



Digital Stethoscope as a New Weapon to Combat Chronic Diseases

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ABSTRACT

Chronic diseases are described broadly as problems that persist a year or longer and necessitate continuing medical attention, impede daily activities, or both. Many telehealth programs are now being developed in order to solve time, location, and financial constraints, as well as to increase patient education and adherence in order to maintain health results. This study will cover a variety of research subjects, including what a digital stethoscope is and how it might help reduce chronic disease rates by enhancing self-monitoring, establishing tele-auscultation, and tele-homecare. We searched several papers from 2018 to 2023 for information about Digital Stethoscope and Chronic Diseases. Medline, Scopus, and Web of Science, were among the databases used. Relevant publications were also found using anthropological and social science databases. According to the 40 journals, digital stethoscopes have been proven to be able to detect normal and abnormal sounds in the heart, lungs, abdomen, and carotid. Remote auscultation examinations carried out between specialists also showed harmonious results. Digital stethoscopes are more practical, affordable, and overcome distance and time problems in accessing health services. Self-monitoring with a digital stethoscope could increase the patient's knowledge about the diseases and the symptoms can be known earlier. In primary health services, digital stethoscopes are useful for the screening process and integrating data into secondary health services and it can facilitate communication between physicians about the patient's condition. In tele homecare, digital stethoscopes are important to improve the quality of telemonitoring in patients with chronic diseases to avoid poor outcomes.

Keywords: chronic diseases, digital stethoscope, self-monitoring, tele-auscultation, tele-homecare.

1. INTRODUCTION

Innovation has gotten to be progressively conspicuous within the healthcare field, extending from consumer-based digital health innovations to advancing tele-health programs. Vitality, tele-health programs have been detailed as quality and secure, and have expanded to patients found in geographic locales with restricted access to assets L. Roelle *et al* [1]. In terms of chronic diseases, digital health could be a solution to barriers in solving chronic disease problems, especially in Indonesia.

The number of people with numerous chronic health disorders has increased Y. Zhao *et al*, [2]. One-third of persons globally are projected to have two or more chronic conditions coexisting C. Hajat, E. Stein [3]. Multimorbidity, an emerging and prominent public health issue globally, has been linked to poorer patient outcomes

and poses a challenge to health systems' ability to optimize personalized care, resulting in a significant economic burden for health systems D. L. Vetrano et al [4].

The majority of chronic illnesses result in poor health outcomes. Biopsychosocial sequelae and associated depression worsen health-related quality of life (HRQoL) M. Bahall & H. Bailey [5]. Chronic diseases have a substantial impact on HRQoL as a burden to the individual and society. HRQoL is frequently harmed by accompanying psychosocial issues such as depression, a lack of social support, and economic difficulties. HRQoL may be influenced by the type of chronic disease, personal influences, and cultural adaptation. Chronic physical illnesses (CPDs) are influenced by comorbid psychological disorders L. O. Daré et al [6]. CPD can potentially result in psychopathological symptoms F. Marchini et al [7].

Addressing chronic disease is a huge problem for global healthcare systems, which have primarily evolved to deal with acute episodic care rather than structured care for patients with long-term conditions. Chronic diseases are distinguished by the fact that they frequently necessitate extended supervision, observation, or care. The distinguishing characteristics of primary care (such as continuity, coordination, and comprehensiveness) make this environment appropriate for chronic condition management R. Reynolds et al [8].

There are numerous barriers that exist when managing chronic diseases. Studies have highlighted a fundamental obstacle in primary care as a lack of care accessibility and other access concerns, such as the unavailability of 24-hour services M. Belizan et al [9]. Another study found that individuals with chronic disorders, particularly those with several chronic conditions, were more likely to receive delayed treatment L. Shi, D. C [10]. This study found that while most patients could use public transportation to get to polyclinics and so get complete services, a few patient groups may still be unable to receive timely care management. Patients with mobility issues, those who do not book follow-up appointments, and those who miss their appointments are among those who fall into this category.

