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Review Article

Trends in the Use of Digital Stethoscopes in Healthcare: A Bibliometric Analysis

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Abstract

Aims: This study aims to review the scientific literature that has been conducted and published regarding the development of one of the medical devices, namely digital stethoscopes and look for novelty as a basis for conducting research.
Methods: This research is a descriptive analysis with a bibliometric analysis approach. Searches for published articles were conducted in August 2023 on the Scopus and Pubmed databases through the Publish or Perish application from 2000-2023.
Results: Of all the literature and publications that have been analyzed and mapped using VosViewer, the majority of studies found focus on discussing the use of digital stethoscopes in listening to and interpreting heart sounds compared to interpreting lung sounds.
Conclusion: Based on the articles collected and processed in VosViewer, the results of this study, which can be used as a reference or basis for researchers, are about digital stethoscope innovations that focus on recording and interpreting lung sounds.

Keywords:
Digital Stethoscope, Heart and Lung Sounds, Physical Assessment

INTRODUCTION

Physical examination is the first step that must be taken by nurses to determine nursing diagnoses and by physicians to determine medical diagnoses (1). Through a physical examination, it is easier for a nurse or doctor to gather detailed information about a person so that they can determine the diagnosis and severity of a patient's illness (2). Errors in conducting physical examinations can be fatal to patient safety, thus reducing patient and family trust in medical personnel (3,4).

A physical examination technique that is always used by medical personnel to detect abnormalities in the body is listening to the sound of certain organs, called auscultation (5). In cases of heart and lung diseases, this auscultation technique is important to determine if the heart is working normally or if there are abnormalities in the heart such as heart leaks, abnormalities in the heart valves, and many other problems that occur in the heart as well as the lungs (6,7).

Auscultation of the heart and lungs can generally be performed with the help of medical devices in the form of an acoustic stethoscope, but in practice, the use of this type of stethoscope can affect the results of the examination due to several things, such as the sensitivity of the examiner's ears, a noisy environment, and the use of a long stethoscope, resulting in discomfort for the user (6,8). Therefore, a physician or nurse is required to have expertise and accuracy in listening to heart sounds (9).

With the development of technology in the field of health care, stethoscopes come in different models and forms, ranging from acoustic (traditional) stethoscopes to digital stethoscopes(10). Digital stethoscopes are part of the innovation in the health sector that combines digital technology with traditional medical devices (11). Some of the advantages of the digital stethoscope feature are that it converts the sounds heard from the heart and lungs into a digital format that can be stored in the form of audio (12,13).The audio from the stethoscope recording can be sent and listened to remotely by specialists or other healthcare workers, making it easier to provide action guidance or diagnosis according to the patient's condition (12,14).

The technology applied to digital stethoscopes, developed with smartphone applications for continuous monitoring analysis of the results of cardiopulmonary auscultation (15,17). The use of smartphone applications in and data processing on digital stethoscopes is a solution to the limitations of chest auscultation with ordinary acoustic stethoscopes (18,19). The design of a digital stethoscope is a proof of technological advances in the health sector for use by health professionals in both clinical and educational settings, with an application design that can listen to and record sounds or sounds from organs in the chest so that they can be played back at any time (Attia, 2022; Aumann & Emanetoglu, 2019).

The research conducted by Zhang, with a cross-sectional, observational method of 30 inpatients confirmed SARS-CoV-2 at Lei Shen Shan Hospital Wuhan China suggests that, auscultatory examination with a wireless stethoscope, proves the role of technology can be practically used in clinical analysis of medical personnel. In addition, the use of a wireless stethoscope can be used as a tool to overcome problems in field practice for users who are less reliable or less sensitive in listening to the sound of examination results (22).

This study aims to review the scientific literature that has been conducted and published on the development of one of the medical devices, namely digital stethoscopes, and look for novelty as a basis for conducting research. Through bibliometric analysis, it is expected to find novelty for researchers to conduct broader research on digital stethoscopes both in terms of their use and in terms of function and appearance.

METHODS

This research is a descriptive analysis research with a bibliometric analysis approach. The search for published articles was conducted in August 2023, which were retrieved from 2 journal databases, namely Scopus and Pubmed, using the Publish or Perish application. The articles were collected by entering the keyword "digital stethoscope" in the search field of the Publish or Perish application. The articles collected were those published in each database between 2000 and 2023, resulting in 90 articles from Scopus and 32 articles from PubMed. The collected articles are then saved in RIS format. The next step is that the collection of articles stored in RIS format can be processed in the VosViewer_1.6.18 application to be analyzed in terms of finding novelty from existing studies.

