

The pacemaker's role in maintaining cardiac physiology: A literature review



<https://doi.org/10.56238/Connexpemultidisdevolpft-134>

Isadora Silva Fernandes

University Center of Patos de Minas, Brazil
Medical student UNIPAM

Ana Luisa Braga Campos

University Center of Patos de Minas, Brazil
Medical student UNIPAM

Laura Rodrigues Lima

University Center of Patos de Minas, Brazil
Medical student UNIPAM

Marcello Augusto Soares Cunha

University Center of Patos de Minas, Brazil
Medical student UNIPAM

Nubia Santos Nogueira

University Center of Patos de Minas, Brazil
Medical student UNIPAM

Paulo Henrique Silva

University Center of Patos de Minas, Brazil
Medical student UNIPAM

Priscila Capelari Orsolin

University Center of Patos de Minas, Brazil
PhD in Genetics and Biochemistry from UFU

Lucas Luis Thiago

University Center of Patos de Minas, Brazil
Specialist in Clinical Medicine from Hospital
Regional Antônio Dias

ABSTRACT

Introduction: In people with heart problems associated with the malfunction of cardiac electrophysiology, it is necessary to use the pacemaker device, the equipment through artificial electrical pulses in the heart muscle of the right ventricle replaces the physiological pacemaker.

Objective: To carry out a careful reading of the existing literature on the pacemaker and its importance in the maintenance of cardiac physiology and, thus, to contribute to future studies in the area and to improve the quality of life of people who need the aid of the device. **Methodology:** This is descriptive research of the integrative literature review type, which sought to answer the attributions of the pacemaker in the maintenance of cardiac physiology. The research was carried out through online access to the National Scientific Electronic Library Online (SciELO), Google Scholar and EBSCO Information Services databases, from August to October 2022. **Results and discussion:** Two important aspects of the literature were highlighted in the research : 1) The advancement of technology that enabled the development of better, less invasive and more accurate devices and the improvement of techniques for tracking heart problems - resulting in a decrease in the number of pacemaker implants and an increase in the number of implants other devices - in addition to pacemaker actuation techniques that improved the way the device works and consequently the patient's physiological function; 2) The influence of the patient's level of knowledge and psychological issues on the effectiveness of the implant, as these variables have the power to act as stimulators and/or inhibitors of acceptance of the surgical procedure and in the post-surgical adaptation, collaborating or not for the treatment effectiveness. **Conclusion:** The success of pacemaker implementation depends crucially on the techniques applied, the technological level of the equipment - these have been perfected and improved over time - and the emotional tranquility of the patients, which mainly reflects in the post-surgical period, that is, in the process of acceptance and adaptation to the pacemaker.

Keywords: Arrhythmias, cardiac, cardiology, heart defects, congenital, pacemaker, artificial.



1 INTRODUCTION

The pacemaker is an electrode that artificially stimulates the heart through pulses by generating electrical stimuli in the heart muscle of the right ventricle, in order to replace the physiological pacemaker existing in the heart, the sinoatrial node (Ferrari et al., 2022). In this way, they are responsible for preventing rhythmic disorders such as bradycardia or heart block and, with this, maintaining an average heart rate that enables the heart to maintain constant blood flow (Goldoni et al., 2019). In this way, the pacemaker enables improved quality of life for patients with heart disease, as pointed out in a study in which 70% to 80% of patients over the age of 65 years reported a considerable increase in their quality of life (Inácio et al., 2021).

