesia
[2]Department of Cardiology and Vascular Medicine, Airlangga University, Surabaya, Indonesia

E-mail: valiant.ezekiel-2021@fk.unair.ac.id; rerdinjulario@gmail.com; lilikdjuari@gmail.com; anudyaamazing@gmail.com

*Corresponding author details: Rerdin Julario; rerdinjulario@gmail.com

ABSTRACT

Permanent pacemaker implantation has become a pivotal intervention for managing symptomatic bradycardia, significantly improving the quality of life (QoL) in affected patients. This literature review examines and compares short-term and long-term QoL outcomes in bradycardia patients who undergo pacemaker implantation. Evidence shows that pacemakers alleviate symptoms such as dizziness, fatigue, and syncope, enhancing physical, psychological, and social well-being. Short-term outcomes highlight substantial benefits, particularly with leadless pacemakers due to their minimally invasive nature and reduced risk of complications. However, long-term outcomes reveal challenges, including diminished QoL improvements over time, psychological adaptation, and device-related complications. These findings underscore the importance of continuous care, targeted education, and advancements in pacemaker technology to optimize patient outcomes. Further research is recommended to address these challenges and explore strategies to enhance long-term QoL in pacemaker recipients.

Keywords: Bradycardia; permanent pacemaker; quality of life; leadless pacemaker; long-term outcomes; short-term outcomes; psychological adaptation; device complications.

INTRODUCTION

Bradycardia, defined as a heart rate below 50–60 beats per minute, encompasses a range of conditions from physiological adaptations in athletes to pathological disorders requiring medical intervention (Sidhu & Marine, 2020). Symptoms of pathological bradycardia include dizziness, chest pain, cognitive impairments, and syncope, which may significantly impact daily functioning and quality of life (QoL) (Alnajim et al., 2021). Etiologies range from sinus bradycardia and sinoatrial node dysfunction to atrioventricular (AV) block. Management strategies depend on the underlying cause and severity, spanning from conservative measures such as lifestyle changes to invasive interventions like permanent pacemaker implantation (Sidhu & Marine, 2020).

Permanent pacemakers have revolutionized the management of symptomatic and chronic bradycardia by providing consistent heart rate regulation. These devices, which sense and respond to intrinsic cardiac signals, have demonstrated significant improvements in patient outcomes and QoL, particularly for conditions like irreversible AV block (DeForge, 2019; Makkar et al., 2023). Technological advancements, including rate-adaptive features and leadless designs, have further enhanced the safety and efficacy of pacemaker therapy (Biffi et al., 2021).

Quality of life is a multifaceted concept defined by the World Health Organization (WHO) as an individual's perception of their position in life relative to their goals and expectations, has emerged as a critical parameter in evaluating healthcare outcomes (Haraldstad et al., 2019). In the context of pacemaker therapy, QoL assessments provide insights into the physical, psychological, and social benefits and challenges experienced by patients. While pacemaker implantation is associated with marked improvements in QoL, the influence of implantation duration on these outcomes remains underexplored (Mohammed Weheida et al., 2021; Udo et al., 2013).

This review aims to synthesize existing evidence on QoL outcomes in bradycardia patients with permanent pacemakers, comparing short-term and long-term implantation effects. By analyzing key determinants of QoL and highlighting potential challenges, this article seeks to guide clinical strategies for optimizing long-term patient well-being.

REVIEW CONTENT

Understanding Bradycardia

- *Definition and Clinical Presentation*

Bradycardia is generally defined as a heart rate below 50-60 beats per minute (Sidhu & Marine, 2020). It can occur due to intrinsic dysfunction of the conduction system or as a response to extrinsic factors.

Bradycardia may be asymptomatic or cause symptoms such as fatigue, dizziness, shortness of breath, and fainting. Those symptoms may indicate an underlying more serious condition (Rehorn et al., 2020). While bradycardia can be a normal finding in young athletes or as part of aging, it may also indicate underlying pathology in the sinus node, atrioventricular nodal tissue, or the His-Purkinje system (Sidhu & Marine, 2020). The evaluation of bradycardia should focus on assessing symptoms rather than solely relying on arbitrary heart rate cutoffs (Sidhu & Marine, 2020).

