

# THE ROLE OF TELECARDIOLOGY IN DEALING WITH PATIENTS WITH CARDIAC RHYTHM DISORDERS IN FAMILY MEDICINE - SYSTEMATIC REVIEW

## VLOGA TELEKARDIOLOGIJE PRI OBRAVNAVI BOLNIKOV Z MOTNJAMI SRČNEGA RITMA V DRUŽINSKI MEDICINI - PREGLED LITERATURE

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Received: Nov 23, 2019

Accepted: Mar 2, 2020

Review article

### ABSTRACT

#### Keywords:

telecardiology, primary healthcare, cardiac rhythm disorders, cost effectiveness

**Purpose:** Heart rhythm disorders (HRD) are often present in patients visiting their family physician (FP). Dealing with their problems is not always simple, efficient and cost effective. The aim of this paper is to review the existing literature about the use and experience of telecardiology in patients experiencing HRD.

**Methods:** We conducted a review of literature in PubMed biographical databases (MeSH thesaurus), Web of Science and Cochrane, between 1995 and 2019. We included original articles in English that describe the use of telecardiology at primary and secondary healthcare levels. Exclusion criteria are those publications that discuss heart failure or observation of the activity of pacemakers or defibrillators and the age of patients under 18 years. A total of 19 papers met the inclusion criteria, thirteen of them were original scientific articles and we included them in the analysis.

**Results:** Use of telemedicine can shorten the time from diagnosis to the necessary treatment (2/13), telemedicine can reduce mortality in patients with acute myocardial infarction (4/13), it can shorten the time to diagnose atrial fibrillations (4/13), it can help determine the diagnosis for patients complaining about heart rhythm disorders which were not detected on the standard ECG recording (2/13) and can also help identify cardiac causes for syncope or collapse (2/13). All studies have confirmed that the use of telecardiology significantly reduces the number of unnecessary referrals to a cardiologist or hospitalization, and shortens the time needed to treat patients with life-threatening conditions.

**Conclusion:** The use of telecardiological techniques increases the quality and safety of work in managing patients with cardiovascular disease in FP practice. Usage of telecardiologic devices can also save money and bridge the gap between the primary and secondary healthcare levels.

### IZVLEČEK

#### Ključne besede:

telekardiologija, primarna zdravstvena oskrba, motnje srčnega ritma, stroškovna učinkovitost

**Namen:** Bolezni srčnega ritma (BSR) so pogoste težave posameznikov, ki obiščejo svojega družinskega zdravnika (DZ). Obvladovanje njihovih težav ni vedno preprosto, pričakovano in stroškovno učinkovito. Namen tega prispevka je pregledati obstoječo literaturo o uporabi telekardiologije in izkušnjah bolnikov z motnjami srčnega ritma z njo.

**Metode:** Pregledali smo literaturo v biografskih bazah PubMed (MeSH tezaver), Web of Science in Cochrane, objavljeno med leti 1995 in 2019. Kriterijem vključitve je ustrezalo skupno 19 prispevkov. Vključitveni kriteriji so obsegali originalne znanstvene članke, ki opisujejo uporabo telekardiologije na primarni in sekundarni zdravstveni ravni. Izključitveni kriteriji so bili obravnava bolnikov s srčnim popuščanjem, delovanje pacemakerjev in vgrajenih defibrilatorjev ter starost bolnikov, nižja od 18 let. Trinajst prispevkov je bilo originalnih znanstvenih člankov in smo jih vključili v analizo.

**Rezultati:** Uporaba telemedicine lahko skrajša čas od diagnoze do potrebnega zdravljenja (2/13), telemedicina lahko zmanjša smrtnost pri bolnikih z akutnim miokardnim infarkt (4/13), lahko skrajša čas za diagnozo atrijskih fibrilacij (4/13), lahko pomaga postaviti diagnozo bolnikom, ki tožijo zaradi motenj srčnega ritma, ki niso bili odkriti na standardnem posnetku EKG (2/13), in lahko pomaga pri iskanju kardialnih vzrokov sinkope oziroma omedlevice (2/13). Vse študije so potrdile, da uporaba telekardiologije znatno zmanjša število nepotrebnih napotitev h kardiologu, zmanjša število hospitalizacij in skrajša čas zdravljenja bolnikov z življenjsko nevarnimi stanji.