A pacemaker can be temporary or permanent, what differs is basically the duration of use and access to controls (Brasil, 2001). For permanent cardiac pacing, two basic components of the pacemaker are implanted - the pulse generator (force source) and one or two electrode cables (positive and negative) (de Almeida GAUCH et al., 1997). There are several ways of configuring these devices and can be adapted to each organism, combining the various programming possibilities for each function, but there are some pre-configurations most routinely used. Among them, the simplest are VVI and AAT. The VVI mode detects and stimulates the ventricle and is inhibited by a detected ventricular event, while the AAT mode detects and stimulates the atrium, and each detected event triggers the generator to fire within the P wave. On the ECG, each QRS is preceded by 2 peaks, the first indicating atrial depolarization and the second indicating the onset of the QRS complex. VDD mode is an alternative type of dual-chamber stimulation, which can be used when the sinus node is functioning normally (Rapsang & Bhattacharyya, 2014).

Thus, the implantation of the pacemaker should be analyzed in a careful and individualized way. The indication in senile patients with bradycardia is more frequent, followed by post-cardiac surgery and post-acute myocardial infarction (AMI) (Goldoni et al., 2019). Currently, the mechanism of the pacemaker device has sensors that allow the increase of the heart rate according to the demand of the metabolism, in addition, it is programmed to correct bradyarrhythmias and restore synchrony by atrioventricular contractions. It is estimated that more than 1 million pacemakers are implanted per year worldwide (Raatikainen et al., 2017).

In addition, it should be noted that cardiac electrophysiology consists of a complex and delicate system. Therefore, it is of paramount importance to understand the mechanism of muscle contraction of the heart to understand its functioning, and for this, it is necessary to know the components of its morphology to be able to cover its pathologies (Guyton & Hall, 2021). In addition, cardiovascular diseases represent the leading cause of death in the world, about one third of all deaths. However, this number has been decreasing according to better health care services and surgical interventions (Carrión-Camacho et al., 2019).



Therefore, this study aims to perform a careful reading of the researches that aim at the attribution of the pacemaker in the maintenance of cardiac physiology, through a bibliographic review on the subject, since it is extremely important to distinguish normal physiology from pathological. Therefore, it can serve as a basis for future studies that aim to further reduce mortality rates from cardiovascular diseases worldwide and continue to provide an improvement in the health of the entire population.

2 METHODOLOGIES

This is a review of the integrative type of literature, which according to Souza (2010), experimental and non-experimental studies would be used for a complete understanding of the phenomenon analyzed, thus incorporating definition of concepts, review of theories and evidence, and analysis of methodological problems of a particular topic, in order to answer what the attributions of the pacemaker in the maintenance of cardiac physiology. The research was conducted through online access in the National Scientific Electronic Library Online (SciELO), Google Scholar and EBSCO Information Services databases, from August to October 2022. The strategy for selecting the articles followed the following steps: search in the selected databases; reading the titles of all articles found and deleting those that did not address the subject; critical reading of the abstracts of the articles and full reading of the articles selected in the previous stages.

In the first stage, the PICO strategy (Acromion for Patient, Intervention, Comparison and Outcome) was used to define the research question. Thus, the following central question that guided the study was defined: "What are the attributions of the pacemaker in the maintenance of cardiac physiology?" In it, the P is observed: cardiac patients with the use of a pacemaker; I: use of the pacemaker; C: does not apply; O: maintenance of cardiac physiology.

To search for the works, the keywords present in the descriptors in Health Sciences (DeCS) were used: in Portuguese: "Artificial Cardiac Pacemaker"; "Cardiology"; "Arrhythmias, Cardiac"; "Cardiac Abnormality" and its correspondents in English. Associated with this, the Boolean operator "and" was used. As inclusion criteria, we considered original articles that addressed the researched theme and allowed full access to the content of the study, published from 2009 to 2022, in English and Portuguese. As exclusion criteria, duplicate articles were excluded in the databases consulted and that did not meet the main subjects of the review.

