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### The Utilization of Telehealth/ Telemedicine In Cardiology In Rural Areas

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## **The Utilization of Telehealth/ Telemedicine In Cardiology In Rural Areas**

### **ABSTRACT**

*Introduction:* Telecardiology has been defined as a way of practicing cardiology through the utilization of telecommunications and a more cost-effective way to deliver cardiac care. As a subset of telemedicine, telecardiology has functioned to bring providers to underserved communities through technological mechanisms. Rural regions have turned to telemedicine and tapped into a network of clinical institutions exchanging practitioners and patients to emphasize value-based instead of volume-based care.

*Methodology:* The methodology of this qualitative study was a literature review having used mixed methodologies. Five electronic databases and government websites were utilized, and one semi-structured interview with an expert in cardiology was conducted. There were 34 sources referenced in the literature review.

*Results:* The research demonstrated how the utilization of telecardiology has increased access to care in isolated rural areas via resources such as smartphone apps and outreach sites.

Additionally, it was found that the use of non-invasive, wearable technology and other modern communication technologies presented a more cost-effective and efficient solution to expensive health care facilities, while allowing patients to remain comfortable in their home environments.

*Discussion/ Conclusion:* Telecardiology technology has shown to have positive impacts on access to care, the delivery process of care, and financial burdens of care for patients living in rural settings. Through telecardiology services, patients in rural areas have had higher frequencies of interaction with their cardiologist/healthcare provider.

*Key Words:* access, cost, effectiveness, telecardiology, telehealth, telemedicine.

## INTRODUCTION

Telehealth has been a term that was often used in conjunction with telemedicine. The Health Resources and Services Administration (HRSA) has stated that telehealth was the application of telecommunication technologies and electronic information for clinical health care from long distances, and health associated administration, education, and even public health. Some of the technologies that can be involved with and have assisted in telehealth have included: the internet, video conferencing, terrestrial and wireless communications, streaming media, and store and forward imaging (HRSA, 2019). The American Telemedicine Association (ATA), has defined telemedicine as the circumstances when a provider, who has been trained in the use of telehealth equipment, presented a patient by way of cameras to a licensed practitioner or non-licensed provider and conducted any hands-on services necessary for a successful experience (American Telemedicine Association, 2011).

As stated by Iskols (2018), various rural regions have struggled with lower incomes, higher tendency of engaging in unhealthy behaviors and a lack of access to various parts of the healthcare system, which has resulted in mortality rates higher than the national average in heart disease (17% higher, where the national average was 165.0 per 100,000 deaths) and COPD (27% higher, where the national average for all chronic lower respiratory diseases was 40.9 per 100,000 deaths). Further, telemedicine has functioned to bring providers to underserved communities through technological mechanisms (Iskols, 2018; Centers for Disease Control and Prevention [CDC], 2018). According to Marcin, Tujano, Sadorra, and Dharmar (2015), rural regions have turned to telemedicine and tapped into a network of clinical institutions exchanging practitioners and patients to emphasize value-based instead of volume-based care (Marcin, Shaikh, & Steinhorn, 2015). Live telemedicine, also referred to as synchronous telemedicine, has involved the

transmission of video and audio between videoconferencing units at the locations of patient and provider, and has been used for subspecialties such as cardiology, radiology, oncology, psychiatry, dermatology, ophthalmology, and many more (Marcin, Trujano, Sadorra, & Dharmar, 2009). Telemedicine initiatives have aided practices in rural areas to achieve many benefits in healthcare. The utilization of telemedicine has also allowed physicians to offer patients more on-demand care in those areas that are underserved. Because of telemedicine efforts, those patients who were homebound or living in rural areas have been capable of accessing care virtually. Further, new telemedicine technology has connected more of these patients with their providers than had ever been connected previously (eVisit, 2018).

