A Bibliometric Analysis and Visualisation of Research Trends in Leadless Pacemaker

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Abstract

Leadless Cardiac pacemakers are material engineering innovations providing pacemaker technology with improved performance and reduced side-effects. Thebibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Leadless pacemaker".All published articles related to "leadless pacemaker" from "Scopus", were analyzed using the VOS viewer to develop analysis tables and visualization maps.This article had set the objective to consolidate the scientific literature regarding "leadless pacemaker"and also to find out the trends related to the same.The most active journal in this research domain wasHealth rhythm Case Reports and Health rhythm. The most active country was the United States of America. The leading organizations engaged in the research regarding cardiac pacemakers were the University hospital in the Santiago United States of America and The Ohio State University Wexner Medical Center. The most active authors who had made valuable contributions related to infusion pumps were El-Chami. M.F

Keywords: Heart,Cardiac pacemakers,Leadless pacemaker,Bibliometric analysis, VOS viewer,

INTRODUCTION

Leadless cardiac pacemakers are material engineering innovationsproviding pacemaker technology withimproved performance and reduced side-effects. Cardiac pacemakers are medical devices providing electrical impulses to cardiac muscles, ensuring regular contractions, regular blood circulation and thereby reducing the chances of a heart arrest. A pacemaker can be permanently implanted or external temporarily used [1]. Pacemakers are battery operated and depending on the active leads, there are three types of pacemakers, namely single chamber, double chamber, and biventricular pacemakers [2][3]. The battery-powered pacemakers had been used since the 1950s and the first implants started in 1958. The future of pacemakers is on battery-less and lead fewer pacemakers [4]. Pacemaker record the vital data related to heart signals and pacing system. The concept of leadless pacemakers initially started in the 1970s [5] and the first implant of leadless pacemakers took place in 2012[6].

The two leadless pacing systems are Micratranscatheter Pacing system (received FDA approval in 2016) and Nanostim Leadless Cardiac Pacemaker.Micra[TM]isthe world's smallest pacemaker, facilitating magnetic resonance imaging (MRI), long battery life, and automatic adjusting of heartbeat [7]. Both the above systems are single-chambered and not appropriate

for patients who require double chamber pacing. Leadless pacemakers are engineered products, having the size of one-tenth and safer than a traditional pacemaker. The main advantages of leadless pacing systems are the absence of problems like pocket infections, hematoma, lead dislodgment[8][9][10][2][11], and lead fracture[11] pneumothorax/hemothorax, cardiac perforation, endocarditis, vascular obstructions, and tricuspid regurgitation[2]

This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding leadless cardiac pacemaker, and materials[12]–[14] for leadless pacemakers. The future of leadless pacemakers is in double-chambered and multi-chambered pacemakers and battery-less pacemakers [8][9][10][2][11]. This article is arranged into four sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion. The following research objectives and research questions are framed for conducting bibliometric analysis systematically.

1.1 Research Objectives
   a) To consolidate the literature regarding leadlesspacemakers
   b) To find out the trends related to research in leadless pacemakers

1.2 Research Questions
   a) Who are the active researchers working on leadless pacemakers?
   b) Which are the main organizations and countries working on leadless pacemakers?
   c) Which are the main journals related to leadless pacemakers?

RESEARCH METHODOLOGY

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE (Leadless pacemaker)on 16/01/2021. All the tables in this paper were created by using Microsoft Excel and VOS Viewer. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation.This paper had been inspired by bibliometric analysis in its presentation style, analysis, and methodology from the works [15]–[21].