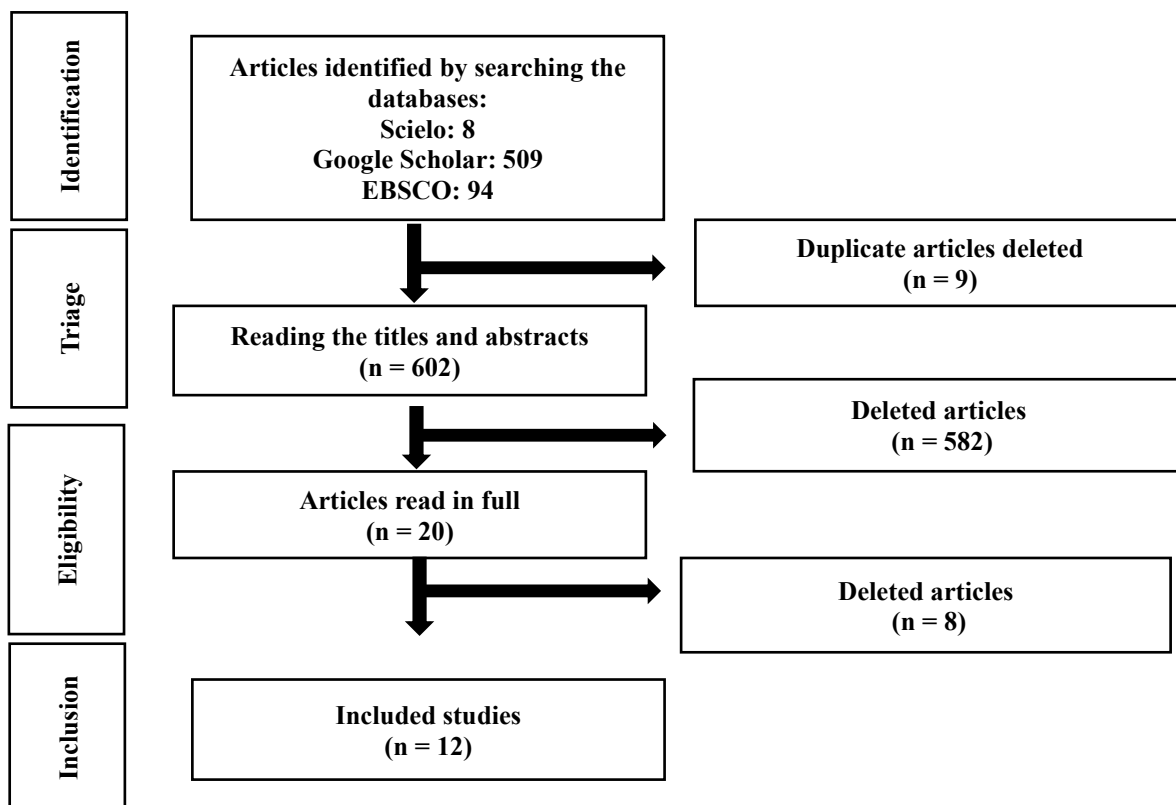
After the stage of survey of publications, 611 articles were found, being excluded 9 that were duplicates, leaving 602 works, of which the title and abstract were read. Subsequently, 582 articles that did not meet the theme of the review were excluded, thus, 20 of the studies were read in full, paying attention to all the criteria, and 8 articles were not used because they did not address the central objectives of the analysis. Thus, 12 articles were selected for final analysis and construction of the



review. Finally, a record of the chosen works was made in order to select the data collection and analysis. The data obtained were made available in the following flowchart (Figure 1), allowing the reader to evaluate the applicability of the integrative review elaborated, in order to achieve the objective of this method.

Figure 1 shows the process of selecting articles through search keywords and the application of the inclusion and exclusion criteria mentioned in this methodology. The flowchart below takes into account the criteria listed by the PRISMA strategy.

Figure 1. Flowchart of steps for the selection of integrative review articles, adapted from the Preferred Reporting Items for Systematic review and Meta-Analyses (PRISMA) (PAGE, 2021).



Source: Prepared by the authors, 2022.

