

Postoperative Follow-Up of Patients with Pacemakers in the State of Veracruz

Claudia Lizbeth García Cortés^{*1}, Dora María Estrada Durán², Bertha Yolanda Guzmán Rivas^{3*}

¹Medical Doctor (MD), Universidad Cristóbal Colón, Veracruz, Mexico.

²Assistant Medical Coordinator for Health Research, OOAD Veracruz Sur, Instituto Mexicano del Seguro Social, Veracruz, Mexico.

³Principal University Researcher, Health Sciences Division, Universidad Cristóbal Colón, Veracruz, Mexico.

ABSTRACT

Introduction: Currently, one of the main causes of morbidity or mortality in Mexico is cardiovascular disease. Nowadays, advances in technology have allowed pacemakers to improve survival, symptom control, and patient quality, but the follow-up phase after the implantation procedure remains critical.

Objective: To describe the postoperative follow-up of patients with pacemaker use in the state of Veracruz, in order to detect any problem in the postoperative period

Material and methods: A retrospective observational, descriptive, cross-sectional study was conducted. Demographic variables, comorbidities, implant indication, device type and mode, as well as follow-up data at 4–6 weeks, 3–6 months, and annual review were collected. A descriptive analysis of the variables was performed

Results: A total of 143 patients over 18 years of age who underwent pacemaker implantation were included, of which 43 corresponded to the General Hospital of Zone No. 8 IMSS Córdoba and 100 to the Regional General Hospital of Orizaba. The mean age was 74.51 ± 11.18 years in Córdoba and 75.16 ± 12.01 years in Orizaba, with a predominance of females and a predominance of systemic arterial hypertension. The most frequent indication was complete atrioventricular block. Most patients had no immediate adverse events. At follow-up, 100% of the patients attended at 4–6 weeks in Córdoba and 97% in Orizaba. At 3–6 months, adherence was 100% in Córdoba and 94% in Orizaba. In the annual review, attendance decreased to 67.44% in Córdoba and 85% in Orizaba.

Conclusion: Postoperative follow-up showed high initial adherence and low frequency of complications recorded.

KEYWORDS: Pacemaker Implantation, Cardiac Arrhythmias, Atrioventricular Block, Bradycardia, Cardiac Pacing, Follow-Up Studies

ARTICLE DETAILS

Published On:
21 March 2026

Available on:
<https://ijmscrs.com>

INTRODUCTION

The American Heart Association defines a pacemaker as a small, battery-powered device that helps the heart beat in a regular rhythm (1). There are different types of devices. According to the number of cables, stimulation site and polarity, they are divided into: unicameral, bicameral, triple chamber, high energy, unipolar, bipolar and tetrapolar (2) Artificial pacemakers can be implantable or temporary external and are used to maintain a proper heart rhythm using electrical impulses. According to the chambers stimulated, they are classified as unicameral, which stimulate a single chamber (atrium or ventricle); bicameral, which stimulate the

right atrium and ventricle allowing better heart coordination; and biventricular resynchronization, used in cardiac resynchronization therapy by stimulating both ventricles (3). (4). Electrical impulses are transmitted to the myocardium by endocardial or epicardial electrodes (2). In addition, there are more recent methods such as stimulation of the conduction system (bundle of His) and leadless intracardiac pacemakers, which seek a more physiological activation and lower risk of complications. The choice of type of stimulation depends on the patient's cardiac pathology and the expected clinical benefit (5)(6). The most common indications for permanent

Postoperative Follow-Up of Patients with Pacemakers in the State of Veracruz

pacemaker implantation are sinus node dysfunction and high-grade atrioventricular (AV) block (7–9).