Inadequate consultation duration was identified by physicians as an existing obstacle to managing patients with multiple chronic conditions and those referred from hospitals with numerous drugs. Both healthcare customers and professionals also expressed concern about increased demand for polyclinic services, which could potentially shorten future consultation times K. M. Foo, M. Sundram, H [11].

With the help of technology, the barriers that exist when managing chronic diseases can coexist over time. Many telehealth programs are currently being developed to address time, distance, and expense constraints, as well as to improve patient education and adherence in terms of preserving health outcomes.

A stethoscope is considered one of the foremost important medical devices since it is non-invasive, accessible in real-time, and much enlightening. With a stethoscope, a doctor can distinguish variations from the norm within the body's frameworks which can lead to a determination Y. Kim, Y. K. Hyon [12]. In the case of someone with a chronic disease, a stethoscope provides an overview of the disease through lung sounds, heart sounds, abdominal sounds, and bruits on the carotid artery.

Progressions in healthcare advance significantly as a result of innovative advancements, where cutting edge innovation empowers us to actualize multifunctional contraptions with quick handling. Advancing the progression of innovation guarantees that gadgets are getting to be more effective, convenient, and helpful and have quicker handling speeds than ever some time recently, fulfilling the wants of the healthcare industry. For illustration, utilizing wearable computerized stethoscopes for sound recording and visualization offers real-time, remote, and persistent auscultation by means of a delicate wearable framework that can be executed as a quantitative symptomatic device for different maladies. The wearable innovation can possibly be combined with smartphone applications for persistent auscultation checking. These recently planned computerized and electronic stethoscopes are innovative headways committed to healthcare experts for use in both clinical and instructive settings, in this way moving forward on conventional auscultation procedures J. J. Seah, J. Zhao [13].

In this narrative review, will be discussed further regarding digital stethoscopes, which provide self-monitoring services, tele-auscultation, and tele-home care, are one of the healthcare technologies available for better management of chronic diseases.

2. MATERIAL AND METHOD

2.1 Narrative Review

The method used to collect the data about digital stethoscopes and its ability to combat chronic diseases is narrative review. The aim of narrative review is to summarize the literature in a manner that is not explicitly systematic, with the minimum requirement for the term systematic relating to the method of the literature search, but in a broader sense including a specific research question and a comprehensive summary of all studies. Several research topics will be addressed in this study, including what the digital stethoscope is and how it might lower chronic disease rates by improving self-monitoring, establishing tele-auscultation, and tele-homecare.

2.2 Data Sources

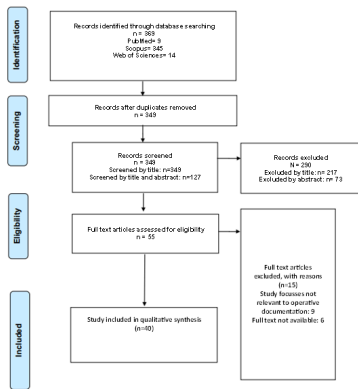


Figure 1. Overview of the search methodology

To get information about Digital Stethoscope and Chronic Diseases, we looked at various articles from 2018 to 2023. The databases included: Medline, Scopus, Web of Science, Academic Search Complete. A number of keywords were applied. The searches used were: “digital stethoscope” AND “self-monitoring”, “tele-auscultation”, “tele-homecare” AND “chronic diseases”. These five keywords were chosen to obtain general results related to how digital stethoscopes can be a means of self-monitoring, tele-auscultation, and tele-home care for patients with chronic diseases.

3. RESULTS

3.1 Tele-auscultation and Digital Stethoscope

Auscultation is a medical approach for listening to sounds inside the patient's body, detecting and diagnosing aberrant sounds. A tele-auscultation is a medical examination procedure similar to the traditional one, but the fundamental difference between the two is the mechanism for transmitting the auscultation's sounds over great distances. The Internet and an electronic stethoscope are the cornerstones to a successful tele-auscultation service. Furthermore, tele-auscultation experiences may differ from traditional ones because it is not face-to-face and may encounter some delay of body sound received from the remote site S. Kamolphiwong, T. Kamolphiwong [14].