3 RESULTS AND DISCUSSION

After reading and analyzing the studies on the role of the pacemaker in the maintenance of cardiac physiology, the interpretation of results was performed, seeking to read all the main actions and findings that are shown in chart 1, as follows:

Table 1 – List of articles selected for integrative review.

Author and year	Title	Objective of the study	Main results
Baranchuk <i>et al.</i> , (2009)	Hypertrophic cardiomyopathy and tachyarrhythmias	To discuss the alternative diagnosis and clinical management in an unusual diagnosis of VT in the presence	The current generation of pacemakers facilitates the diagnosis of complicated clinical situations.



	detected by pacemaker	of non-obstructive hypertrophic cardiomyopathy.	
Mota <i>et al.</i> , (2010)	Ectopic positioning of pacemaker electrode	To present the case of a patient with the cardiac form of Chagas disease with left ventricular dysfunction and 2nd degree atrioventricular block Mobitz II, associated with several episodes of syncope.	Removal of the electrode in cases of early diagnosis of the pacemaker electrode position in the systemic circulation may be positive.
Santos <i>et al.</i> , (2011)	Biofilm in artificial pacemaker: fiction or reality	To describe the scientific evidence regarding biofilm formation and the occurrence of infection associated with cardiac pacemakers in order to identify the main recommendations for prevention and control. To evaluate in the studies the incidence of infection, as well as the microbiota present in pacemakers.	The reduced size of the generator, the improvement in the quality and durability of the electrodes, the improvement of implant and asepsis techniques contributed to the technological evolution of pacemakers.
Barros <i>et al.</i> , (2014)	Evaluation of aspects of quality of life in patients after cardiac pacemaker implantation	To evaluate aspects of quality of life in post-pacemaker implantation patients and relate it to gender, age and time of implantation.	Age and time of implantation would be inversely proportional factors for a good quality of life after implantation.
Silva <i>et al.</i> , (2016)	Complications after Surgical Procedures in Patients with Cardiac Implantable Electronic Devices: Results of a Prospective Registry	To identify the rates of postoperative complications, mortality and hospital readmissions and to evaluate the risk factors for the occurrence of these events.	The aging of the population, as well as the increase in the number of comorbidities and prescription of anticoagulants and antiplatelets may contribute to the rate of complications.
Grandson (2019)	Sociodemographic and clinical characteristics of patients submitted to the implantation of electronic cardiac devices in a university hospital	To characterize patients with implantable cardiac devices in relation to sociodemographic and clinical data.	Decreased use of pacemakers over time. Significant increase in the implantation of other devices.
Santos <i>et al.</i> , (2019)	Performance of the multidisciplinary team in self-care in an elderly woman submitted to cardiac pacemaker implantation: case report	To report the case of the performance of the multidisciplinary team in self-care in an elderly woman submitted to cardiac pacemaker implantation.	Low level of knowledge about electronic devices in relation to their functionality, diagnosis for implantation, home care and their action in adverse reactions are obstacles to the success of the applicability of pacemakers.
Gonçalo <i>et al.</i> , (2020)	Health-related quality of life of patients with permanent cardiac pacing.	To evaluate the health-related quality of life of patients with permanent cardiac pacemakers.	Factors such as emotional problems, well-being and low income can interfere with the success of treatment.
Rodrigues (2021)	Bioimpedance measurement to assist the action of the implantable	Implement a bioimpedance measurement system to assist the decision to act of frequency-sensitive pacemakers, using the Gaussian	Regardless of the system, the Gaussian sine has better results. The synchrony obtained by the PHP technique makes it a viable,