RESULTS

According to the articles collected through the Publish or Perish application, a total of 122 articles on digital stethoscope were obtained from Scopus and Pubmed databases between 2000 and 2023. Based on the number of article publications from year to year, it seems to experience ups and downs and is not the same every year, this can be seen in Figure 1. The most publications were in 2019 with 19 research articles, followed by 2020 with 16 articles. Together with the development from year to year, it proves that research on stethoscope is growing in the health sector.
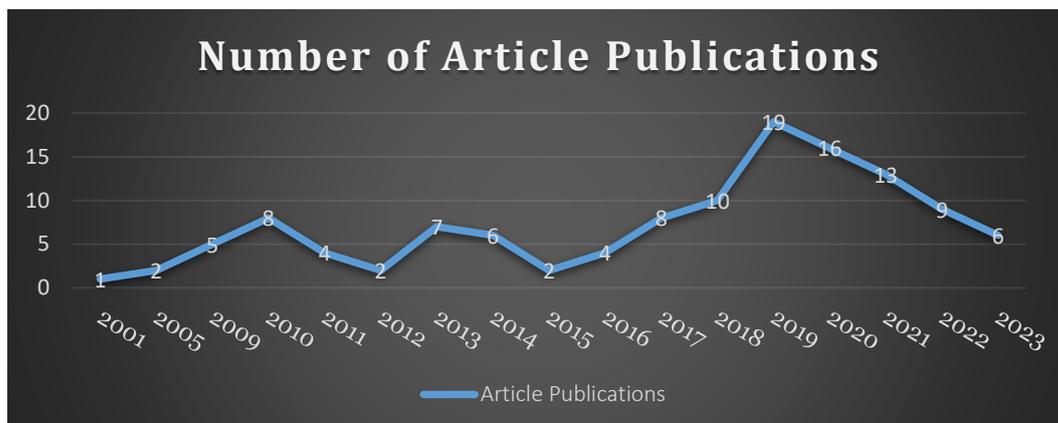
Figure 1. Growth Chart of the Number of Articles on Digital Stethoscope from 2000-2023

Regarding the publication of the articles with the most citations, it has been summarized in Table 1. Based on the table, it can be seen that the first rank of the author of the article with the highest number of citations is the article of M.E.H. Chowdury published by Sensors journal (Swittzerland) in 2019 with 84 citations, followed by the article of S.Swaruf whose article was published by Medical Deviaces: Evidence and Research in 2018 with 54 citations.

Table 1. Top 10 authors with most citations

Ranking	Penulis	Tahun	Publikasi	Jumlah Sitasi
1	M.E.H. Chowdury	2019	Sensors (Switzerland)	84
2	S.Swaruf	2018	Medical Deviaces: Evidence and Research	54
3	Y. Ma	2021	BioCAS 2019-Biomedical Circuits and Conference Proceedings	53
4	J.S.Chorba	2021	Journal Of The American Heart Association	41
5	M. Klum	2020	Sensors (Switzerland)	39
6	A.Lakhe	2016	Journal of Medical Engineering and Technology	35
7	A.N.Makaryus	2013	American Journal of Cardiology	35
8	Y. Bai	2005	Proceedings of the 7th International Workshop on Enterprise Networking and Computing in Healthcare Industry, HEALTHCOM 2005	35
9	A.Sinharay	2016	Conference on Connected Health: Aplications,Systems and Engineering Technologies, CHASE 2016	25
10	A.Ramanathan	2019	Acta Paediatrica, Internatiional Journal of Paediatrics	24

The next application used is VosViewer, this application is used to visualize the mapping of the research that has been done and to find novelties in the research. The display of VosViewer consists of three views including network visualization, overlay visualization, and density visualization. The mapping results from VosViewer Network Visualization in Figure 2 show that there are 28 keyword items grouped into 4 clusters with different colors. Among others, red for cluster 1, green for cluster 2, blue for cluster 3, and finally yellow for cluster 4. The Network Visualization view shows the networks that are related between keyword items. Digital Stethoscope is closely related to several other keywords such as Electrocardiography, Heart Rate, Heart Sound, Assessment, and Birth.
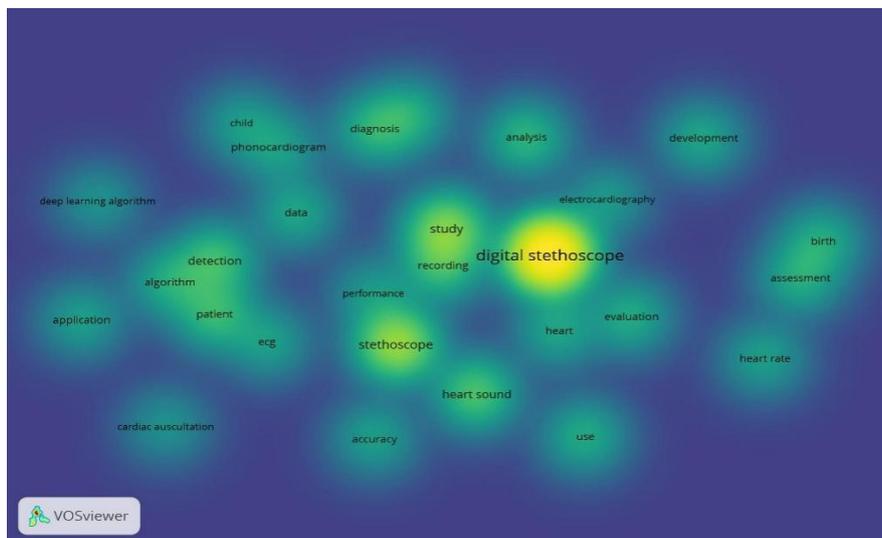
The Overlay Visualization view in Figure 3 shows the progress of research based on the novelty or time of publication of a journal. The colors available in this display range from blue to yellow. The figure shows that the blue color means that the publication of the journal with these keywords is in the vulnerable years between 2016 and 2017, while the bright yellow color is interpreted as the keywords of the most recent journal publications, namely between 2019 and 2023 with the keywords birth, electrocardiography, performance, detection, and deep learning algorithms.