- *Pathophysiology of Bradycardia*

The primary causes of bradycardia include sinus bradycardia, sinoatrial node dysfunction, and AV block (Alnajim et al., 2021). Sinus bradycardia arises from reduced impulse generation in the sinoatrial node due to intrinsic damage (e.g., myocardial infarction, fibrosis) or extrinsic factors (e.g., hypothermia, medications) (Goldberger et al., 2013; Olshansky et al., 2017). Sinoatrial node dysfunction, often caused by idiopathic fibrosis or ischemia, impairs the node's ability to initiate regular impulses (Da Costa et al., 2002). AV block, characterized by delayed or absent conduction through the AV node, is classified into three degrees of severity and can significantly impair cardiac output depending on the degree of blockage (Da Costa et al., 2002).

- *Management Approaches*

Effective management of bradycardia requires a comprehensive approach encompassing history-taking, physical examination, and diagnostic testing. ECG serves as a cornerstone in diagnosing conduction abnormalities and determining the severity of bradycardia (Wung, 2016). For symptomatic patients, acute management includes pharmacological interventions like atropine or temporary pacing to stabilize cardiac output (Kardiologi Indonesia et al., 2014). Permanent pacemakers remain the definitive therapy for recurrent or chronic symptomatic bradycardia, particularly in cases of sick sinus syndrome and high-grade AV blocks where other treatments are insufficient (Alnajim et al., 2021). Modern guidelines emphasize a holistic approach, addressing both the underlying disease and patient-specific factors to improve long-term outcomes (Sidhu & Marine, 2020).

- *Permanent Pacemaker*

A permanent pacemaker is an implantable medical device designed to regulate cardiac rhythm by delivering electrical impulses to the myocardium when intrinsic conduction is inadequate (Jackson, 2010; Kotsakou et al., 2015)The device comprises a pulse generator, which houses the battery and circuitry, and one or more leads that transmit electrical signals to the heart (Goyal et al., 2019).

Permanent pacemakers are classified based on their pacing capabilities, such as single-chamber or dual-chamber devices, and their adaptability to physiological demands through rate-modulation features. These devices are externally programmable, allowing clinicians to optimize pacing modes according to the patient's specific needs (Kotsakou et al., 2015). Advances in pacemaker technology have led to the development of leadless pacemakers, which eliminate complications associated with transvenous leads, such as lead dislodgement and infection (Goyal et al., 2019).

The primary objective of pacemaker therapy is to restore adequate cardiac output, alleviate symptoms of bradycardia, and enhance overall quality of life. Clinical benefits include improved exercise tolerance, reduced hospitalizations for cardiac-related conditions, and a lower risk of heart failure (Mond & Proclemer, 2011). These outcomes underscore the critical role of pacemakers in managing chronic and symptomatic bradycardia.

Overview of Quality of Life

- *Definition of Quality of Life*

Quality of life (QoL) is a multidimensional construct encompassing physical, psychological, and social domains, reflecting an individual's overall well-being and satisfaction with life. According to the World Health Organization (WHO), QoL is defined as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns" (Karimi & Brazier, 2016).

QoL has gained increasing prominence as a critical outcome measure in healthcare research and practice, influencing policy decisions and clinical interventions (Haraldstad et al., 2019). It serves as a key indicator of the effectiveness of medical treatments and the impact of health conditions on daily life. Understanding QoL requires a comprehensive approach, integrating both subjective perceptions and objective measures such as health status, educational attainment, and living conditions (Schmidt et al., 2006). For patients with chronic conditions like bradycardia, QoL assessments can provide valuable insights into the physical, psychological, and social implications of disease and its management.