	pacemaker using the wavelet transform	sine as an injection signal and the wavelet transform as a filter.	effective, reproducible and lower cost alternative.
Ferrari <i>et al.</i> , (2022)	Ventricular Synchrony in Parahissian Cardiac Pacing: Alternative by Physiological Cardiac Activation (Indirect Stimulation of the Beam of His)?	To compare cardiac synchrony, technical characteristics and results of electronic parameters between two techniques of indirect ACE of the bundle of His: the non-selective and the parahissian.	PHP approaches non-selective His beam capture (NS-HBP) in terms of homogeneous ventricular activation (cardiac synchrony).
Forno <i>et al.</i> , (2022)	Stimulation of the Left Branch of the His-Purkinje System: Initial Experience	To retrospectively analyze the intraoperative and electrocardiographic outcomes and the clinical data of the initial follow-up of patients undergoing ER stimulation.	The right stimulation of the left branch is a feasible and safe technique to reestablish the physiological activation of the left ventricle in patients with indication for a pacemaker.
Kulchetscki & Scanavacca (2022)	Parahissian Cardiac Stimulation – New Alternative for More Physiological Stimulation of the Heart?	To discuss whether Parahissian cardiac pacing would be the new physiological stimulation alternative.	Physiological cardiac pacing minimizes the deleterious effects caused by direct right ventricular (RV) myocardial stimulation.

Source: Prepared by the authors, 2022.

In view of what was presented in the table above, it was possible to observe the following questions, namely: 3.1. The advancement of equipment and techniques, with their positive and negative aspects; 3.2. The influence of the patient's level of knowledge and psychological issues on the effectiveness of the implant.

3.1 THE ADVANCEMENT OF EQUIPMENT AND TECHNIQUES, WITH THEIR POSITIVE AND NEGATIVE ASPECTS

Over the years, pacemaker equipment and techniques have evolved in search of greater accuracy and effectiveness in the treatment of heart disease. According to Santos et al. (2011) factors such as the reduced size of the generator, the improvement in the quality and durability of the electrodes, the improvement of implant and asepsis techniques contributed to the technological evolution of pacemakers. However, complications are still persistent and need resolution. Also in the same publication, it was demonstrated that systemic antibiotic prophylaxis could significantly reduce the incidence of infectious complications after permanent pacemaker implantation.

The study by Neto (2019) demonstrated that there was a significant decrease in the use of pacemakers over time and concomitantly there was a trend of the significant increase in the implantation of other devices. Despite this, with the increase in the diagnosis of Heart Failure, associated with structural cardiac lesions and arrhythmogenic diseases associated with structural diseases of the heart, the main treatment that allows more benefits to patients is still the implantation



of the pacemaker.

But in order to obtain improvements for the implantation of pacemakers, several studies have emerged demonstrating new techniques. Among them, Rodrigues (2021), in an analysis that implemented a bioimpedance measurement system to assist the decision of action of frequency-sensitive pacemakers, using the Gaussian sine as an injection signal, due to its similarity with the format considered ideal, showed that, regardless of the system, the Gaussian sine presents better results, with lower RMS, while the square wave presents higher RMS, being the least suitable. In addition, the synchrony obtained by the PHP technique makes it a viable, effective, reproducible and lower cost alternative compared to the NS-HBP already used. This is because PHP approaches the non-selective capture of the bundle of His (NS-HBP) in terms of homogeneous ventricular activation (cardiac synchrony) resulting from the electrical conduction that determines ventricular contraction (Ferrari et al., 2022).

According to Forno et al. (2022), the right stimulation of the left branch is a feasible and safe technique to reestablish the physiological activation of the left ventricle in patients with indication of pacemaker. It can decrease or perhaps prevent dyssynchrony caused by conventional right ventricular muscle stimulation and reduce rates of pacemaker-induced cardiomyopathy. However, in patients previously submitted to intravascular implants, the reduction of the caliber of the venous pathway by fibrosis and/or adhesion due to the presence of old electrodes can lead to the important reduction of sheath mobility, essential for the proper positioning of the set and fixation of the electrode (Forno et al., 2022).