RESULTS AND DISCUSSION

1.1 Results
This first round of search produced an outcome of289 documents, inninelanguages, out of which 274 documents were in English. The classification of document categories is shown in Figure 1. For improving the quality of the analysis, we had selected only the peer-reviewed articles and all other documents had not been considered. Thus after using filters "Article"and "English" the second round search produced an outcome of 180 English articles (both open access and others) andhad been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this domain since 1999 had been shown in Figure 2.
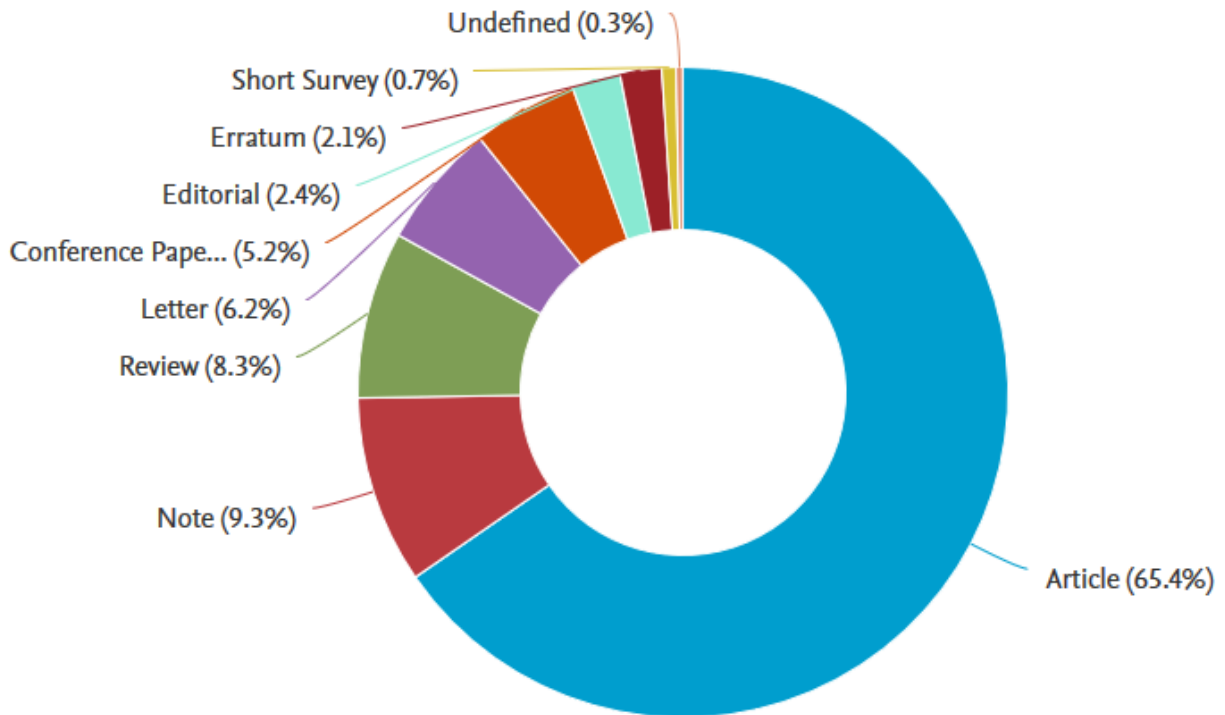
Figure 1: Classification of the documents on "Leadlesspacemaker", Source:
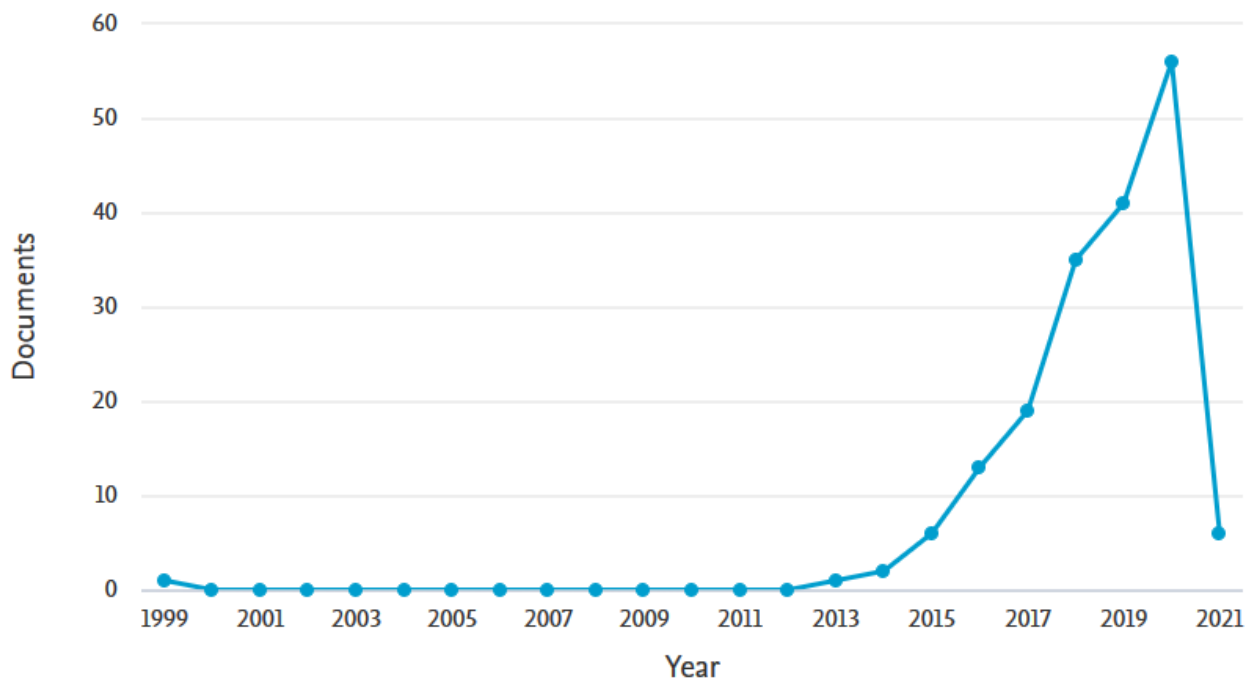www.scopus.com