- *Physical Determinants of Quality of Life*

Quality of life (QoL) is a multidimensional construct encompassing physical, psychological, and social domains, reflecting an individual's overall well-being and satisfaction with life. According to the World Health Organization (WHO), Physical health is a fundamental determinant of QoL, directly influencing an individual's ability to engage in daily activities. Chronic illnesses that impair physical function, such as bradycardia or other cardiovascular conditions, can significantly diminish QoL. Symptoms like fatigue, reduced mobility, and dependence on caregivers may lead to decreased independence and lower life satisfaction (Sokas et al., 2021).

Conversely, good physical health enhances an individual's ability to participate actively in various aspects of life, contributing to a higher QoL. Research highlights the pivotal role of regular physical activity and sufficient strength in improving physical functioning and overall well-being (Leibinger et al., 2023).

Emerging studies also emphasize the importance of sleep quality, linking poor sleep patterns to reduced QoL outcomes (Strine & Chapman, 2005).

For pacemaker patients, improvements in physical health following implantation are closely tied to their QoL. The restoration of cardiac output and alleviation of symptoms like syncope and fatigue enable better participation in daily activities and social interactions, underscoring the interplay between physical health and overall QoL.

- *Psychological Contributions to Quality of Life*

Psychological well-being plays a critical role in shaping QoL, with conditions such as anxiety, depression, and stress negatively impacting life satisfaction and overall mental health. For instance, patients experiencing depression or high levels of stress often report lower QoL scores, as these conditions reduce their ability to manage daily challenges (Kim, 2022).

Positive psychological interventions, such as counseling and support groups, have been shown to reduce anxiety and depression, boosting self-confidence and improving QoL (Quan Lei, 2021). Moreover, patient education about their health conditions is a key factor in fostering psychological resilience. Studies indicate that informed patients exhibit greater confidence in managing their conditions, leading to improved QoL scores (Khaliq et al., 2020). In the context of pacemaker therapy, psychological challenges such as fear of device malfunction or dependence may contribute to reduced QoL.

- *Environmental and Social Influences on Quality of Life*

External factors, including socioeconomic status (SES), environmental conditions, and social support, also significantly influence QoL. Individuals with lower SES often face barriers to accessing healthcare services, which can negatively affect their overall HRQoL (Sun et al., 2023). Limited resources may hinder timely treatment, exacerbating health disparities and reducing life satisfaction.

Environmental factors such as access to green spaces, clean air, and safe neighborhoods are strongly associated with better QoL. Urban planning that prioritizes recreational areas and reduces pollution can positively impact physical and mental health (Van Kamp et al., 2003). Social determinants, including social support networks, stigma, and self-esteem, further shape QoL outcomes. For pacemaker patients, strong social support has been linked to improved adherence to treatment and greater life satisfaction. Conversely, stigma or misconceptions about living with a pacemaker can lead to unnecessary lifestyle restrictions, underscoring the need for education and community engagement to address these barriers (Lin et al., 2023).

Determinants of Quality of Life in Pacemaker Patients

- *Symptoms Management and Health Improvements*

Pacemaker implantation restores the heart's ability to maintain an adequate cardiac output, addressing symptoms such as fatigue, dizziness, and syncope that significantly impair QoL (Mulpuru et al., 2017). Improved hemodynamic stability post-implantation reduces hospitalizations and lowers the risk of developing heart failure, further enhancing overall health and functionality (Mond & Proclemer, 2011). A study also proves that the implantation of a pacemaker can increase the life expectancy of patients (Kosztin et al., 2019).

- *Impact of Pacemaker Type*

Differences in QoL outcomes are observed between patients with conventional pacemakers (C-PMs) and leadless pacemakers (L-PMs). L-PMs offer advantages such as minimally invasive implantation, fewer mobility restrictions, and reduced procedural complications. Studies show that patients with L-PMs report higher scores in physical functioning and emotional well-being, particularly in the early stages post-implantation (Yu et al., 2023). However, the high cost of L-PMs remains a barrier to widespread adoption, necessitating strategies to improve accessibility.