A digital stethoscope can be used to detect indicators of disease in a patient's internal organs, such as the heart, lungs, intestines, or carotid arteries, during a physical examination. A digital stethoscope can identify S1, S2, S3, S4 heart sounds, as well as other noises such as ejection or non-ejection clicks, PLOP tumors, pericardial sounds, pacemaker sounds, and murmurs M. Maleki [15]. A digital stethoscope may detect lung bubbles in the form of typical breath sounds, as well as extra breath noises such as wheezing, rhonchi, and crackles. Meanwhile, for the abdominal region, the stethoscope may detect bowel noises, and for the carotid artery, the stethoscope can detect bruits in the carotid artery as a symptom of atherosclerosis in the carotid artery. A digital stethoscope can aid in the early diagnosis of numerous heart, lung, and gastrointestinal disorders.

Considerations comparing acoustic and electronic stethoscopes in individual and tele-auscultation are rare. One of the products called Stethoscope was compared for patients with irregular heart sounds, counting heart mumbles, and other pathologic findings. Stemoscope demonstrates to be exceptionally simple to tune in to and share sounds. Moreover, with a phonocardiogram related to the recording, cardiologists can effortlessly alter the quality of the recording, and this is often valuable when they have trouble identifying atrial fibrillation and untimely heartbeats. Stemoscopes are much closer to genuine life sounds compared to the sounds recorded by other brands of electronic stethoscopes. Frequently, perusers feel that the recording gives a harsher mechanical quality to the S1/S2, so they require time to adjust M. Fan et al [16].

Another stethoscope that builds for detecting lung sound using deep learning analysis shows that deep learning has performed well in identifying, classifying, and assessing respiratory diseases from lung sound recordings, particularly the CNN model with 2D spectrogram input. While several obstacles remain, such as noise reduction, model interpretability, and performance robustness, the potential benefits of deep learning-based lung sound analysis for the intelligent stethoscope are enormous D. M. Huang [17].

Research on the use of low-cost digital stethoscopes for remote lung auscultation using 27 respiratory sound samples showed that remote auscultation can allow one to other pulmonologists to evaluate the same sounds. The level of agreement reliability is high on detecting normal, wheezing, and crackling sound. Namely Cohen's kappa for normality, hypophonesis, wheezing, rhonchi and crackles was 0.691, 0.481, 0.737, 0.314, and 0.900, respectively-each. In conclusion, the use of low-cost digital stethoscopes is feasible, and may improve the quality of remote visits in patients with chronic pathologies I. Garcia Olivé et al [18]

In the concept of tele-auscultation, a study is needed on how digital stethoscope users (in this case cardiologist doctors) can use digital stethoscopes well and in a coordinated manner with each other so that there is the same interpretation of the results. In a cross-sectional study that discusses the comparison between traditional face-to-face auscultation and digital-based interpretation of heart sounds mentions that an average degree of agreement ($Kappa = 0.583$) between the two methods, lower than previous studies, possibly due to the lack of clinical information available to the evaluator in the digital method. However, remote auscultation between two cardiologists showed satisfactory agreement ($Kappa = 0.615$), though lower than some prior studies. Factors affecting agreement include training in tele-auscultation, the quality of heart sound recordings, and variability in clinical experience among evaluators. Residual variability could also stem from differences in academic background and professional experience among cardiologists F. C. G. Doualla [19]. The digital stethoscope is built in a practical form that incorporates sensor technology and is coupled with a mobile application, allowing doctors to send test results in the form of signals and audio recordings to consultation doctors to avoid misdiagnosis.