Telecardiology has been defined as a way of practicing cardiology through the utilization of telecommunications and a more cost-effective way to deliver cardiac care (IGI-Global, 2019). An article by Raikhelkar and Raikhelkar (2015) indicated that Telecardiology was one of the fastest growing fields within the scope of telemedicine (Raikhelkar & Raikhelkar, 2015). Due to the use of IT, advancements in telecardiology have been extraordinary from 2003 to 2013 due to the continued use of mobile devices and further implementation of cloud computing, which has been indicated to inexpensively broaden collaboration of Telecardiology (Hsieh, Li, & Yang, 2013). The HITECH Act aimed to reduce rehospitalizations through meaningful use and improved technology have heightened the interest of cardiologists across the United States (U.S.) to provide telemedicine through remote visits, exams, consultations and even continuous monitoring through implantable devices (Gold & McLaughlin, 2016; Kuehn, 2016; U.S. Department of Health & Human Services [HHS.gov], 2017). Telemonitoring of symptoms and physiological data for patients with heart conditions has been done either manually or automatically; It was considered manual when the data was received and interpreted by healthcare professionals, but when the data

was assessed by specific software at a monitoring center, it was considered automatic (Piotrowicz et al., 2016). Nguyen and Silva researched a smartphone-enabled electrocardiogram (ECG) device in conjunction with a smartphone app that was recognized for having given patients the ability to capture and transmit information from a single-lead ECG directly to their physicians (Nguyen & Silva, 2016).

The purpose of the research was to determine whether Telehealth/Telemedicine technologies for Cardiology have had a positive impact on access and delivery of care for individuals living in rural areas; As well as whether it has had a positive impact on cost efficiency of care and the ability of Telecardiology patients from rural areas to afford and receive the level of care that is necessary.

## METHODOLOGY

The hypothesis for the research was that telecardiology technology has had a positive impact on access to care, the delivery process of care, and financial burdens of care for patients living in rural settings, so that those patients in rural areas would have higher frequencies of interaction with their cardiologist/healthcare provider.

The conceptual framework for this research adhered to the processes and research framework utilized by Yao, Chu, and Li (2010), and can be seen in Figure 1. This framework illustrates the application of telemedicine/ telehealth in determining a positive or negative impact from the utilization of telecardiology in rural areas. The literature review was conducted by SN and JS and validated by AC, who functioned as a second reader and confirmed that the references utilized in this research study met the criteria for inclusion.

### *Step 1: Literature Identification and Collection*

A literature review was used to investigate the variables and how utilization of telehealth and telemedicine have influenced them. The gathering of reviewed literature was conducted through search of scholastic databases such as PubMed, EBSCOhost, ProQuest, Google Scholar, and Google. Government websites were also used in this search. Terms utilized to search in these databases included: “Telehealth”, OR “Telemedicine”, OR “Telecardiology”, OR “Access” OR “Cost”, OR “Effectiveness.” To analyze the role that telemedicine/ telehealth variables have played in expansion and utilization of health services related to cardiology in rural areas, a semi-structured interview, which had been approved by the Marshall University IRB on October 09, 2019, was conducted with an expert who was fluent in the efforts and on the utilization of telecardiology in rural areas. The interview was done in person at the office of the interviewee and was not audio recorded. I began with the expert reading through, going over, and signing the consent document with the co-investigator. It contained 6-8 questions, where the set of questions depended on whether the expert had used Telecardiology technologies prior to the interview (See Appendix 1).

### *Step 2: Literature Analysis*

The search was limited to peer reviewed articles written in English and published between the years 2009 and 2019, in order to acquire current research and data. The articles were then examined for relevance to the utilization of telecardiology methods and tools, effect of quality of care delivered via these methods, as well as other variables of interest related to telecardiology and rural health. The search yielded over 50 articles and periodicals, with a total of 30 being chosen to include in the research.

Using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method, the search established [49] pertinent articles. Articles were excluded (N=24)

if they did not meet the inclusion criteria. Articles were included (N=11) if they could appropriately augment further discussion on the main topic and important variables. References from other sources (N=9) were also included in the search. The [34] references included were subject to full text review and were included in the data abstraction and analysis (see Figure 2). Only [11] references were used in the results section (Moher, Liberati, Tetzlaff, Altman, The PRISMA Group, 2009). (see Figure 2).