**Zaključek:** Uporaba telekardioloških tehnik povečuje kakovost in varnost dela pri obravnavi bolnikov s kardiovaskularnimi težavami v praksi DZ. Uporaba telekardioloških pripomočkov lahko tudi prihrani denar in odpravi vrzel med primarno in sekundarno ravni zdravstvene oskrbe.

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## 1 INTRODUCTION

In Europe, 50% of all deaths occur due to cardiovascular diseases (1). In 2016, cardiovascular diseases were a cause of 40% of all deaths in Slovenia, 47% of women's deaths and 32% of men. When talking about cardiac diseases there are three main causes of death: acute myocardial infarction, arrhythmia and heart failure. The age-standardized mortality rate in Slovenia had surpassed the European average in the eighties and nineties of the previous century. However, this difference has been decreasing since 2000 and is getting closer and closer to the European average (2). In terms of the causes of primary care visits, cardiac diseases represent 5.60% of the total number of visits, i.e. 283,143 medical check-ups. Cardiac diseases are the seventh most common cause for visits to the family medicine physician (FP) (3). This data shows that medical service expenses related to cardiovascular diseases are high. Arrhythmia affects millions of people each year. Some types of arrhythmia are hard to diagnose as they occur sporadically, whereas others do not present any danger for health (e.g. supraventricular extrasystole (SVES) or paroxysmal supraventricular tachycardia (PSVT), but they can still cause symptoms and discomfort to patients. On other hand, there are still some life-threatening arrhythmias, such as ventricular tachycardia (VT), which can significantly affect patient's health (4, 5). In everyday practice doctors are still using the common methods, such as referring patients to a cardiologist and/or recording an ECG, when treating patients without having the opportunity to access the modern technology in this field of medicine. The other methods, e.g. an ultrasound, an MRI/CT scan or a scintigraphy require a specialist's time, are very expensive and the waiting time is long. Considering the dimension and the severity of the problem, the need for cheaper yet reliable continuous monitoring of the cardiovascular system has arisen. Telemedicine is a concept that describes telecommunication and information technology with the purpose of providing medical help remotely. With the help of information and communications technology, it enables medical service when the healthcare provider and patients are not in the same place geographically. It helps to minimize the distance and improves access to medical service that is not always available in remote rural areas. The early form of telemedicine included the telephone and the radio, while in modern times video calls and more progressive diagnostic methods are available in various mobile apps, and telemedical devices have become more and more popular (6). The use of what is called eHealth, which could be considered a part of telehealth, lies in its ability to access medical data while not being limited to a specific location (7). The use of eHealth has been increasing in recent years, especially low-cost sensors that trace various physiological parameters, such as

body temperature, heartbeat and blood pressure (8). Within digital health, mHealth (mobile Health) involves all applications of telecommunications and multimedia technologies for the delivery of healthcare information. mHealth refers to the practice of medicine supported by mobile devices such as mobile phones, tablets, personal digital assistants and the wireless infrastructure (9).

Digital technology is becoming an increasingly important tool for a family physician, especially in communication with patients and colleagues, with the presumption that connections in the telecommunications network are secure enough for the exchange of sensitive data in the form of text, sound, image or other information transmission (10). With the help of these transferred data, a physician can treat or control the course of treatment, advise certain diagnostic methods and prevent deterioration in the patient's condition (11).

Telecardiology is a specialized version of telemedicine, which is a newer method of managing patients with suspected or known cardiac problems (12); it allows FP's direct access to consultant specialists by forwarding the ECG records via telephone or wireless connection (13). Through its use, the quality, speed and cost-effectiveness of treating patients with cardiovascular problems on the primary level can be improved.

The purpose of this article is to evaluate the state of activity in telemedicine on the primary level in Slovenia and around the world and to review the existing literature about the use and experience of telecardiology at the primary healthcare level, to see where and if there is an opportunity of improvement and further research.