3.2 Digital Stethoscope for Self-monitoring in People with Chronic Diseases

Some chronic conditions, such as coronary heart disease, heart valve disease, chronic obstructive pulmonary disease (COPD), and asthma, are frequently diagnosed by physicians using a stethoscope in response to patient complaints.

The conventional stethoscope consists of a hollow tube attached to a chest piece composed of a larger diaphragm coupled cavity and a smaller hollow, open bell. Heart and lung noises vibrate the diaphragm in

contact with the patient's chest wall, causing sound waves to travel through the cavity and up the hollow tube to the earpiece.

Although most physicians are trained to accurately diagnose diseases of the cardiovascular and respiratory systems using a single auscultation event, there is a possibility of misdiagnosis or underdiagnosis due to potential limitations such as the absence of symptoms during an examination or even the physician's presbycusis. Furthermore, the usage of this classic stethoscope relies on the doctor's interpretation of the examination results, thus the general public cannot use it.

As a result, the introduction of digital stethoscopes, which allow the recording of small irregularities in heart and lung sounds, has prompted S. Swarup [20]. The recording can be used by clinicians and researchers for in-depth analysis in order to advance optimal intervention options for complex patient circumstances. Other benefits of a digital stethoscope include the ability to amplify chest sounds for better listening, the ability to integrate with computerized algorithms for automated anomaly detection, and the ability to be used as a remote monitoring device for better patient management Y. Y. Ang, L. R [21].

The digital stethoscope has the potential to be utilized as a medical equipment that can help self-monitoring, particularly for patients with chronic conditions, due to its capacity to detect and monitor digitally and its ease of use. The usage of a digital stethoscope can save money on transportation because patients do not need to come to the hospital as regularly for examinations because they can use telemonitoring via an app linked to the digital stethoscope.

According to research, many individuals with chronic conditions or limited mobility stay in nursing homes or at home without seeing a doctor. Furthermore, the demand for telemedicine among patients in difficult-to-reach areas is increasing [12]. However, clinicians find it difficult to evaluate these patients, and auscultation is rarely performed. Battery advancements enabled the development of embedded CPUs with low power consumption and integrated sensors, allowing clinicians to check patients from a distance G. Yilmaz et al [22].

According to various studies, it is demonstrated that the digital stethoscope can be utilized as a cardiac screening tool for preoperative evaluation of patients preparing for hip replacement surgery. Similarly, in locations where resources are scarce, an electronic stethoscope with an integrated phonocardiogram could be a useful tool for juvenile heart evaluation.

Additionally, utilizing acoustic wave technology focused at the knees, probable diagnoses of chronic illnesses identified in the joints of elderly people can be evaluated. The important signals are collected using an electronic stethoscope or high-resolution recording equipment in order to measure the wide-frequency audio signals of the knee joint. Stethoscopes aid in distinguishing between patients with healthy and degenerative knee joints, allowing clinicians to select the optimal rehabilitation procedures Y.-T. Cheng, C.-C. Ta [23].

King et al. [24] emphasized its monitoring function, such as employing a digital stethoscope to detect lung aeration in infant respiratory distress syndrome King et al. [24]. The electronic stethoscope could also be used to detect coronary artery disease, which causes faint murmurs and can be recognized by analysis with a diagnostic procedure. AI-based algorithms can also be employed with digital stethoscopes to detect aortic stenosis T. Ghanayim et al [25]. If low-grade murmurs can be detected early, it may lead to the diagnosis of a disease that would otherwise be clinically asymptomatic. Following that, the appropriate workup can be undertaken, allowing for earlier detection of the disease in its preclinical stage as well as a possible longer treatment window, potentially resulting in improved clinical results [13].

The digital stethoscope has the potential to improve self-monitoring for patients with chronic conditions due to some of the benefits listed above. Self-monitoring is only useful if it results in a benefit for the patient. There are a variety of potential benefits, including improved clinical outcomes (or at least improvement in surrogate outcome markers), such as lower HbA1c in diabetic patients, greater patient convenience (e.g., self-monitoring may eliminate the need to visit a clinic for testing), and improved psychological well-being of the patient. All of these, individually and collectively, may lead to lower healthcare expenses M. J. O'Kane [26].