## RESULTS

### *Access to Care and Utilization of Telecardiology Technology*

A smartphone app has been developed that used the lightsource and camera of a phone to attain a photoplethysmographic recording of the pulse wave in order to detect potential Atrial Fibrillation (AF), which was the same concept used to detect heart rates in exercise and fitness devices (Freedman, 2016). Eagle Telemedicine indicated that cardiac problems have tended to be the number one reason for patient transfers from small hospitals, while often, all that was required was a consultation, which could have been conducted through telemedicine (Eagle Telemedicine, 2019). Rocha (2014) highlighted a program in Iowa focused on providing echocardiograms to patients in rural areas and those who did not live within a reasonable driving range of expert cardiologists. The program established 24 outreach sites where patients with heart conditions could have ultrasounds conducted and sent to the program's central hub, where an expert cardiologist would review the exam, diagnose, and suggest treatment for the patient (Rocha, 2014). Additionally, Gruca, Pyo and Nelson (2016) found that as of 2016, 45% of cardiologists in Iowa had participated in a rural outreach program. There was also a significant difference in the travel times for patients from all rural census tracts, where those visiting a primary cardiologist location

or an outreach location 1 or more times had an average time of 14.7 minutes  $\pm$ 11.0-, and those visiting 4 or more times had an average time of 19.5 minutes  $\pm$ 14.3- (Gruca, et al., 2016).

#### *Delivery of Care for Telecardiology Patients*

Inglis et al. (2010) discovered positive impacts on heart failure rehospitalizations with a telemonitoring intervention compared to usual care, where the risk ratio was 0.71 and confidence interval (using a 95% confidence) was 0.60 to 0.83 (Inglis et al, 2010). It was found by Lin et al (2010) that the accuracy for a remote wireless ECG in detecting AF episodes were 92.83% and 94% accurate for the two algorithms used in the detection system (Lin et al., 2010). A research study by Ong et al. (2016) focused on the effectiveness of Remote Patient Monitoring (RPM) for care transition in adult patients with heart failure found no significant difference in the patient readmissions for 180-days. Those who received the remote monitoring intervention had readmission rates of 50.8%, while those who did not receive the intervention had readmission rates of 49.2% (Ong et al., 2016). Additionally, Chaudhry et al (2010) found no statistical significance in the readmission and death rates between a telemonitoring group and a usual-care group of HF patients. In the study, readmission rates were 49.3% for telemonitoring and 47.4% for usual care, while the death rate for telemonitoring was 11.1% and 11.4% of usual care (Chaudhry et al., 2010).

#### *Cost Effectiveness for Telecardiology Technology Utilization*

Majumder, Mondal, and Deen (2017) indicated that the use of non-invasive, wearable technology and other modern communication technologies presented a more cost-effective and efficient solution to expensive health care facilities, while allowing patients to remain comfortable in their home environments (Majumder, et al., 2017). Sohn et al. (2012) discovered a significant difference of 25% lower cost for those with mild HF symptoms involved in a “Telemedicine for the Heart” program (Sohn et al., 2012). On the other hand, Klersy et al. (2011) found there to be a

progressive linear increase in cost savings as the adoption of RPM devices increased until at least the 50% adoption mark. This was found through a budget impact analysis conducted in Europe. Figure 3 shows this linear increase for the categories of the lowest, median, and highest DRG tariffs. Each beginning at 0% and €0, the three categories are shown to rise consistently until at least 50% adoption of RPM; At 50% adoption, the categories are shown at savings of about €150, €250, and €450. (Klersy et al., 2014).

## DISCUSSION

The purpose of this research project was to examine the utilization of telehealth/ telemedicine in the delivery of healthcare within the cardiology subspecialty in rural areas. The results elucidated the accessibility of care via telecardiology, as well as quality of care, and the financial impact of having used telecardiology within rural populations.

Based on the results of this study, smartphone apps have proven to be an effective tool in the collection of information used to detect abnormal cardiac arrhythmias. The results have also shown that the utilization of telecardiology in rural areas has expanded access to patients by having established outreach sites in remote areas. The purpose of these outreach sites has been to serve as a location used to collect and communicate diagnostic data to cardiac specialists. In addition, it was indicated that although there have been positive benefits for using at-home monitoring programs for cardiac patients, telemedicine for cardiac patients, there has not been substantial benefits in the process of care delivery for these patients. When it came to the cost effectiveness for utilizing this type of care, research demonstrated that Telecardiology Technology use has been successful in increasing cost savings for care.