- *Complications and Long-Term Device-Related Challenges*

While pacemakers are generally safe, complications can arise, impacting long-term QoL. Early issues include pneumothorax, hematomas, and lead dislodgement, while late complications may involve lead fractures, infections, or device-related endocarditis (Mulpuru et al., 2017). Advances such as leadless pacemakers aim to mitigate these risks, but ongoing device maintenance and replacement remain areas of concern for patients and clinicians alike (Mulpuru et al., 2017)

- *Adaptation Psychological Adaptation to Pacemaker Use*

Adaptation to pacemaker devices plays a critical role in determining the quality of life for patients, emphasizing the need for comprehensive rehabilitation and targeted education. Effective rehabilitation programs should integrate medical, physical, and psychological components while optimizing pacing parameters to ensure the best outcomes (Iskenderov et al., 2020). Rate-adaptive pacemakers, which adjust pacing rates according to metabolic needs, have been shown to significantly enhance the quality of life for patients with chronotropic incompetence (Kwiatkowska et al., 2014). Despite a general understanding of their implants, patients often lack specific knowledge about precautions and appropriate actions in various scenarios, highlighting the necessity for structured educational interventions (Salles et al., 2013). Utilizing frameworks such as Leventhal's self-regulatory model, educational strategies can positively reshape patients' illness perceptions, fostering a more benign view of their condition and improving adherence to treatment (Rakhshan et al., 2013).

- *Anxiety and Depression*

The prevalence of anxiety and depression among patients with permanent pacemakers (PM) has been highlighted as a significant factor affecting their quality of life. Studies report anxiety rates of 23.5%

and depression rates of 7.1% in PM recipients, underscoring the psychological burden associated with living with such a device (Rafsanjani et al., 2021). This burden is exacerbated by factors such as dependency on the device, concerns about its functionality, and a lack of understanding about its benefits, leading to increased anxiety and depressive symptoms (Polikandrioti, 2021). Women and individuals with lower educational levels are particularly susceptible, indicating the need for targeted interventions (Polikandrioti, 2021). Addressing these psychological challenges through patient education and psychological support has shown the potential to enhance patients' coping mechanisms and improve their overall quality of life.

- *Social and Lifestyle Changes Post-Implantation*

Pacemaker implantation often brings positive changes in social and lifestyle domains. Many patients report increased confidence in participating in physical and social activities due to reduced symptoms and improved physical capabilities (Bongiorni et al., 2013). However, a study found the significant impact of misconceptions on the daily activities of pacemaker patients, leading to unnecessary lifestyle restrictions. For instance, patients' perception of safety when using mobile phones increased from 28.1% to 96.5%, and for electrical switches from 16.4% to 96.5%, after the intervention. These findings of limitations can influence patients' perceptions of freedom and independence, impacting QoL (Khaliq et al., 2020).

Influence of Implantation Duration on Quality of Life in Pacemaker Patients

- *Short-Term Outcomes: Immediate Benefits and Challenges*

The short-term effects of pacemaker implantation on quality of life (QoL) are significant, as this period reflects the immediate physical and psychological impact of the procedure. Research indicates that leadless pacemakers (L-PM) offer notable advantages over conventional pacemakers (C-PM). For instance, a study found that patients with L-PM experienced less chest discomfort and fewer physical restrictions during the initial recovery period (Cabanas-Grandío et al., 2020). These outcomes align with another study where L-PM recipients scored significantly higher in physical function (56.51 vs. 42.90, $p < 0.001$) and role physical (52.63 vs. 24.80, $p < 0.001$) at one-month post-implantation (Yu et al., 2023).

In terms of procedural complications, L-PM systems eliminate the risks associated with transvenous leads and subcutaneous pockets, which are primary sources of complications in C-PM procedures (Cabanas-Grandío et al., 2020; Yu et al., 2023). This reduction in physical burdens translates into improved physical recovery and psychological adaptation, as evidenced by higher vitality scores in L-PM recipients at one month (Yu et al., 2023).

However, both groups demonstrated psychological concerns related to their cardiac health, with C-PM patients expressing heightened worry about device complications. A study noted that this preoccupation can adversely affect mental health, emphasizing the need for comprehensive patient education and support during the short-term recovery period (Yu et al., 2023).