## 2 METHODOLOGY

### 2.1 Database

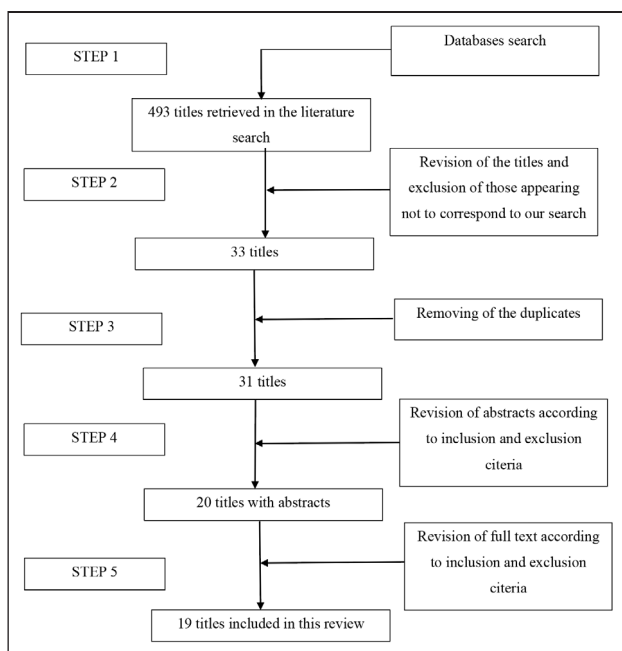
We performed a literature search using PubMed (1995-2019; thesaurus MeSH), Web of Science (1995-2019) and Cochrane (1995-2019). We used the following terms: Telemedicine AND Primary Healthcare OR Healthcare AND Cardiac rhythm disorders AND Cost effectiveness. The search was limited to English-language articles. We searched within the title, abstract and keywords.

Original articles and systematic reviews which describe the use of digital techniques in cardiology (telecardiology), especially with adults that suffer from cardiovascular diseases such as heart rhythm disorders or chest pain, were included in the review.

### 2.2 The Course of Choosing Academic Publications

Out of all the publications, there were only six that discussed the use of telecardiology in primary healthcare, and for this reason we also included the secondary healthcare level. Publications that discuss heart failure or

observation of the activity of pacemakers or defibrillators were not included. Another exclusion criterion was the age of patient under 18 years. The search strategy consisted of five steps. In the first step, we performed a search in the databases according to search terms. In the second step, we reviewed the titles and excluded those appearing not to correspond to our search terms. Removing of duplicates was the third step. The abstracts of the remaining articles were reviewed in the fourth step. The abstracts that did not meet the inclusion criteria were excluded. In the fifth step, we reviewed the full text of the remaining articles and excluded those that again did not correspond to the type of study eligible for our review under our inclusion and exclusion criteria. Nineteen articles were included, from which thirteen were original articles and six of them were systematic reviews. The results of the thirteen original articles were analyzed and the findings were summarized (Figure 1).



**Figure 1.** The course of choosing academic publications that were included in the research and analysis.

### 3 RESULTS

A total of nineteen articles were included in this review after applying the search strategy (Figure 1). Six of the articles were systematic reviews dealing with telecardiology and its cost-effectiveness only on the primary as well as on other levels of healthcare (Table 1).

**Table 1.** Number of academic publications considering the search term from the database of publications.

Search term	Number of results			Number of publications included in the analysis
	PM	Coch	WS	
Telemedicine AND Primary Healthcare AND Cardiac rhythm disorders AND Cost effectiveness	5	0	8	6
Telemedicine AND Healthcare AND Cardiac rhythm disorders AND Cost effectiveness	29	32	419	13
<b>TOTAL</b>	<b>34</b>	<b>32</b>	<b>427</b>	<b>19</b>

Legend: PM - PubMed; Coch - Cochrane; WS - Web of Science

The authors of included articles (Table 2) used different ECG accessories to establish the heart's activity. Its values provided us with information about coronary circulation (14-16, 18) and hearth rhythm (17, 19-26). With the help of telemedicine, i.e. telecardiology, the collected data and information were forwarded to a person in another location, who was more competent in this field and could provide quicker and more effective treatment for the patient.