Patients gained insight into their disease course by self-monitoring disease activity and obtaining a graphic picture of their PROM values over time. Patients expressed appreciation for both the long-term knowledge into their disease pattern and the capacity to predict an exacerbation. They also stated that they learned more about their disease, felt better prepared for a consultation, and felt less reliant on their health care professional to manage their sickness. Diabetes self-monitoring literature has already demonstrated a link between disease knowledge and self-monitoring L. Renskers [27]. Although some knowledge is required for self-monitoring, the process of self-monitoring helps to expand disease-related knowledge. Adequate disease-related knowledge is important because it may influence patients' treatment, compliance, and self-management performance, as well as the ability to recognize signs, symptoms, and patterns, as supported by a study on telehealth experiences in patients C. Dye, D. Willoughby [28]. All of these factors are important in collaborative decision-making and contribute to the effectiveness of consultations.

Patients with heart failure, for example, have a variety of physical symptoms such as dyspnea, shortness of breath, exhaustion, edema, sleep problems, palpitations, discomfort, cough, and poor appetite, as well as mental symptoms such as melancholy, anxiety, and fear. Other reported symptoms include decreased physical capacity, a general sense of being "unwell," and an inexplicable difference M. Matsuda [29]. Most self-care intervention programs used to reduce HF patient re-hospitalization focus on increased knowledge of heart failure and its symptoms, treatments, and self-care, improved adherence to self-care behaviors (i.e., medical recommendations), or nurses' assessment of their signs and symptoms (telephone follow-up, home care, messaging, and tele-monitoring) M. Mizukawa et al [30]. A digital stethoscope can be useful in detecting dyspnea, breathlessness, and palpitations by the patient or the patient's family, allowing for early detection of symptoms and data collection to determine the patient's healing process.

3.3 Digital Stethoscope as a Tele-auscultation in Health Service

There are three types of health services: primary, secondary, and tertiary. Each health service has a role to play in the management of chronic diseases. The digital stethoscope is a medical device that can be used in any line of health care and can improve interoperability because patient data can be integrated into primary, secondary, and tertiary health services through tele-auscultation, thereby increasing the quality of services provided and improving patient outcomes.

3.3.1 Primary Health Care

Primary health care is critical in the treatment of chronic illnesses. Population aging, globalization and urbanization, genetics, social determinants of health, and behaviors, in particular, are key factors in determining the increasing occurrence of chronic conditions in children and young adults, which is reflected in a high number of unmet needs and medical costs J. Longhini [31]. This process has resulted in one of the most serious health issues of our time, known as multimorbidity, which is the occurrence of two or more chronic diseases. Furthermore, the world's population is aging, creating an increased demand for human resources and novel care delivery models, particularly in basic healthcare settings.

Patients with chronic conditions will receive health services through primary care. That is supported by research. When compared to patients in townships with median management intensity, patients in high-intensity townships have 4.8% more primary health care visits, 5.2% fewer specialist visits, 11.7% lower likelihood of inpatient admission, and 3.6% lower medical spending. They also had better adherence to medicine and blood pressure control. The resource savings from avoiding inpatient admissions outweigh the program's expenditures H. Ding et al [32]. According to the study, enhancing primary health care can provide accessible, affordable, and adequate quality management of chronic diseases, resulting in less usage of specialist and inpatient services. It also highlights the importance of aligning primary health care providers' incentives and knowledge to convince patients to make appropriate use of primary health care.