In the immediate postoperative period, clinical follow-up is essential: pacemaker function, vital signs and wound condition are monitored, avoiding complications such as infections or electrode displacement. Regular checks allow you to adjust the programming, monitor the battery and confirm the correct operation of the system. Thus, the success of the treatment depends not only on the surgical technique, but also on a comprehensive and continuous follow-up, guaranteeing greater safety and quality of life for the patient(10)

Most complications occur in the hospital or during the first 6 months. Complications of shunts are the main reason for pacemaker reimplantation. Other complications include, but are not limited to, infections, hematomas, pericardial effusion or tamponade, pneumothorax, coronary sinus dissection, or perforation(11,12)

Frequency and phases of follow-up (13)

Follow-up of the patient with a pacemaker is divided into three phases:

- Early surveillance, initial post-implantation phase, pre-discharge assessment and 4 to 6 weeks after hospital discharge; It allows the condition of the generator bag to be evaluated and the proper optimization of the equipment parameters
- Maintenance: includes follow-up after the first evaluation, suggesting an annual periodicity
- Intensified monitoring. more intense monitoring as the device approaches the end of battery life (consumption of 75% of capacity or any other indication of battery drain), as well as the presence of unexpected changes in measurements (change in cable impedance or threshold), considering a periodicity of evaluations of 3 to 6 months, as well as the planning and indication of hospitalization

MATERIAL AND METHODS.

A descriptive, retrospective, cross-sectional, multicenter observational study was carried out that included information on adult patients over 18 years of age who underwent cardiac intervention for the application of pacemakers at the IMSS Regional General Hospital of Orizaba and IMSS Córdoba Zone 8 General Hospital, during 2025. A non-probabilistic convenience sampling was performed. All cases of pacemakers that were admitted during the current year will be considered. Records of patients with a history of pacemaker placement, over 18 years of age, both sexes, were included. Patient records with multiple cardiac and/or cardiovascular interventions were excluded and incomplete records were eliminated. Demographic, clinical and follow-up variables obtained from the clinical records were analyzed. Demographic variables included age, , and sex, Clinical variables included comorbidities (systemic arterial hypertension, type 2 diabetes mellitus, and chronic kidney disease), pacemaker indication (atrioventricular block, sinus

node dysfunction, or others), type of pacemaker (single-chamber, dual-chamber, or resynchronizing), and post-implantation complications, such as infection, electrode displacement, or hematoma. Likewise, clinical follow-up variables were recorded, which included evaluation at 4–6 weeks, evaluation at 3–6 months, and annual evaluation, according to the controls documented in the clinical record. A descriptive analysis was obtained that included frequencies and percentages for qualitative variables, frequencies, measures of central tendency and dispersion for quantitative variables.

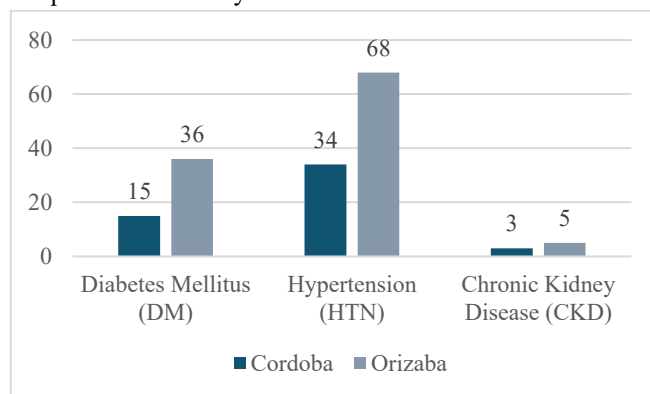
This study was subject to ethical standards that serve to promote respect for all human beings and to protect their health and individual rights.

RESULTS.