In addition, Kulchetscki & Scanavacca (2022) exposed a new technique, the so-called physiological cardiac pacing, which includes a set of methods designed to electrically stimulate, directly or indirectly, the intraventricular conduction system of the heart. Its greatest benefit would be to minimize the deleterious effects caused by direct stimulation of the right ventricular (RV) myocardium, which generates dyssynchrony and possible contractile dysfunction of the left ventricle in the medium and long term. The method includes lower costs, given its feasibility with the use of conventional pacemaker electrodes, a faster learning curve and, apparently, higher sensitivity of the R wave compared to implants in the His Beam. On the other hand, among the possible disadvantages, there is the need to measure ventricular dyssynchrony during implantation, through a software not yet widely available, a longer fluoroscopy time and success rates that are still variable, depending on the learning curve of the qualified professionals.

In addition, the study by Baranchuk et al. (2009) demonstrated that the current generation of pacemakers facilitates the diagnosis of complicated clinical situations. In the study, the identification of ventricular tachycardia in a patient with non-obstructive hypertrophic cardiomyopathy and syncope helped in the decision to make a pacemaker upgrade to an implantable cardioverter defibrillator. This



earlier diagnosis, facilitated by the new generation, is able to save the patient's life or reduce the damage.

Finally, as demonstrated by Mota et al. (2010), most of the reports in the literature are favorable to the removal of the electrode in cases of early diagnosis of the position of pacemaker electrode in the systemic circulation. Of these, most of the cases described are related to the presence of congenital anomalies of the interatrial septum, such as patent foramen ovale and atrial septal defect. This is the importance of performing complementary tests after implantation, because if there is any inadequacy it will be perceived as soon as possible.

3.2 THE INFLUENCE OF THE PATIENT'S LEVEL OF KNOWLEDGE AND PSYCHOLOGICAL ISSUES ON THE EFFECTIVENESS OF THE IMPLANT

The study by dos Santos et al. (2019) showed that the low level of knowledge about electronic devices in relation to their functionality, diagnosis for implantation, home care and their action in adverse reactions are obstacles to the success of the applicability of pacemakers and this reflects on the daily lives of patients. Issues such as pain, discomfort, and fear are often patients' scores when performing their daily activities with the implant.

In this sense, according to Barros et al. (2014) as age increases, the worse the quality of life in functional capacity and discomfort, and the longer the time of pacemaker implantation, the worse the quality of life in vitality. Thus, age and time of implantation would be inversely proportional factors for a good quality of life after implantation.

According to Silva et al. (2016), the rates of perioperative and postoperative complications in procedures related to Implantable Electronic Cardiac Devices increased considerably and disproportionately to the number of initial implantations of the devices. Several factors may be related to this fact, including the aging of the population, as well as the increase in the number of comorbidities and prescription of anticoagulants and antiplatelets. The high mortality rate, however, was rarely related to the surgical procedure, but rather to the severity of the disease itself that led to the implantation. Thus, it observed a higher risk of mortality among octogenarian patients with severely decreased ventricular function or symptomatic heart failure, or who received oral anticoagulant therapy. On the other hand, patients undergoing pulse generator exchange procedures alone or other procedures that did not involve intravascular manipulation had significantly lower risks of death, hospital readmission or complications.

Gonçalo et al. (2020) analyzed various areas of the life of patients with implants. Emotional well-being was always better assessed, while emotional problems were poorly assessed, suggesting that some emotional aspects interfered with their regular daily tasks. Regarding emotional well-being, patients were asked if they considered themselves nervous, calm or calm, if they felt



discouraged/depressed, or if they were happy people. The issues of emotional problems, however, focused on the aspects that interfered with their occupational tasks and regular daily tasks. Patients with low monthly family income and low-income patients did not have many leisure opportunities, which may explain why patients did not perceive changes in social functioning caused by potential problems of a physical or emotional nature. Thus, they demonstrated that these psychological consequences may be due to the fact that follow-up consultations focus on the functioning of the device, while the emotional aspects, important for the effectiveness of the treatment, are disregarded in the vast majority of cases.