Patients with chronic conditions benefit greatly from primary health care. Family doctors and nurses play a vital role in health promotion, illness prevention, health maintenance, counseling, patient

education, diagnosis, and treatment in this field. Tele-auscultation has the potential to improve the quality of basic health care services. Health personnel can avoid disease by employing tele-auscultation with a digital stethoscope since early diagnosis of a disease is one of them. It has been endorsed by cardiologists, who state that the digital stethoscope is simple to use and that the majority of them would consider employing this tele-auscultation approach in a telemedical context. The digital stethoscope enabled cardiologists to distinguish between normal and pathological sounds [16]. The availability of tele-auscultation will allow health workers to conduct consultations remotely utilizing web-based and Android-based applications. Good health maintenance is one of the expected outcomes for individuals with chronic conditions in primary care. Tele-auscultation will make it easier for patients and their families or caregivers to conduct periodic auscultatory physical examinations at home, receive real-time results, and consult on next steps with the doctor via an app connected to a digital stethoscope.

3.3.2 Secondary Health Care

An integrated strategy to chronic illness care delivery can improve health outcomes. Integrating primary and secondary care has the potential to improve communication and access to care, ultimately boosting health and increasing patient satisfaction and involvement. It may also have the potential to reduce needless spending and improve healthcare system cost effectiveness S. Murtagh et al [33]. The World Health Organization suggests promoting continuity of care through efficient and cost-effective referral and communication networks between primary and secondary services, with doctors at the heart of multi-professional teams from the health, social, and other sectors. Continuous patient and family involvement in care planning, administration, and oversight is required for successful integrated care. This self-management empowers patients and guarantees that patient-centered, tailored care is provided. It is a priority to develop such integrated systems to address the growing burden of chronic disease. Chronic illness treatment and management accounts for 80% of doctor visits, 40% of hospital admissions, and 75% of hospital bed days. Our findings suggest that integrating primary and secondary care can improve clinical outcomes while also being cost-effective for people suffering from specific chronic illnesses (e.g., diabetes, COPD, Parkinson's disease). Multidisciplinary teams, healthcare professional education, and e-health interventions were among the interventions we found. There appears to be a scarcity of studies examining entire populations with chronic illnesses as well as specific integrated care solutions M. H. J. Schulte [34].

Some aspects to emphasize in secondary care treatments for chronic disease patients include the ability of interdisciplinary teams to improve patient outcomes. Tele-auscultation with a digital stethoscope can speed up the process of physical examination, consultation with consulting doctors on the patient's condition, and entering and updating patient data in digital medical records. This accelerated method will improve the work efficacy of health workers while overcoming a lack of time, resources, or personnel. Not only does the presence of a digital stethoscope facilitate coordination among health workers, allowing them to improve internal communication and provide every health worker with strong evidence of the results of physical examinations and auscultation of patients in the form of sound recordings, allowing them to provide suggestions related to interventions for patients. Integrating digital stethoscopes with applications and electronic medical records can also help to solve administrative issues linked to the completeness of electronic medical records.

Tele-auscultation with a digital stethoscope can improve e-health treatments in addition to increasing multidisciplinary work. The effectiveness of eHealth interventions in improving treatment adherence for asthma and COPD is presumably related to the type, context, and intensity of the interventions, as well as differences in operationalization and measurement of medication adherence, according to research on several asthma and COPD patients who were given e-health interventions M. H. J. Schulte [35]. Furthermore, auscultatory physical examination can detect disorders such as asthma and COPD. As a result, the digital stethoscope plays an important function in this situation.

3.4 Digital Stethoscope for Tele-homecare

The goal of home health care is to provide health and social assistance to older persons in their homes in order to improve and preserve their function and to prevent institutionalization. Skilled nursing and psychiatric nursing, physical and occupational therapy, home health aide assistance, and social work support are all possible services. The pilot study looked at using volunteer community members who had been trained as Health Coaches to coach discharged home health care patients, with the goal of enhancing chronic disease self-management practices and lowering hospital readmissions and emergency department use [28]. The Health Coach program treatment group showed reduced rates of hospital readmissions and emergency department visits than the comparison group, albeit the changes were not statistically significant [28].