Figure 2: Period wise publication of articles, Source: WWW.scopus.com

Co-authorship analysis of top authors had been shown in figure 3. For a better presentation of
the analysis, the parameters used were the minimum number of documents of an author as
fourand the minimum number of citations of authors as one. This combination plotted the
map of33 authors, in seven clusters. The overlay visualization map of co-authorship analysis

plotted in Figure 3, points out the major researchers with their strong co-authorship linkages and clusters involved.
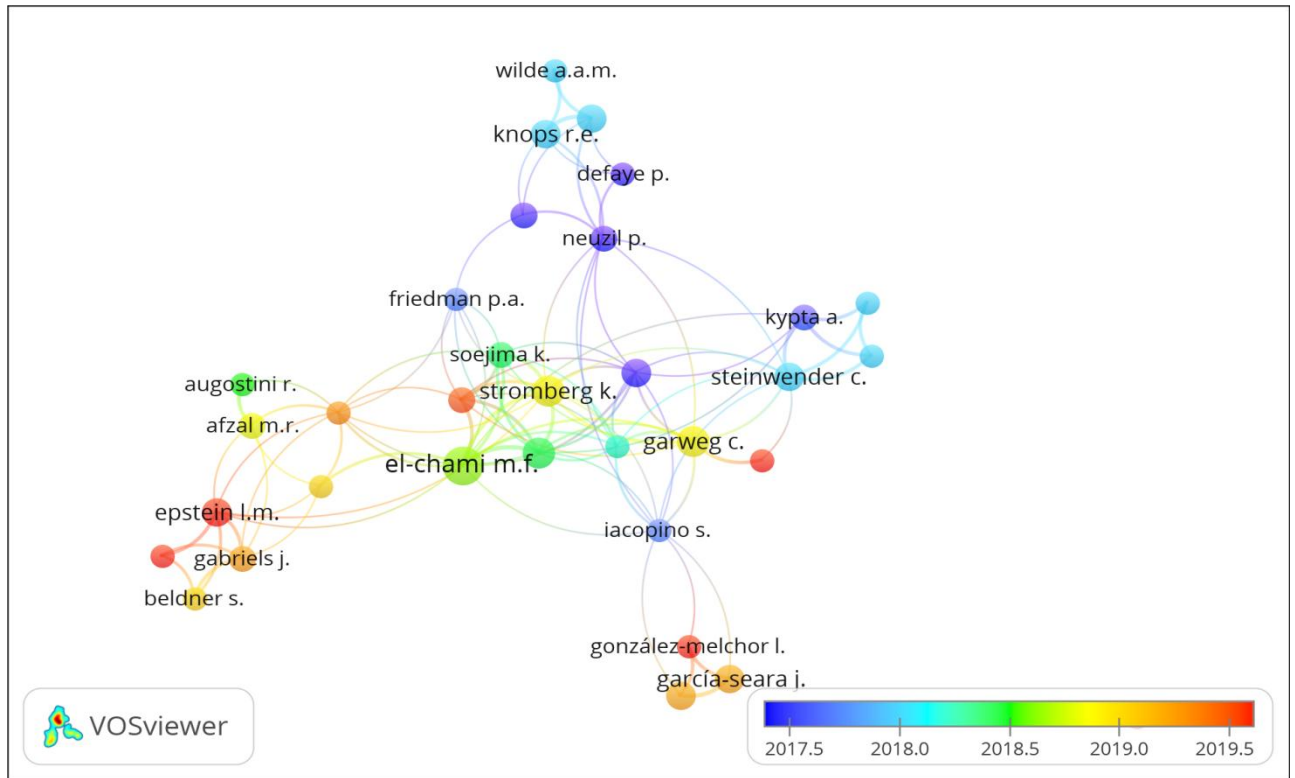