**Table 2.** Authors, number of participants, study type, use of accessories and research fields in analyzed original articles.

First author	Year	Country	Number of participants	Study type	Accessory	Research field			Reference
						HRD	STEMI	Syncope	
Scalvini	2002	Italy	952	Prospective, randomized study	Portable ECG		*		(14)
Lieberman	2006	United Kingdom	3.259	Prospective, case control study	Stationary ECG		*		(15)
Sorensen	2007	Denmark	759	Prospective, randomized study	Stationary ECG		*		(16)
Leijdekkers	2009	Australia	200	Prospective, case control study	Wireless ECG sensor	*			(17)
Chan	2012	Canada	594	Prospective, randomized study	Stationary ECG		*		(18)
Orchard	2014	Australia	88	Quantitative study	Wireless ECG sensor	*			(19)
Brunetti	2014	Italy	109.750	Cost analysis study	ECG record	*			(20)
Klein-Wiele	2016	Germany	184	Retrospective, cross-sectional study	Stationary ECG	*			(21)
Halcox	2017	United Kingdom	1001	Retrospective, randomised controlled trial	Wireless ECG sensor	*			(22)
Rozena	2018	United States of America	98	Prospective, single-center study	Wireless ECG sensor	*			(23)
Bumgarner	2018	United States of America	100	Prospective, non-randomized, adjudicator-blinded study	Stationary ECG vs Wireless ECG sensor	*			(24)
Sutton	2018	United Kingdom, Germany	177 physicians	Quantitative study, comparative assessment	Stationary ECG vs insertable cardiac monitoring			*	(25)
Benditt	2019	United States of America	199 physicians	Quantitative survey	Stationary ECG vs insertable cardiac monitoring			*	(26)

The effect of telemedicine on the time span from diagnosis of myocardial infarction to the necessary treatment was explored by Scalvini. He divided the time from the moment of experiencing chest pain until reperfusion of the myocardium with the help of PCI (percutaneous coronary intervention) in three groups: from the beginning of the pain to the decision to seek medical help; from the moment of this decision to actually visiting a physician and finally from the visit to the PCI (14). A total of 200 emergency physicians, who were sending their ECG records via telecommunication networks to 22 cardiologists, participated in this research. They found out that the time from the actual visit at the physician's office to the PCI can be significantly reduced with the help of this technology. The same study indicated that also the number of referrals was reduced, with 74% of patients not needing any further treatment. Lieberman came to similar findings. His research was carried out on 3259 patients, who were divided into an intervention and a control group (15). He found that 58% of the participants in the intervention group were referred to a cardiologist right after the emergency physician carried out the ECG recording. In the control group they were able to have a

teleconsultation with a cardiologist and that gave them the opportunity to treat 90% of patients by themselves without having to refer them to specialists. In this study it was pointed out that the costs can be significantly reduced if teleconsultation is used, because fewer patients would be referred to a specialist.

With the help of telecardiology, Sorensen also tried to reduce the time taken from the patient's home to the hospital with a Cath Lab (16). He included 13 ambulances and their patients with a suspicion of acute myocardial infarction. These ambulances were equipped with an ECG recording device that was sending the records directly to a cardiologist via telephone lines. In the first six months of use they treated 11% of patients with STEMI (ST-Elevation Myocardial Infarction) and after that the numbers went up to 73%. In other words, patients were directly referred to the PCI without being treated in the hospital. The study has proven that even patients that live far away from the hospital can be treated appropriately and with the same quality as those living near the hospital.