Home health care services have evolved into home telemonitoring services with the help of technology. The advantages of home telemonitoring are comparable to those of normal home health care. This service is available at any time and by any health worker or doctor, lowering travel costs and saving time. Furthermore, the present service can be used during a pandemic to ensure that patients with chronic conditions who require regular monitoring continue to receive adequate care.

Home telemonitoring can help patients feel more confident about their health, enhance their self-care, and improve how they monitor their health. Telemonitoring plays a role in improving the overall quality of care provided to patients, improved patient knowledge of the symptoms to look out for, improved patient knowledge of how to better manage their illness, improved patient knowledge of the nature of their clinical condition, facilitate interacting with patients, monitoring the patients, and clinicians recommending telemonitoring service to other patients and clinicians J. Li, M. Varnfield [36].

Home telemonitoring will be more efficient for monitoring the patient's physical health through auscultation now that a digital stethoscope is available. The virtual consultation and physical evaluation enabled by digital stethoscope and otoscope were supplemented by face-to-face visits for asthma education, spirometry, and venipuncture S. Simeone [37].

Another recent large-scale retrospective study by Bian et al. found a 21% relative decrease in emergency department utilization for asthma patients after three years of school-based teleconsultation in a rural community J. Bian et al [38]. The greatest reduction in emergency department presentations (35%) occurred in the final year of the study, implying that telemedicine programs may need to be phased in before their full benefits can be recognized K. V Blake [39].

The study that looked at the feasibility of using digital stethoscopes during telecardiology visits for infants with palliated congenital heart disease found that the digital stethoscope was easy for providers and caregivers to use, and caregivers found the visits reassuring. The digital stethoscope's auscultation of heart sounds and murmurs was equivalent to in-person examinations, with strong inter-rater agreement. The majority of visits resulted in comprehensive lung evaluations.

Providers felt that using a digital stethoscope aided medical decision-making and improved the overall quality of telemonitoring. There were no missed events, deaths, or false positives as a result of using a digital stethoscope that resulted in unnecessary emergency care visits. In certain cases, the digital stethoscope assisted in detecting substantial changes in murmurs, prompting immediate hospitalization and surgical surgery A. Stagg et al[40].

The workflow of tele-home care is extremely different. According to research on the TytoCare Platform, clinicians will use existing health gadgets (Tyto gadgets) to check physical ailments in real time by making video calls through an application. The doctor will immediately receive and read the findings of the physical examination. The results of this test can be followed up with additional clinical examinations performed face-to-face and the selection of the appropriate therapy A. D. Singh [41].

This procedure can also be used with a digital stethoscope. A digital stethoscope with an application can help clinicians and patients communicate more effectively on how to use the digital stethoscope, the results received, and what the patient should do based on these results. As a health device, the digital stethoscope will be immediately connected to the application, so that when the stethoscope is used, the auscultation findings are delivered to the doctor. If clinicians at the hospital require patient data to schedule additional clinical

examinations or to offer information, the data can be forwarded to the hospital and stored into the electronic medical record.

4. CONCLUSION

Through self-monitoring, tele-auscultation, and tele-homecare, digital stethoscopes are thought to be capable of assisting in the management of chronic diseases and conditions. Digital stethoscopes make it easy for patients to examine themselves so that they may find out their condition on a regular basis; also, digital stethoscopes promote health services that are more economically affordable, shorter in time, and can be done anytime and anywhere. Very important during a pandemic and aids people in remote places in monitoring their health problems, particularly those with chronic ailments or conditions that necessitate regular monitoring.

AUTHORS' CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: 1. Thareq Barasabha 2. Muhammad Abdul Raziq; Data collection: Ayu Cetiya Mahayekti; Analysis and interpretation of results: Ayu Cetiya Mahayekti; Draft manuscript preparation: 1. Ayu Cetiya Mahayekti, 2. Syifa Nuril 'Aini, 3. Muhammad Abdul Raziq, 4. Thareq Barasabha. All authors reviewed the results and approved the final version of the manuscript.

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