- *Long-Term Outcomes: Sustained Benefits and Emerging Issues*

Long-term outcomes highlight the sustained benefits of pacemaker systems on QoL. At three months post-implantation, L-PM patients consistently outperformed C-PM patients in several QoL metrics, particularly in physical and mental health domains. A study reported that the physical component summary (PCS) score of the L-PM group was significantly higher (61.25 vs. 50.57, $p < 0.001$), while their mental component summary (MCS) scores were also superior (72.00 vs. 65.97, $p < 0.001$) (Yu et al., 2023). L-PMs also provide psychological benefits by reducing visible device components and associated maintenance concerns. A study observed that only 11.4% of L-PM recipients reported limitations due to surgical discomfort at three months, compared to 38.1% in the C-PM group ($p = 0.004$). This reduction in discomfort likely contributes to improved physical activity levels and mental well-being in L-PM patients (Yu et al., 2023).

Nevertheless, barriers such as cost limit the widespread adoption of L-PMs, particularly in resource-constrained settings (Yu et al., 2023). While initial findings suggest promising long-term benefits, further research is needed to evaluate device longevity and reimplantation rates to support broader implementation (Yu et al., 2023).

CONCLUSIONS

This review highlights the significant impact of permanent pacemaker implantation on improving the quality of life (QoL) in bradycardia patients, particularly in alleviating symptoms like dizziness, syncope, and fatigue, with notable short-term benefits seen in leadless pacemakers due to reduced complications and better recovery. However, long-term outcomes show that these benefits may diminish over time due to factors such as physiological adaptation, device-related challenges, and psychological issues, underscoring the need for continuous care and patient education. Further research is crucial to optimize long-term QoL, improve accessibility to advanced pacemaker technologies, and address barriers to sustained patient well-being.

ACKNOWLEDGMENT

The author would like to thank all the supervisors and institution for enabling the successful implementation of this study.

REFERENCES

[1] Alnajim, F. A., Alkhidhr, M. A. S., Alanazi, M. A. A., Bawazeer, A. A. J., Shahar, A. I., Alsharif, B. M., Alanazi, O. Q. Kh., Darraj, O. Q. I., Mohamed, N. M., Alawi, A. A. M., & Alsoghayer, A. B. S. (2021). An overview of diagnosis and management of bradycardia: Literature review. Archives of Pharmacy Practice, 12(1–2021), 13–15. https://doi.org/10.51847/VPUSKNW32W

[2] Biffi, M., Capobianco, C., Spadotto, A., Bartoli, L., Sorrentino, S., Minguzzi, A., Piemontese, G. P., Angeletti, A., Toniolo, S., & Statuto, G. (2021). Pacing devices to treat bradycardia: current status and future perspectives. In Expert Review of Medical Devices (Vol. 18, Issue 2, pp. 161–177). Taylor and Francis Ltd. https://doi.org/10.1080/17434440.2021.1866543

[3] Bongiorni, M. G., Proclemer, A., Dobreanu, D., Marinskis, G., Pison, L., Blomström-Lundqvist, C., Chen, J., Estner, H., Hernandez-Madrid, A., Hocini, M., Larsen, T. B., Potpara, T., Sciraffia, E., & Todd, D. (2013). Preferred tools and techniques for implantation of cardiac electronic devices in Europe: results of the European Heart Rhythm Association survey. Europace : European Pacing, Arrhythmias, and Cardiac Electrophysiology : Journal of the Working Groups on Cardiac Pacing, Arrhythmias, and Cardiac Cellular Electrophysiology of the European Society of Cardiology, 15(11), 1664–1668. https://doi.org/10.1093/EUROPACE/EUT345