(The present research included patients over 18 years of age who had a pacemaker placed. A sample of a total of 143 patients was obtained, of which 43 corresponded to the General Hospital of Zone 8 IMSS Córdoba and 100 to the IMSS Regional General Hospital of Orizaba. Regarding the demographic variables, an average age of 74.51 years was observed at the Hospital de Córdoba with a standard deviation of 11.18. with an age range of 44 to 95 years. with a predominance of the female sex representing 53.5% (n=23). At the Hospital de Orizaba, the mean age was similar at 75.16 years with a standard deviation of 12.01, with an age range of 18 to 98 years with a predominance of females representing 56% (n=56)

However, in relation to comorbidities, a frequency of diabetes mellitus was observed in the Hospital of Córdoba of 34.9% (n=15), while in Orizaba the frequency was 36% (n=36) in relation to arterial hypertension a frequency of 79.1% (n=34) was observed in the Hospital of Córdoba, while in Orizaba the frequency was 68% (n=68). Regarding chronic kidney disease, a frequency of 7% (n=3) was observed in the Hospital of Córdoba, while in Orizaba the frequency was 5% (n=5) (Graph 1)

Graph 1. Comorbidity



Note: Distribution of comorbidities among the study population (Diabetes Mellitus, Hypertension, and Chronic Kidney Disease).

Postoperative Follow-Up of Patients with Pacemakers in the State of Veracruz

The most frequent indication in both hospitals was complete AV block (n=30 vs n=58) (Table 1)

Table 1. Baseline Cardiac Rhythm Disorders in Patients Undergoing Pacemaker Implantation

CENTER	DIAGNOSIS	NUMBER OF PATIENTS
ORIZABA	Complete AV Block	58
CÓRDOBA	Complete AV Block	30
ORIZABA	Bradycardia	13
ORIZABA	Second-Degree AV Block	9
ORIZABA	Heart Failure	6
CÓRDOBA	Second-Degree AV Block Mobitz II	6
ORIZABA	Sick Sinus Syndrome	4
CÓRDOBA	Sinus Bradycardia	3
ORIZABA	Atrial Fibrillation	2
ORIZABA	Silent Myocardial Ischemia	1
ORIZABA	Mild Tricuspid Regurgitation	1
ORIZABA	Aortic Valvular Disease	1
ORIZABA	Degenerative Conduction System Disease	1
ORIZABA	Left Bundle Branch Block	1
ORIZABA	First-Degree AV Block	1
CÓRDOBA	Intermittent Nodal Rhythm	1
CÓRDOBA	Atrial Flutter / Fibrillation	1
CÓRDOBA	Severe Bradycardia with Syncope	1
CÓRDOBA	Left Bundle Branch Block	1

The pacemaker that was most used in the Hospital of Córdoba was the VVI-R-ST-JUDE Implant, followed by the VVI-R BIOTRONIK implant, on the other hand, in the Hospital of Orizaba, there was greater variability showing that the most used was the DDD-R BIOTRONIK implant, followed by the DDD BIOTRONIK implant (Table 2.).

Table 2. Distribution of Pacemaker Types Implanted by Medical Center

CENTER	PROCEDURE / DEVICE	NUMBER OF PATIENTS
ORIZABA	DDD-R Implant – Biotronik	25
ORIZABA	Other	19

CÓRDOBA	VVI-R Implant – St. Jude	19
ORIZABA	DDD Implant – Biotronik	18
ORIZABA	VVI-R Implant – Medtronic	13
CÓRDOBA	Other	12
CÓRDOBA	VVI-R Implant – Biotronik	12
ORIZABA	VVI Implant – Biotronik	11
ORIZABA	VVI-R Implant – St. Jude	7
ORIZABA	VVI-R Implant – Biotronik	7

Note: types of pacemaker devices implanted in the Orizaba and Córdoba centers, including VVI, VVI-R, DDD, and DDD-R systems.