All the described studies included patients with chest pain and suspicion of acute myocardial infarction (14-16),

whereas Chan tried to find out whether telecardiology can reduce the mortality of patients after STEMI (18). He was interested in the one-year survival in patients with STEMI after PCI; the research included 594 patients. After calling the emergency service, the patients were divided into two groups. One group followed the common protocol of treating a patient with STEMI, whereas the other 167 patients were treated with the help of an ECG algorithm to establish the diagnosis of acute myocardial infarction. All patients were sent to the Cath Lab and were treated there. After one year, they found out that patients who were treated with the help of the ECG algorithm, got treatment sooner and that their mortality was reduced by 62% in comparison to the control group. Klein-Wiele carried out a study with the purpose of establishing the actual number of patients presenting with palpitations that actually have heart rhythm disorders. In his study, he included patients that were complaining about chest pain and those with palpitations. Twelve FP participated in this study, which was carried out in Germany (21). Patients had to be in the sinus rhythm during the treatment and had to have complains about palpitations in their medical history. The study established that 61.4% of the patients did not have any HRDs. In 14.7% of cases it was paroxysmal atrial fibrillation and in 6.5% ventricular tachycardia. In 88.7% of all patients, their FP changed their pharmacotherapy, whereas 26.8% were referred to a psychotherapist. 2.8% of the patients were treated with cardioversion and one patient had a Cardioverter Defibrillator (ICD) implanted.

Some studies were also carried out to assess the satisfaction of physicians as well as patients with the use of telemedical equipment (15-17, 13). Leijdekkers conducted a similar study. He compared the usefulness of the ECG sensor in comparison to the standard Holter monitor (17). Cardiologists included in the study patients with a low risk of heart rhythm disorder. Patients had to carry the sensor for one day and after that they only had to use it in case of a strange feeling in their chest. They had to return the device after two to four weeks. Additionally, they had to answer a questionnaire about how they would rate the usefulness of the sensor and simplicity of handling it. A total of 21 out of 47 patients had already carried a Holter monitor in their past and they answered that (89.3%) the sensor is handier, and its use is simpler (90.5%). In the rest of the studies, physicians had to fill out a questionnaire about satisfaction with different methods of telecardiology (15, 16, 19). Mostly they were satisfied, because the treatment was quicker and more effective.

In assessing atrial fibrillation (AF) 4 studies used a wireless ECG sensor. Orchard used an innovative iPhone ECG - an iECG sensor which operates with Apple iPhones and aims to diagnose atrial fibrillation in seemingly healthy persons older than 65 years (19). She included three ambulances, in which nurses made screening tests with patients older

than 65 years before the actual check-up at the doctor. This test lasted for about 30 seconds and the recording was sent via wireless network to a validated algorithm, which showed whether the atrial fibrillation is present or not. Before the patient visited the physician, they already had received this information. During the screening test, 19% of the 88 participants had atrial fibrillation.

Halcox (22) conducted a trial of AF screening using an AliveCor Kardio monitor attached to a Wi-Fi-enabled iPod in 1001 patients divided into two groups; 19 patients were diagnosed with AF versus 5 in the control group. He concluded that screening twice weekly with this method is more likely to identify incident AF. Similarly, Rozena (23) used Cardiiio Rhythm Mobile Application for AF detection. The application correctly identified 93.1% of AF and showed promising potential in accurate detection of AF. Bumbarner compared Kardia Band with Apple Watch to a 12-lead ECG (24). His reports were similar to Rozena's, the device showed 93% sensitivity and 84% specific in accurately differentiated AF from sinus rhythm.

All studies emphasized that the use of telemedicine is beneficial, but Brunetti was interested in the costs surrounding telemedicine (20). The cost-analysis was carried out with patients who had called the emergency service at a certain time. Paramedics had a 12-lead ECG that they used for the diagnostic approach. This ECG report would be sent via mobile phone connection with a telemedical centre; therefore, the cardiologist could see the record. If the patient had STEMI, he was immediately transferred to PCI. At the time of this research, they recorded 109,750 ECGs. They compared the costs of the teleconsultation with those of receiving the patient at the hospital and then transferring them to PCI. They found out that the final price for treating one patient can vary from EUR 8.10 to EUR 38.4 for one treatment. The treatment provided with telemedicine was cheaper.