Figure 3: Co-authorship analysis on basis of authors

The citation analysis of top authors had been shown in table 1, along with co-authorship links.For the citation analysis, the parameters used were the minimum number of documents of an author as one and the minimum citations of an author as one.

Table 1: Highlights of most active authors

Description	Authors	Documents	Citations	Average citations per documents	Link strength
Authors with the highest publication, citations, and co-authorship links	El-Chami.M.F	11	233	21.1	108

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as25. This combination plotted the map of 30thresholds, in twoclusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.
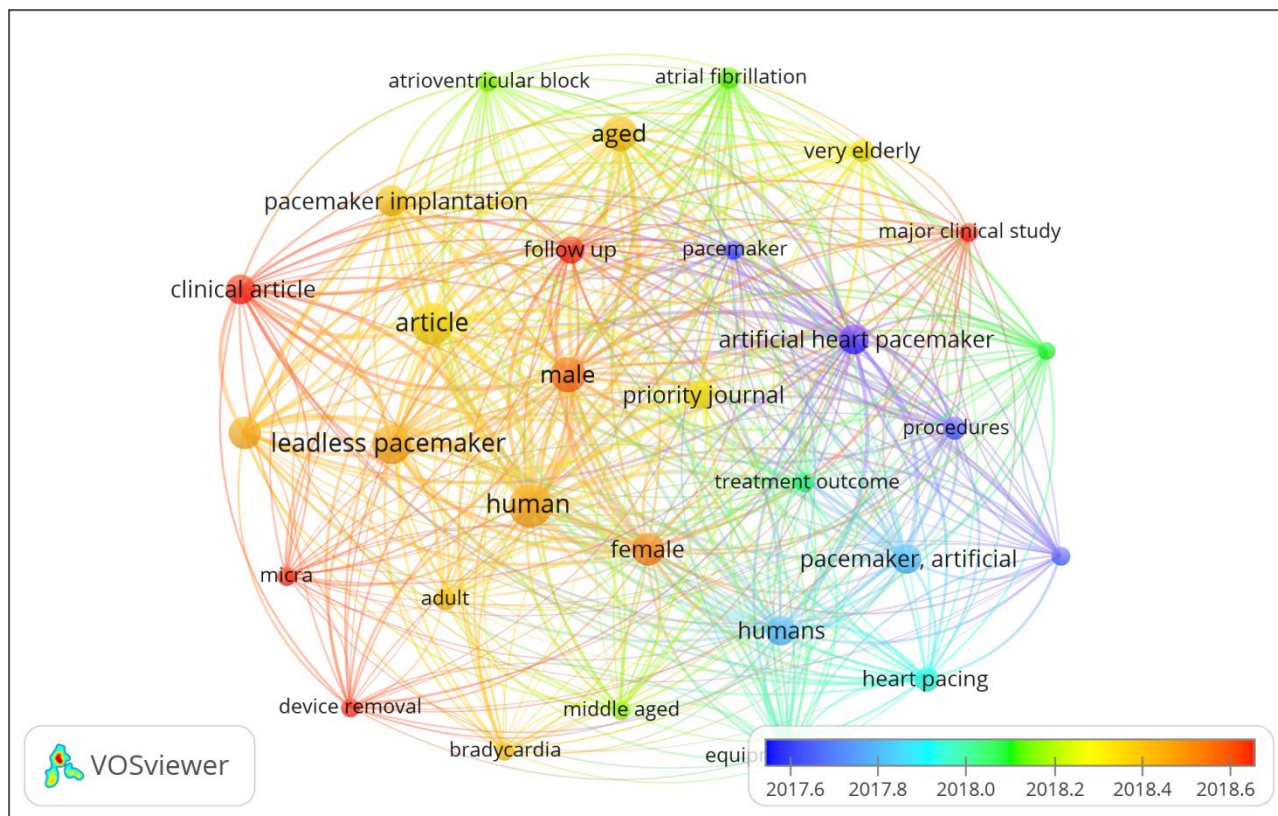
Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on "Leadless pacemakers" had been found out by the volume of publications and citation analysis, the parameters used are the minimum number of documents of an organization as one and the minimum number of citations of organizations as one. The leading organization in the research regarding "Leadless", with the highest number of publications and citations,was the University hospital in Santiago, Spain,and Royal Victoria Infirmary of the United Kingdom. (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document	H-Index
University hospital in Santiago	Spain	8	152	19	2
The Ohio State University Wexner Medical Center	United States of America	8	35	4.37	3