The mode that was most frequently used in the Hospital of Córdoba was the VVI-R (n=34), followed by the DDD-R (n=3) and MRI (n=3), in the Hospital of Orizaba the DDD mode (n=25) was most frequently used, followed by the VVI-R (n=25) and the DDD-R (n=21) (Table 3)

Table 3. Distribution of Pacemaker Pacing Modes by Medical Center

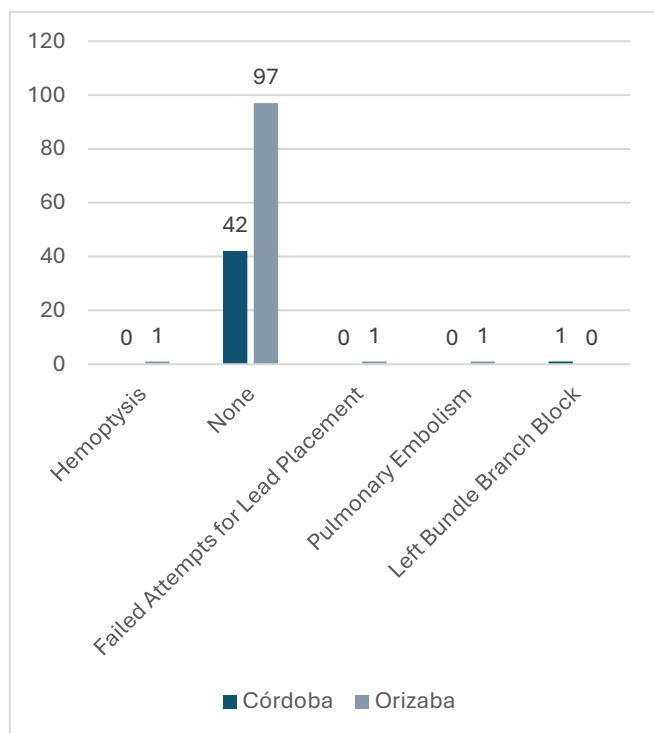
CENTER	PACEMAKER MODE	NUMBER OF PATIENTS
CÓRDOBA	VVI-R	34
ORIZABA	VVI-R	25
ORIZABA	DDD	25
ORIZABA	DDD-R	21
ORIZABA	VVI	19
ORIZABA	AAI-R	6
CÓRDOBA	MRI	3
CÓRDOBA	DDD-R	3
ORIZABA	VVI CSL	1
ORIZABA	VII-R	1
ORIZABA	VII	1
ORIZABA	DDD-VIP	1
CÓRDOBA	VVI-R + DR-T	1
CÓRDOBA	VVI	1
CÓRDOBA	ERI	1

Note: pacing modes used in pacemaker implantation procedures at the Orizaba and Córdoba centers.

Regarding complications, it was observed that in both hospitals most of the patients did not present complications, In Córdoba only one patient presented left bundle branch block (n=1), while in Orizaba, there was pulmonary embolism (n=1), failed attempt to place (n=1) and presence of hemoptysis (n=1) (Graph 2)

Graph 2. Post-Procedural Complications by Medical Center

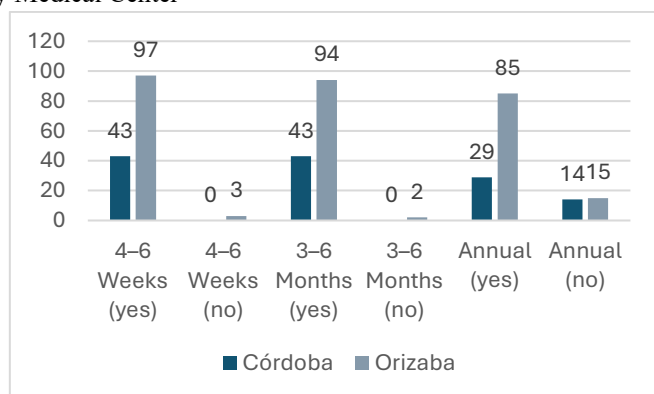
Postoperative Follow-Up of Patients with Pacemakers in the State of Veracruz



Note: Bar chart displaying the frequency of complications following pacemaker implantation. Most patients in both centers presented no complications.