The field of telemedicine has been evolving to meet the demands of today's ever-changing healthcare system (Vogenberg & Santilli, 2018). The literature review has suggested that the advancement of technology has enabled widespread accessibility and affordability to those in both rural and urban areas via technological means such as computers, smartphones, apps, and designated devices. With the vast variation in types of mobile devices and tools available, more patients are able to track and monitor their health status more efficiently. In regard to the delivery of care, telemedicine has been traditionally used to treat patients who were in remote areas with limited access to healthcare facilities. Telemedicine has also addressed the issue of shortage of providers in rural areas and has become a common method of patients for obtaining convenient healthcare services.

It has been argued that monitoring is not a treatment but more so an alternative method for systematically organising effective care (Clark, Inglis, McAlister, Cleland, & Stewart, 2007). Therefore, the programmes that have offered remote monitoring have not been deemed as adequate substitute for specialist care (Jaarsma, et al., 2006). There has also been speculation that the lack of face-to-face interaction will negatively impact the establishment of patient-provider relationships. This can be attributed to the growth in physician's availability on telemedicine platforms. On these platforms patients have the option to search and choose which provider they wish to interact with. Patients will also have access to their provider profiles which includes information such as education, experience, relevant details to their services offered, and patients can even view provider ratings. With so many options of providers to see, and their on-call availability it will have become very common for patients to see multiple providers as needed for each time they visit instead of routinely seeking service from a previously established provider.

### *Semi-Structured Interview*

It was first established that the expert has implemented at least one form of telemedicine technology in to their practice. It was indicated that telemedicine technology was implemented after the expert and others at the practice had been approached by telemedicine companies. The expert indicated that the most commonly used form of telemedicine was a device for post-cardiac surgery that is taken to the patient's home by a nurse; The nurse taught patients to use the device, then the patient was able to hook up to the device each day, and the device transmits the patient's vital information to the nurse. The expert indicated that this technology has made the treatment of post-surgery patients easier in terms of treating issues more quickly and reducing readmission rates. Further, this has changed the way the expert's practice was run due to the ability to be aware of issues earlier and correcting them promptly. The expert speculated that about 90% of their patients have used this technology, but did not expand on the amount of patients from rural areas. The expert also did not comment on cost impacts, as they generally have little to do with billing and cost areas.

### *Limitations*

The limitations of this literature review are attributed to the following reasons. There were only six databases used to obtain the information regarding telemedicine and cardiology which was used to supply the content of this paper. In addition, more information needs to be collected and published on the use of telemedicine/ telehealth in regard to the scope of research involving telecardiology in rural areas. Finally, researcher and publication bias can not be excluded.

### *Practical Implications*

As a result of the shortage of healthcare providers and the increased need for accommodating care, there has been an incline in the need for more telemedicine companies than before. Telemedicine platforms have been offering 24/7 on-call services to accommodate the

patient populations they serve in both urban and rural areas. However, when patients shift to virtual care services provided with telemedicine, this can decrease the viability for clinics and small facilities in rural areas that have been already struggling to remain sustainable. Thus, a widespread adoption of telemedicine services can negatively impact the communities.

### CONCLUSION

The primary hypothesis of this qualitative study has been supported by the literature review. Telecardiology technology has shown to have positive impacts on access to care and the financial burdens of care for patients living in rural settings. However, there have not been significant positive impacts for the delivery process of care. Through telecardiology services, patients in rural areas have had higher frequencies of interaction with their cardiologist/healthcare provider.