4 CONCLUSIONS

The success of the implementation of the pacemaker depends crucially on the techniques applied, the technological degree of the equipment and the emotional tranquility of the patients. It was evident that the small size of the generator, its quality and durability positively influence the outcome of the implant. However, according to the studies, there are still considerable risks regarding the implementation of the electrode, such as infectious complications, thus emphasizing the importance of antibiotic prophylaxis. Another achievement guaranteed over time was the emergence of new treatment alternatives, using different devices and techniques, being possible the direction of diagnosis and individualized treatment, following the demands of each patient.

In addition, the patient's knowledge about the process that will be carried out is essential for the success of the implementation. It is the duty of the professional to clarify the doubts and anxieties of his patient so that the emotional aspects do not interfere negatively throughout the process, even in the post-procedure follow-up. That said, it is essential that the measurement of the effectiveness and success of the electrode is based on the proper functioning of the device, and, more considerably, on the quality of life provided by it.



REFERENCES

1. Almeida GAUCH, P. R.; HALPERIN, C.; dos Santos GALVAO FILHO, S.; de PAOLA, A. A. V.; MATEOS, J. C. P.; MARTINELLI FILHO, M. ... & GRECO, O. T. (1997). Orientações a Respeito das Interferências sobre Marcapassos Cardíacos Deca-Daec 1996: Orientações a Respeito das Interferências sobre Marcapassos Cardíacos Deca-Daec 1996. *Journal of Cardiac Arrhythmias*, 10(1), 4-12.
2. Baranchuk, A.; Divakaramenon, S. Ribas, S. & Morillo, C. A. (2009). Cardiomiopatia hipertrófica y taquiarritmias detectadas por marcapaso. *Arquivos Brasileiros de Cardiologia*, 92, 40-42.
3. Barros, R. T. D.; Carvalho, S. M. R. D.; Silva, M. A. D. M. & Borges, J. B. C. (2014). Avaliação de aspectos da qualidade de vida em pacientes pós-implante de marca-passo cardíaco. *Brazilian Journal of Cardiovascular Surgery*, 29, 37-44.
4. Brasil, V. V. (2001, April 27). Qualidade de vida do portador de marcapasso cardíaco definitivo: antes e após implante. *Teses.usp.br*. <https://teses.usp.br/teses/disponiveis/83/83131/tde-14082007-140827/pt-br.php>
5. Carrión-Camacho, M. R.; Marín-León, I.; Molina-Doñoro, J. M. & González-López, J. R. (2019). Safety of permanent pacemaker implantation: a prospective study. *Journal of clinical medicine*, 8(1), 35.
6. Ferrari, A. D. L.; Gazzoni, G. F.; Domingues, L. M. L.; Willes, J. C. F.; Cabral, G. C.; Ferreira, F. V. C. ... & Reis, G. (2022). Sincronia Ventricular na Estimulação Cardíaca Parahissiana: Alternativa por Ativação Cardíaca Fisiológica (Estimulação Indireta do Feixe de His). *Arquivos Brasileiros de Cardiologia*, 118, 488-502.
7. Forno, A. R. J. D.; Ternes, C. M.; Rech, J. V. T.; Nascimento, H. G.; Lewandowski, A.; Damasceno, G. & d'Avila, A. (2022). Estimulação do Ramo Esquerdo do Sistema His-Purkinje: Experiência Inicial. *Arquivos Brasileiros de Cardiologia*, 118, 505-516.
8. Goldoni, L. F. N.; Sales, R. L.; Luciano, K. S.; Kraus, A. & de March Ronsoni, R. (2019). Registro Epidemiológico de Implante de Marcapasso Cardíaco Permanente em um Centro de Referência. *Journal of Cardiac Arrhythmias*, 32(4), 257.
9. Gonçalo, S. D. S.; Grotti, E. M. D. O.; Furuia, R. K.; Dantas, R. A. S.; Rossi, L. A. & Dessotte, C. A. M. (2020). Health-related quality of life of patients with permanent cardiac pacing. *Texto & Contexto-Enfermagem*, (29.ed.).
10. Hall, J. E. & Hall, M. E. (2021). *Guyton & Hall - Tratado de Fisiologia Médica* (14.ed.). Grupo GEN.
11. Inácio, N. A.; Muniz Neto, M.; Menezes Junior, A. D. S.; Fernandes, J. F.; Barbosa, V. A.; Laranjeira, T. D. A. & Arruda, M. (2021). Health-Related Quality of Life in Elderly Patients with Pacemakers. *Brazilian Journal of Cardiovascular Surgery*.
12. Kulchetscki, R. M. & Scanavacca, M. (2022). Estimulação Cardíaca Parahissiana–Nova Alternativa de Estimulação mais Fisiológica do Coração. *Arquivos Brasileiros de Cardiologia*, 118, 503-504.