However, with respect to follow-up, at 4 to 6 weeks in Córdoba, 100% (n=43) of the patients attended the clinic, while in Orizaba only 97% (n=97) attended the clinic, 100% (n=43) of the patients in Orizaba attended the clinic at 3-6 months, and only 94% (n=94) of the patients attended the clinic. The annual review showed that only 67.44% (n=29) of the patients in Córdoba attended follow-up, and 85% (n=85) of the patients in Orizaba

Graph 3. Follow-Up Compliance at Different Time Intervals by Medical Center



Note: Bar chart showing the proportion of patients attending follow-up visits at 4-6 weeks, 3-6 months, and annual evaluations in the Orizaba and Córdoba centers.

In Córdoba, during the review carried out between the fourth and sixth week, a case of acute myocardial infarction was registered. At the annual check-up, thirteen patients had

their follow-up appointment pending and one did not show up.

In Orizaba, at the 4-6 weeks follow-up, the following events were identified: one patient had valve stenosis, another pulmonary embolism, one required pacemaker repositioning, another was evaluated by oncology, and one more was referred to another unit. At the 3- to 6-month review, one additional case of stenosis was reported, two cases of embolism, one patient evolved to complete atrioventricular block, another persisted with symptoms, one received radiotherapy, one attended for review in a different unit, and one presented left ventricular outflow tract obstruction. In the annual review, one patient was sent to the third level of care, one case of pulmonary embolism was reported, one had suspected dysfunction of the device and another was followed up at another institution; the rest of the patients did not attend the consultation.

DISCUSSION

A total of 143 adult patients who underwent pacemaker placement at the IMSS Regional General Hospital of Orizaba and at the IMSS Córdoba Zone 8 General Hospital were included in this research, 100 of them belonged to the Orizaba Hospital.

The evaluation of the demographic variables showed a similar age among the 2 units, obtaining an average of 74.51 ± 11.18 in the Hospital of Córdoba and an average of 75.16 ± 12.01 . The predominant sex was female (53.5% vs 56%). The registry of comorbidities showed a high frequency of arterial hypertension, with 79.1% of the sample from Córdoba and 67% of the sample from Orizaba, in a lower percentage diabetes mellitus was presented as a comorbidity in 34.9% in the Hospital of Córdoba and in 36% in Orizaba, the frequency of chronic kidney disease was lower. In Ethiopia, Markos et al. (2024) recorded systemic arterial hypertension (79.1%) as the most frequent comorbidity (14). Atrioventricular block stood out as the most frequent indication. This is consistent with an investigation carried out in Ethiopia by Markos et al. in 2024 where complete AV block was the main indication in 78.8% of cases. Similarly, Finke et al. (2025) mentioned that AV block was the most frequent indication (15). There was variability in the pacemaker used and the most frequent mode was in the Hospital of Córdoba was the VVI-R (n=34), followed by the DDD-R (n=3) and MRI (n=3), in the Hospital of Orizaba the DDD mode (n=25) was most frequently used, followed by the VVI-R (n=25) and the DDD-R (n=21). With respect to complications, it was observed that in both hospitals most of the patients did not present complications. This is similar to the research of Chami et al and Markos et al where they report a frequency of complications ranging from 4 to 15%. (14,16) Regarding follow-up at 4 to 6 weeks in Córdoba, 100% (n=43) of the patients attended the clinic, while in Orizaba only 97% (n=97), of the 3-6 months 100% (n=43) of the patients in Orizaba attended the consultation, and only 94%

Postoperative Follow-Up of Patients with Pacemakers in the State of Veracruz

(n=94) of the patients attended the consultation. The annual review showed that only 67.44% (n=29) of the patients in Córdoba attended follow-up, and 85% (n=85) of the patients in Orizaba. This coincides with the research of Subías (2025) where a significant reduction in hospital visits was observed, with fewer major events due to device malfunction. Markos et al (2024) in their research carried out on 118 patients had a follow-up of 3.9 years (14). In this sense, the study by Nieto et al. (2021) showed that of 42 functional units analyzed, 90.5% perform remote monitoring, and even 52.4% replace face-to-face monitoring with remote monitoring(17). Similarly, research by Pérez et al. (2022) showed that remote monitoring reduces the economic, social, and environmental impact, and that 96% of patients show excellent satisfaction (18).