Co-authorship analysis of the countries engaged in the research on "Leadless pacemakers" had been shown in Figure 5. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as two and the minimum number of

citations of authors as one. This combination plotted the map of27 countries,8clusters. The overlay visualization map of co-authorship analysis plotted in Figure 5, points out the main countries with their strong co-authorship linkages and clusters involved.
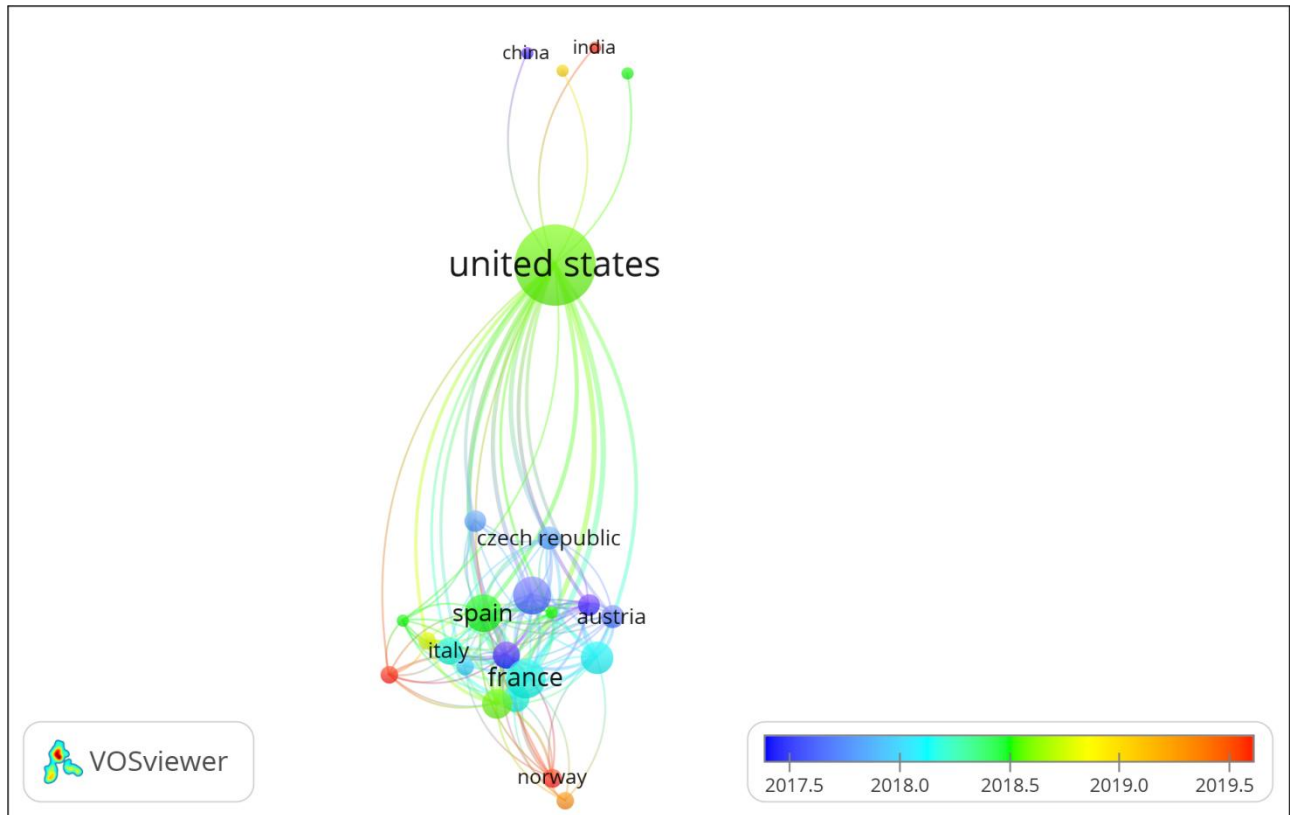