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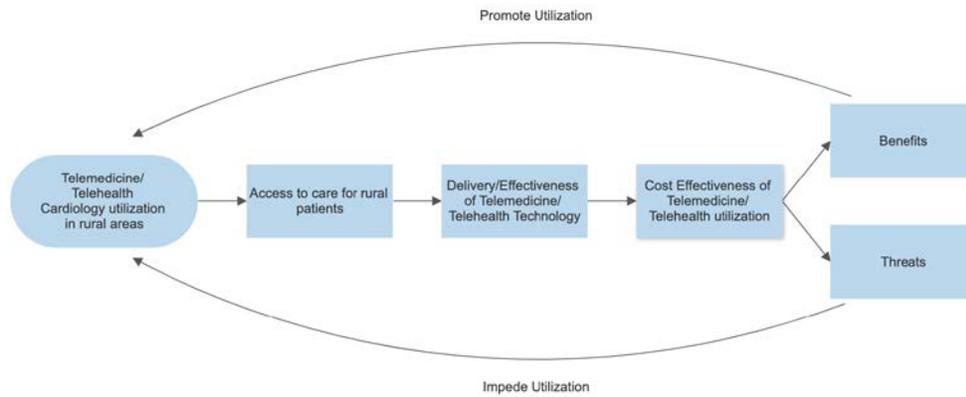
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*Figure 1.* Conceptual Framework created by investigators using SmartDraw and adapted from that of Yao, et al (2010) (Yao et al., 2010; SmartDraw, 2019).