[4] [4] Cabanas-Grandío, P., García Campo, E., Bisbal, F., García-Seara, J., Pachón, M., Juan-Salvadores, P., Paredes, E., Molinero, A., Martínez-Sande, J. L., Arias, M. Á., & Íñiguez Romo, A. (2020). Quality of life of patients undergoing conventional vs leadless pacemaker implantation: A multicenter observational study. Journal of Cardiovascular Electrophysiology, 31(1), 330–336. https://doi.org/10.1111/jce.14322

[5] Da Costa, D., Brady, W. J., & Edhouse, J. (2002). Bradycardias and atrioventricular conduction block. BMJ (Clinical Research Ed.), 324(7336), 535–538. https://doi.org/10.1136/BMJ.324.7336.535

[6] DeForge, W. F. (2019). Cardiac pacemakers: a basic review of the history and current technology. Journal of Veterinary Cardiology, 22, 40–50. https://doi.org/10.1016/j.jvc.2019.01.001

[7] Goldberger, A. L., Goldberger, Z. D., & Shvilkin, A. (2013). Bradycardias and Tachycardias. Goldberger's Clinical Electrocardiography, 184–197. https://doi.org/10.1016/B978-0-323-08786-5.00020-8

[8] Goyal, Y., Agarwal, S., Barman, S., Pranav, A., Prasad, D., & Nath, V. (2019). Evolution of Pacemaker: A Review. Lecture Notes in Electrical Engineering, 556, 649–654. https://doi.org/10.1007/978-981-13-7091-5_55

[9] Haraldstad, K., Wahl, A., Andenæs, R., Andersen, J. R., Andersen, M. H., Beisland, E., Borge, C. R., Engebretsen, E., Eisemann, M., Halvorsrud, L., Hanssen, T. A., Haugstvedt, A., Haugland, T., Johansen, V. A., Larsen, M. H., Løvereide, L., Løyland, B., Kvarme, L. G., Moons, P., … Helseth, S. (2019). A systematic review of quality of life research in medicine and health sciences. In Quality of Life Research (Vol. 28, Issue 10, pp. 2641–2650). Springer International Publishing. https://doi.org/10.1007/s11136-019-02214-9

[10] Iskenderov, B. G., Ivanchukova, M. G., & Berenshtejn, N. V. (2020). Medical rehabilitation approaches in patients with implanted pacemaker. CardioSomatics, 11(1), 28–34. https://doi.org/10.26442/22217185.2020.1.200096

[11] Jackson, A. (2010). An overview of permanent cardiac pacing. Nursing Standard (Royal College of Nursing (Great Britain) : 1987), 25(12). https://doi.org/10.7748/NS2010.11.25.12.47.C8111

[12] Kardiologi Indonesia, J., Hanafy, D. A., Yuniadi, Y., Raharjo, S. B., Tondas, A. E., Rahadian, A., Yamin, M., Tanubudi, D., Hartono, B., Munawar Alamat Korespondensi Dicky Hanafy Divisi Aritmia, M. A., Kardiologi dan Kedokteran Vaskular, D., & dan Pusat Jantung Nasional Harapan Kita, F. (2014). Forum Aritmia Pedoman Terapi Memakai Alat Elektronik Kardiovaskular Implan (Aleka) Perhimpunan Dokter Spesialis Kardiovaskular Indonesia 2014. Jurnal Kardiologi Indonesia •, 35(3), 171–245.

[13] Karimi, M., & Brazier, J. (2016). Health, Health-Related Quality of Life, and Quality of Life: What is the Difference? PharmacoEconomics, 34(7), 645–649. https://doi.org/10.1007/S40273-016-0389-9

[14] Khaliq, G. K., Rehan, F. H., Qadir, F., Mueed, A., Mumtaz, Z., Irfan, G., & Shafquat, A. (2020). ASSESSING PACEMAKER PATIENTS' PERCEPTION OF LIFESTYLE: AFTER AN EDUCATIONAL INTERVENTION. Pakistan Heart Journal, 53(1). https://doi.org/10.47144/phj.v53i1.1918

[15] Kim, Y. (2022). Mental health and quality of life according to sleep in cancer survivors. Perspectives in Psychiatric Care, 58(4), 2442–2448. https://doi.org/10.1111/ppc.13079