CONCLUSIONS

In the present study, a sample of a total of 143 patients was analyzed, of which 43 corresponded to the Hospital of Córdoba and 100 to the Hospital of Orizaba. Both hospitals presented similar demographic characteristics with an average age of close to 75 years and a predominance of women. The most frequent indication was complete atrioventricular block. Regarding postoperative follow-up, at 4-6 weeks, care was high in both hospitals (100% in Córdoba and 97% in Orizaba). At 3-6 months, adherence continued to be adequate, however, in the annual review, care decreased, especially in Córdoba. Most patients had no serious adverse events. The complications found were rare and isolated. We can conclude that patients with pacemakers in the postoperative period usually have a good follow-up during the first 6 months, since from the moment they begin with the use of the pacemaker, health specialists usually inform them of the appropriate indications for a good postoperative period.

REFERENCES

- I. American Heart Association. American Heart Association [Internet]. 2024 [cited 2025 Sep 16]. Pacemaker. Available from: <https://www.heart.org/en/health-topics/arrhythmia/prevention--treatment-of-arrhythmia/pacemaker>
- II. León-Romero LF, Fernández-Domènech JA, Cueva-Parra Á, Yáñez-Guerrero P, Ruiz-González G, Gómez-Flores JR, et al. Guía para identificar características específicas en dispositivos de estimulación cardíaca mediante figura radiológica. *Arch Cardiol Mex*. 2023 Apr 1;93(2):223–32. doi:10.24875/ACM.21000395 PubMed PMID: 37037220.
- III. Stanford Health Care. Stanford Medicine Health Care [Internet]. 2025 [cited 2025 Aug 20]. Types of Pacemakers. Available from: <https://stanfordhealthcare.org/medical-treatments/p/pacemaker/types.html>
- IV. Bodin A, Texier I, Bisson A, Pierre B, Herbert J, Jacobs M, et al. Dual-chamber vs. single-chamber pacemaker in patients in sinus rhythm with an atrioventricular block: a nationwide cohort study. *European Society of Cardiology*. 2024 Sep 14;26(1). doi:10.1093/EUROPACE/EUAE238 PubMed PMID: 39271128.
- V. Noor TA, Rana MOR, Kumari S, Umer B, Malik J, Ashraf A, et al. Outcomes of primary leadless pacemaker implantation: A systematic review. *Ann Noninvasive Electrocardiol*. 2023 Nov 1;28(6). doi:10.1111/ANEC.13084 PubMed PMID: 37606307.
- VI. Glikson M, Cosedis-Nielsen J, Brix-Kronborg M, Michowitz Y, Auricchio A, Moshe-Barbash I, et al. Guía ESC 2021 sobre estimulación cardíaca y terapia de resincronización. *Rev Esp Cardiol*. 2022 May 1;75(5):430.e1-430.e86. doi:10.1016/J.RECESP.2021.10.025
- VII. Camacho MB, Kocheril AG. Leadless Pacemaker Implantation in a Patient With Diminutive Subclavian Veins. *J Invasive Cardiol*. 2022 Feb 1;34(2):E114–6. doi:10.25270/JIC/21.00118 PubMed PMID: 34995209.
- VIII. Usó-Barberà L. CUIDADOS POSTIMPLANTE DE MARCAPASOS Y REHABILITACIÓN CARDÍACA [Internet]. Universidad Jaume I; 2021 [cited 2025 Sep 17]. Available from: <https://repositori.uji.es/server/api/core/bitstreams/b2bd3d68-4b18-45e7-9426-e05f7b3f066c/content>
- IX. Wileczek A, Stodolkiewicz-Nowarska E, Reichert A, Kustron A, Sledz J, Biernikiewicz W, et al. Reevaluation of indications for permanent pacemaker implantation after cardioneuroablation. *Polish Heart Journal (Kardiologia Polska)*. 2023;81(12):1272–5. doi:10.33963/V.KP.97828 PubMed PMID: 37997826.
- X. Puette JA, Malek R, Ahmed I, Ellison MB. Manual of Pediatric Cardiac Care: Volume 1, Second Edition [Internet]. StatPearls Publishing; 2024 [cited 2025 Aug 20]. p. 425–38. Pacemaker Insertion. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK526001/> doi:10.1007/978-981-19-8357-3_50 PubMed PMID: 30252257.
- XI. Dalia T, Amr BS. StatPearls [Internet]. StatPearls Publishing; 2023 [cited 2025 Aug 20]. Pacemaker Indications. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK507823/> PubMed PMID: 29939600.
- XII. Oterino-Manzanas A. Resultados de un servicio 24/7 de implante emergente de marcapasos permanentes [Internet]. Universidad de Salamanca; 2025 [cited