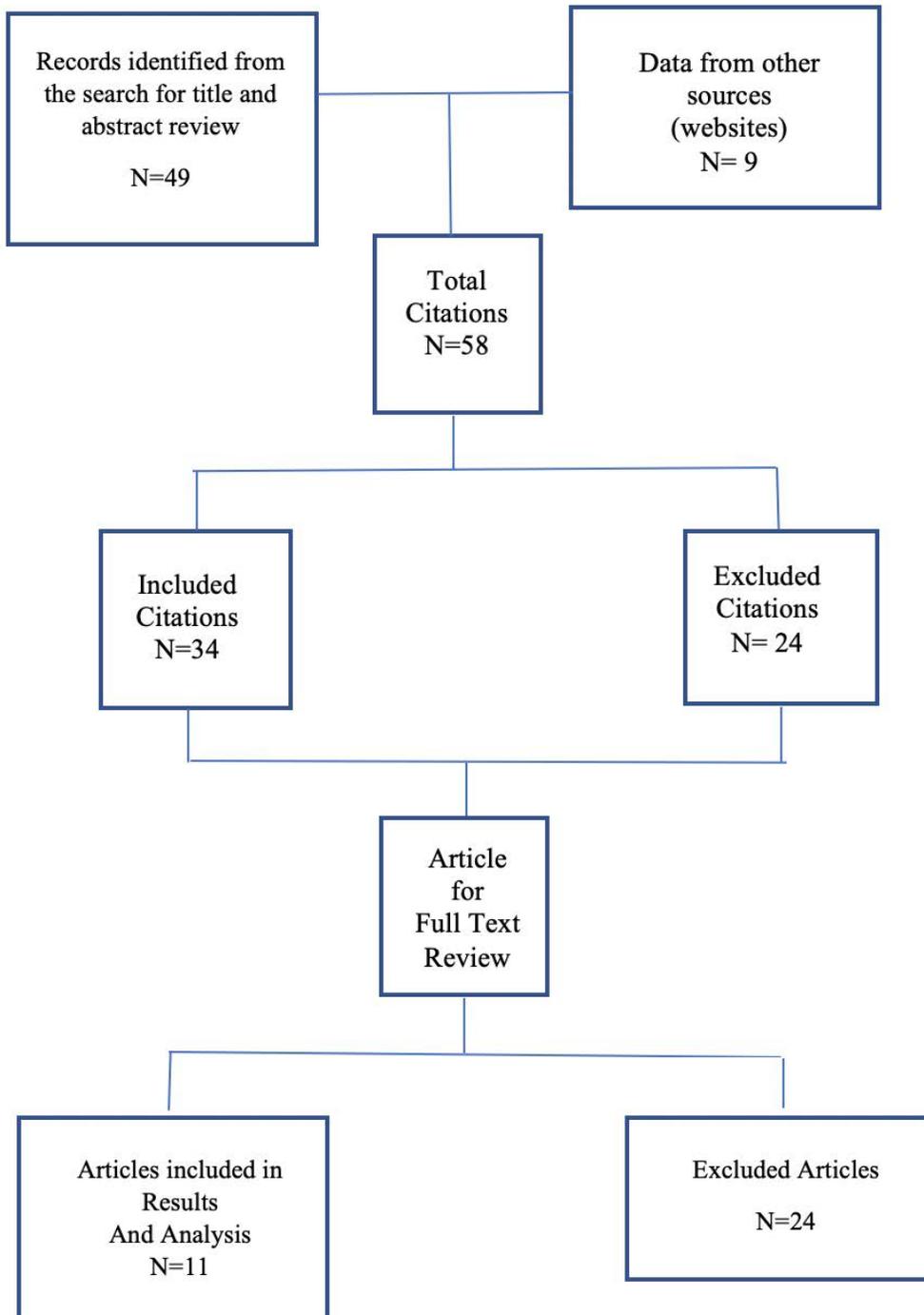


Figure 2: Overview of Literature Evaluation adapted from Moher, Liberati, Tetzlaff, Altman, The PRISMA Group (2009) For more information, visit [www.prisma-statement.org](http://www.prisma-statement.org).

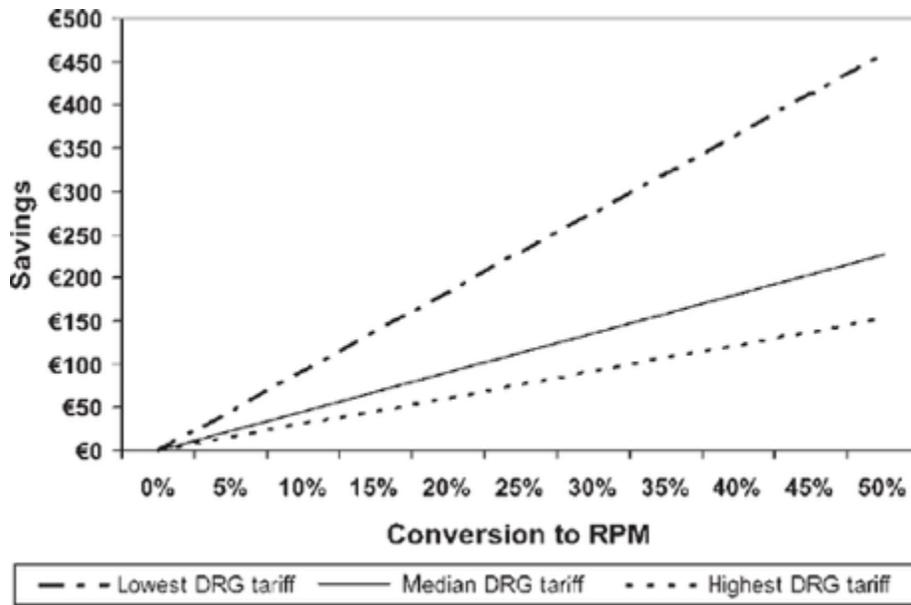


Figure 3. Budget Analysis for RPM Adoption. This figure demonstrates the linear increase in cost savings associated with RPM adoption from (Klersy et al., 2011).

## APPENDIX A

Questions from the semi-structured interview with the expert, conducted on (month,date, 2019)

- Have you implemented any forms of telemedicine technology into your practice?
  - If yes:
    - How did you first implement telemedicine into your cardiology practice?  
Why?
    - What modes for treating patients via telemedicine have you used? Why?
    - Which mode of telemedicine to prefer the most for treating your patients?  
Why?
    - How many patients, if any, have you treated via telemedicine who were from rural areas? Why/Why not?
    - How has the utilization of telemedicine/telecardiology impacted the cost of care for your patients? Why?
    - What features in technology could make the utilization of telecardiology easier and/or better? Why?
    - Has the utilization of telecardiology changed the way you run your cardiology practice in general? Why/Why not?
  - If no:
    - Has there been a specific reason that you have not implemented telemedicine into your practice? Why?
    - Do you plan to implement telemedicine technology into your practice in the future? Why?
    - Which form of telemedicine technology would you most look forward to implementing? Why?

- Do you believe that any of your patients (especially those living in rural areas) would benefit from the use of telemedicine? Why?