[16] Kosztin, A., Boros, A. M., Merkel, E., Schwertner, W. R., Behon, A., & Merkely, B. (2019). Improved life expectancy in patients after dual-chamber pacemaker implantation. In Kardiologia Polska (Vol. 77, Issues 8–8, pp. 659–660). Medycyna Praktyczna Cholerzyn. https://doi.org/10.33963/KP.14938

[17] Kotsakou, M., Kioumis, I., Lazaridis, G., Pitsiou, G., Lampaki, S., Papaiwannou, A., Karavergou, A., Tsakiridis, K., Katsikogiannis, N., Karapantzos, I., Karapantzou, C., Baka, S., Mpoukovinas, I., Karavasilis, V., Rapti, A., Trakada, G., Zissimopoulos, A., Zarogoulidis, K., & Zarogoulidis, P. (2015). Pacemaker insertion. Annals of Translational Medicine, 3(3), 42–42. https://doi.org/10.3978/J.ISSN.2305-5839.2015.02.06

[18] Kwiatkowska, M., Lea-Banks, H., Mereacre, A., & Paoletti, N. (2014). Formal modelling and validation of rate-adaptive pacemakers. Proceedings - 2014 IEEE International Conference on Healthcare Informatics, ICHI 2014, 23–32. https://doi.org/10.1109/ICHI.2014.11

[19] Leibinger, E., Åvitsland, A., Resaland, G. K., Solberg, R. B., Kolle, E., & Dyrstad, S. M. (2023). Relationship between health-related quality of life and physical fitness in Norwegian adolescents. Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation, 32(4), 1133–1141. https://doi.org/10.1007/S11136-022-03309-6

[20] Lin, C., Wan, X., Zhang, R., Yang, X., & Liu, Y. (2023). Quality of life and its influencing factors in patients with schizophrenia. Journal of Central South University (Medical Sciences), 48(3), 472–480. https://doi.org/10.11817/j.issn.1672-7347.2023.220438

[21] Makkar, J. S., Milasinovic, G., & Ching, C. K. (2023). Complementary role of governments, nongovernmental organizations, industry, and medical societies in expanding bradycardia therapy access. European Heart Journal, Supplement, 25(SH), H22–H26. https://doi.org/10.1093/eurheartjsupp/suad124

[22] Mohammed Weheida, S., Gebril, H., Mohamed Mohamed, H., & Fathy, Y. (2021). Quality of Life of Patients pre/post Pacemaker Implantation. In Original Article Egyptian Journal of Health Care (Vol. 12, Issue 1).

[23] Mond, H. G., & Proclemer, A. (2011). The 11th world survey of cardiac pacing and implantable cardioverter-defibrillators: calendar year 2009--a World Society of Arrhythmia's project. Pacing and Clinical Electrophysiology : PACE, 34(8), 1013–1027. https://doi.org/10.1111/J.1540-8159.2011.03150.X

[24] Mulpuru, S. K., Madhavan, M., Mcleod, C. J., Cha, Y.-M., & Friedman, P. A. (2017). THE PRESENT AND FUTURE STATE-OF-THE-ART REVIEW Cardiac Pacemakers: Function, Troubleshooting, and Management Part 1 of a 2-Part Series A BRIEF HISTORY OF CARDIAC PACING.

[25] Olshansky, B., Chung, M. K., Pogwizd, S. M., & Goldschlager, N. (2017). Sinus Node. Arrhythmia Essentials, 1–27. https://doi.org/10.1016/B978-0-323-39968-5.00001-9

[26] Polikandrioti, M. (2021). Patient Perceptions and Quality of Life in Pacemaker Recipients. Journal of Innovations in Cardiac Rhythm Management, 12(12), 4769–4779. https://doi.org/10.19102/icrm.2021.121103

[27] Rafsanjani, M. H. A. P., Masoudi, S., Radmanesh, M., & Bostani, Z. (2021). Comparison of depression and anxiety among pacemaker and implantable cardioverter-defibrillator recipients: A cross-sectional study. Pacing and Clinical Electrophysiology : PACE, 44(2), 235–239. https://doi.org/10.1111/PACE.14152