- 2025 Sep 16]. Available from: <https://gredos.usal.es/handle/10366/164177> doi:10.14201/GREDOS.164177
- XIII. Inzunza-Cervantes G, Díaz-Dávalos J de J, Flores-Anguiano A, Ornelas-Aguirre JM, Peralta-Figueroa IC, Zazueta-Armenta V. Seguimiento del paciente con marcapasos: interrogatorio y programación básica. *Rev Med Inst Mex Seguro Soc*. 2023 Nov 6;61(6):809–18. doi:10.5281/ZENODO.10064399 PubMed PMID: 37995347.
- XIV. Markos S, Nasir M, Ahmed M, Abebe S, Amogne M, Tesfaye D, et al. Assessment of Trend, Indication, Complications, and Outcomes of Pacemaker Implantation in Adult Patients at Tertiary Hospital of Ethiopia: Retrospective Follow Up Study. *Int J Gen Med*. 2024 Jan 11;17:93–103. doi:10.2147/IJGM.S448135
- XV. Finke J, Pasierski M, Dąbrowski EJ, Kurasz A, Brączkowski J, Drzażdżynska A, et al. Permanent pacemaker implantation following mitral valve surgery. State-of-the-art scoping review. *Eur J Cardiothorac Surg*. 2025 Jul 1;67(7). doi:10.1093/EJCTS/EZAF210 PubMed PMID: 40569191.
- XVI. El-Chami M, Garweg C, Clementy N. American College of Cardiology [Internet]. 2024 [cited 2025 Aug 21]. Leadless Pacemakers at 5-Year Follow-Up. Available from: <https://www.acc.org/Latest-in-Cardiology/Journal-Scans/2024/03/11/15/57/leadless-pacemakers-at>
- XVII. Nieto-Gutiérrez MP, García-García A, Borrego-Iglesias MI, Calero-Vallés Y, Bastos-Amador P, Cózar-León R, et al. Análisis multicéntrico sobre la organización de seguimiento remoto en pacientes portadores de marcapasos. *Revista Asociación Española de Enfermería en Cardiología* [Internet]. 2021 [cited 2025 Sep 16];28(84):Cardiol. 2021; 28 (84): 5-11. Available from: <https://revista.enfermeriaencardiologia.com/index.php/aec/article/view/51>
- XVIII. Pérez-Díaz P, Jiménez-Díaz J, Higuera-Sobrino F, Bastante-Díaz MC, Pérez-de-Madrid EC, Fernández-Trujillo Á, et al. Grado de satisfacción e impacto social y medioambiental en pacientes incluidos en un programa de seguimiento remoto de marcapasos. *Revista Colombiana de Cardiología*. 2022 Jan 1;29(1):23–8. doi:10.24875/RCCAR.M22000113