13. Mota, G., Prazeres, J.; Freitas, N.; Magalhães, L.; Reis, F. & Aras, R. (2010). Posicionamiento ectópico de electrodo de marcapaso. *Arquivos Brasileiros de Cardiologia*, 94, 122-124.
14. Neto, D. V. C. (2019). Características sociodemográficas e clínicas dos pacientes submetidos ao implante de dispositivos cardíacos eletrônicos em um Hospital Universitário. *Repositorio.ufmg.br*. <http://hdl.handle.net/1843/31642>
15. Page, M. J.; McKenzie, J. E.; Bossuyt, P. M.; Boutron, I.; Hoffmann, T. C.; Mulrow, C. D. & Moher, D. (2021). A declaração PRISMA 2020: uma diretriz atualizada para relatar revisões sistemáticas. *Revisões Sistemáticas*, (10.ed.).
16. Raatikainen, M. J.; Arnar, D. O.; Merkely, B.; Nielsen, J. C.; Hindricks, G., Heidbuchel, H. & Camm, J. (2017). A decade of information on the use of cardiac implantable electronic devices and interventional electrophysiological procedures in the European Society of Cardiology Countries: 2017 report from the European Heart Rhythm Association. *Ep Europace*, 19(2), 1-90.
17. Rapsang, A. G. & Bhattacharyya, P. (2014). Marcapassos e cardioversores desfibriladores implantáveis-considerações gerais e anestésicas. *Revista Brasileira de Anestesiologia*, 64, 205-214.
18. Rodrigues, G. M. D. M. (2021). Medição de bioimpedância para auxiliar a atuação do marcapasso implantável utilizando a transformada wavelet. *Repositorio.unb.br*. <https://repositorio.unb.br/handle/10482/41219>
19. Santos, A. K. T.; Freitas, C. C. D. S. L.; Dutra, M. O. M.; de Oliveira Araújo, M. G. & Baptista, R. S. Atuação da equipe multiprofissional no autocuidado em idosa submetida ao implante de marcapasso cardíaco: relato de caso. <https://editorarealize.com.br/artigo/visualizar/53263>
20. Santos, A. P. A.; Watanabe, E. & Andrade, D. D. (2011). Biofilme em marca-passo artificial: ficção ou realidade. *Arquivos brasileiros de cardiologia*, 97, 113-120.
21. Silva, K. R. D.; Albertini, C. M. D. M.; Crevelari, E. S.; Carvalho, E. I. J. D.; Fiorelli, A. I.; Martinelli Filho, M. & Costa, R. (2016). Complications after surgical procedures in patients with cardiac implantable electronic devices: results of a prospective registry. *Arquivos Brasileiros de Cardiologia*, 107, 245-256.
22. Souza, M. T. de; Silva, M. D. da & Carvalho, R. de. (2010). Integrative review: what is it? How to do it? *Einstein* (Sao Paulo, Brazil), 8(1), 102–106.