[28] Rakhshan, M., Hassani, P., Ashktorab, T., & Majd, H. A. (2013). The nature and course of illness perception following cardiac pacemaker implantation: A self-regulatory approach. International Journal of Nursing Practice, 19(3), 318–325. https://doi.org/10.1111/IJN.12073

[29] Rehorn, M. R., Koontz, J., Barnett, A. S., Black-Maier, E., Piccini, J. P., Loring, Z., Schroder, J., & Sun, A. Y. (2020). Noninvasive electrocardiographic mapping of ventricular tachycardia in a patient with a left ventricular assist device. HeartRhythm Case Reports, 6(7), 398–401. https://doi.org/10.1016/J.HRCR.2020.03.015

[30] Salles, M., Amet, D., Archer, V., Elbaz, N., Teiger, E., Paul, M., & Astier, A. (2013). Évaluation de l'appropriation d'un dispositif médical implantable par les patients. Annales Pharmaceutiques Françaises, 71(6), 423–428. https://doi.org/10.1016/J.PHARMA.2013.06.004

[31] Schmidt, S., Mühlan, H., & Power, M. (2006). The EUROHIS-QOL 8-item index: psychometric results of a cross-cultural field study. European Journal of Public Health, 16(4), 420–428. https://doi.org/10.1093/EURPUB/CKI155

[32] Sidhu, S., & Marine, J. E. (2020). Evaluating and managing bradycardia. Trends in Cardiovascular Medicine, 30(5), 265–272. https://doi.org/10.1016/J.TCM.2019.07.001

[33] Sokas, C., Herrera-Escobar, J. P., Klepp, T., Stanek, E., Kaafarani, H., Salim, A., Nehra, D., & Cooper, Z. (2021). Impact of chronic illness on functional outcomes and quality of life among injured older adults. Injury, 52(9), 2638–2644. https://doi.org/10.1016/J.INJURY.2021.03.052

[34] Strine, T. W., & Chapman, D. P. (2005). Associations of frequent sleep insufficiency with health-related quality of life and health behaviors. Sleep Medicine, 6(1), 23–27. https://doi.org/10.1016/j.sleep.2004.06.003

[35] Sun, Y. A., Kalpakavadi, S., Prior, S., Thrift, A. G., Waddingham, S., Phan, H., & Gall, S. L. (2023). Socioeconomic status and health-related quality of life after stroke: a systematic review and meta-analysis. In Health and Quality of Life Outcomes (Vol. 21, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s12955-023-02194-y

[36] Udo, E. O., Van Hemel, N. M., Zuithoff, N. P. A., Nijboer, H., Taks, W., Doevendans, P. A., & Moons, K. G. M. (2013). Long term quality-of-life in patients with bradycardia pacemaker implantation. International Journal of Cardiology, 168(3), 2159–2163. https://doi.org/10.1016/J.IJCARD.2013.01.253

[37] Van Kamp, I., Leidelmeijer, K., Marsman, G., & De Hollander, A. (2003). Urban environmental quality and human well-being: Towards a conceptual framework and demarcation of concepts; a literature study Urban environmental quality and human well-being Towards a conceptual framework and demarcation of concepts; a literature study. In Landscape and Urban Planning (Vol. 65). https://www.researchgate.net/publication/222219378

[38] Wung, S. F. (2016). Bradyarrhythmias: Clinical Presentation, Diagnosis, and Management. In Critical Care Nursing Clinics of North America (Vol. 28, Issue 3, pp. 297–308). W.B. Saunders. https://doi.org/10.1016/j.cnc.2016.04.003

[39] Yu, M., Li, Y. P., Shi, D. M., & Zhou, Y. J. (2023). Comparation of quality of life in Chinese patients undergoing leadless versus conventional pacemaker implantation. Clinical Cardiology, 46(1), 49–56. https://doi.org/10.1002/clc.23939