The last display is the density visualization, in this section, keywords are displayed with colored circles behind them, this means that the brighter the color of the circle, the more the keyword has appeared in research publications. In Figure 4 you can see the largest bright yellow circle on the keywords digital stethoscope and stethoscope.

Figure 2. Network visualization map of terms in the title/abstract field of publications related to Digital Stethoscope from 2000-2023.

Figure 3. Map overlay visualization Map overlay visualization of terms in the title/abstract field of publications related to Digital Stethoscope from 2000-2023

Figure 4. Visualization map of term density in the title/abstract field of publications related to Digital Stethoscope 2000-2023

DISCUSSION

Bibliomeric analysis is a method of literature review that collects and evaluates the body of literature on a particular topic. The analysis is used as literature mapping, evaluation, and finding knowledge gaps (23).

The results of the VosViewer analysis show that there are 4 clusters with 28 keywords or variables in the publications harvested on Publish or Perish. In this first cluster, we can see that the focus of research is on the use of stethoscope in the physical assessment of patients, especially in listening to the patient's heart sounds, as stated in the study conducted by Swarup and Makaryus (13), listening to the heart sounds is the basis for the doctor to make a diagnosis, so the role of stethoscope is very important in the patient assessment process. A stethoscope is one of the medical devices used to assess organs that can produce sounds such as heart, lung, and bowel sounds (24,25).

In the second and third clusters, it can be seen that the focus of research is on the use of digital stethoscopes and electric stethoscopes in recording patients' heart sounds in order to reduce the occurrence of errors in diagnosis caused by lack of sensitivity of the examiner and lack of experience. This is in line with the statement of Aparna Lkhe (26) in his article, which states that digital stethoscopes can overcome the shortcomings of conventional stethoscopes because heart sounds can be amplified, stored in audio, so that they can be played and sent for consultation. On the other hand, this digital stethoscope can be used as a learning tool for new nurses or new doctors in listening to and distinguishing normal and abnormal heart sounds (6). In addition to its advantages, the digital stethoscope also has disadvantages, including more expensive cost compared to using a traditional stethoscope, and errors can occur if there is damage to the device, so it can affect the interpretation (27).

The fourth cluster shows that researchers are focusing on heart sounds, which are sounds made when the heart works to pump blood. The examination of heart sounds by doctors using a stethoscope is an important part of the physical examination (17). Normal heart sounds are often referred to as S1 and S2, with S1 sounds

occurring during ventricular contraction and closure of the atrioventricular valves, while S2 sounds occur at the end of ventricular contraction and closure of the aortic and pulmonary valves (28). Meanwhile, abnormal heart sounds usually occur because there are problems with the ventricles or problems with the heart valves (29).

Digital stethoscopes are evidence of technological developments in the health sector that can help and facilitate health workers in performing assessments on patients (19). Of all the literature and publications analyzed and mapped using VosViewer, the majority of the research found focuses on discussing the use of digital stethoscopes in listening to and interpreting heart sounds compared to interpreting lung sounds. After seeing an overview of the analysis from VosViewer, there are several gaps or updates for researchers to be able to conduct further research on digital stethoscope innovations that focus on recording and interpreting lung sounds. With the development and innovation, it is hoped that digital stethoscopes will be more optimal in helping healthcare workers, especially nurses and doctors.

CONCLUSION

The digital stethoscope is one of the updates in the health sector that combines digital technology with traditional stethoscopes. Based on the articles collected and processed in VosViewer, the findings in this study can be used as a reference or foundation for researchers, namely regarding digital stethoscope innovations that focus on recording and interpreting lung sounds.

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