Figure 5: Co-authorship analysis on basis of countries

The citation analysis of top countries had been shown in table 3, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of acountry as one and the minimum citations of the country as one.

Table 3: Highlights of Active Countries

Description	Country	Documents	Citations	Link strength
The country with the highest publication, citations, and co-authorship links	United States of America	83	842	73

The most active country in this research domain was the United States of America, with the highest number ofpublications, and citations.

Link analysis and citation analysis were used to identify the most active journal in this research domain. We have taken the parameters of the minimum number of documents of a journal as one and the minimum number of citations of a journal as one for the link analysis and citation analysis. Highlights of the most active and relevant journals related to "Leadless pacemakers"are shown in table 4. Table 4shows the journal activity of this research domain

through parameters of publication volume, citations, and co-authorship linkages.

Table 4: Analysis of journal activity

Description	Journal details	Documents	Citations	Average citations per documents	Link strength
Journal with the highest publications,	Healthrhythm Case Reports	28	74	2.68	47
Journal with the highest citations and co-authorship links	Health rhythm	16	266	16.6	69

From the above discussion regarding the bibliometric patterns in the research regarding leadless pacemakers,this research had observed a gradual increase in research interest regarding leadless pacemakersfrom the starting of the millennium and the momentum is going on positively.This points out the relevance and potential of this research domain (Refer to Figure 2).The most active authors in this research domainwasEl-Chami. M.F with the highest publication, citation, and co-authorship links respectively (Refer to table 1).The overlay analysis of top countries researching cardiac pacemakersindicates that the United States of America is the leading countryrelating tothe highest numberof publications, citations, and co-authorship links(Refer to figure 5). The top journal of this research domain was identified as the Health rhythm Case Reports and Health rhythm.Fromthese wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding cardiac pacemakers.

CONCLUSION

A leadless cardiac pacemaker was an interesting research domain and the most active journal related to this research domain were the Health rhythm Case Reports and Health rhythm.The most active countrywas the United States of America.The leading organizations engaged in the research regarding cardiac pacemakerswerethe University hospital in the Santiago United States of America and The Ohio State University Wexner Medical Center.The most active authors who had made valuable contributions related toinfusion pumpswere El-Chami. M.F.This research domain offers a new avenue for researchers and future research can be on innovations in cardiac pacemakers through use of technology in medical science[22], [23].

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