Sutton (25) and Benditt (26) were interested in cardiac rhythm disorders in patients experiencing syncope or collapse. The guidelines recommend the use of Holter monitoring when syncope or collapse recurrence is daily and wearable monitors for those recurring monthly (27). Sutton took a survey of 177 participants, emergency doctors (ED) and cardiologists from Germany and the United Kingdom (25). Among ED, 20% from the UK and 31% from Germany chose diagnostic ambulatory electrocardiogram monitoring rather than Holter monitoring when dealing with patients having daily symptoms; but when treating patients for infrequent events (less than 1 per month) 15-30% of them chose Holter monitoring and only 50% selected an insertable cardiac monitor. For cardiologists, 6% from the UK and 10% from Germany did not choose Holter for daily symptoms but for infrequent symptoms, and 80% would select an insertable cardiac monitor. He concluded that in evaluating syncope or collapse, most

physicians use diagnostic ambulatory electrocardiogram monitoring according to the guidelines. Benditt conducted similar research in the United States of America and he interviewed 199 doctors of different specializations (26). Responders reported that 17-23% syncopes have cardiac cause and 25% chose ambulatory electrocardiogram

monitoring rather than Holter for daily events, but for less frequent events 12-18% would choose a Holter, 20-34% a conventional or a mobile cardiac telemetry system and 53-65% an insertable cardiac monitor.

**Table 3.** Principal findings.

Reference	Topic, study question	Sample size	Methods	Main results	Level of healthcare		
					Pri- mary	Second- dary	Both
(14)	Can telemedicine shorten the time from diagnosis of acute myocardial infarction to the necessary treatment?	200 emergency physicians, who were sending their ECG records via telecommunication networks to 22 cardiologists	They divided the time from the moment of experiencing chest pain until reperfusion of the myocardium with the help of PCI in three groups: from the beginning of the pain to the decision to seek medical help; from the moment of this decision to actually visiting a physician and finally from the visit to the PCI	The time from the actual visit at physician's office to the PCI can be significantly reduced with the help of this technology and 74% of patients were not in need of further treatment.			*
(15)	Can telemedicine shorten the time needed from visit to FP to cardiologist in the case of acute myocardial infarction?	3259 patients, who were divided into an intervention and a control group	Participants in the intervention group were referred to a cardiologist right after the emergency physician carried out the ECG recording. In the control group they had a chance of teleconsultation with a cardiologist	58% in the intervention group were referred to a cardiologist, in the control group they treated 90% of patients by themselves without having to refer them to specialists.	*		
(16)	Can telecardiology reduce the effect of the patient being distant from the hospital with a Cath Lab?	13 ambulances and their patients with suspicion of acute myocardial infarction.	Ambulances were equipped with an ECG recording device that was sending the records directly to a cardiologist via telephone lines.	At first, they treated 11% of patients with STEMI and after a period of time, the number went up to 73%.			*
(17)	Is the ECG sensor more user friendly in comparison to the standard Holter monitor?	47 patients	Personal Health Monitor sensor versus Holter monitoring	21 of 47 patients already had carried a Holter monitor in their past and they answered that (89.3%) the sensor is handier, and its use is simpler (90.5%).			*
(18)	Can telecardiology reduce the mortality of patients with acute myocardial infarction?	594 patients with STEMI after PCI	After calling the emergency service, the patients were divided into two groups. One group followed the common protocol of treating a patient with STEMI, while the other 167 patients were treated using the ECG algorithm to establish acute myocardial infarction.	The patients who were treated with the help of ECG algorithm, got treatment earlier and this reduced their mortality by 62% in comparison to the control group.			*
(19)	Can iPhone ECG screening by nurses help find more incident AF?	88 patients (age 74.8±8.8 years)	AliveCor Kardio monitor attached to a WiFi-enabled iPhone used for routine scanning for AF	19% had AF			*

Reference	Topic, study question	Sample size	Methods	Main results	Level of healthcare		
					Pri- mary	Second- ary	Both
(20)	Is telemedicine cost effective?	109,750 ECG records	Paramedics had a 12-lead ECG, this ECG report would be sent via mobile phone to a telemedical center, where the cardiologist could see the record.	They compared the costs of the teleconsultation with those of receiving the patient at the hospital and then transferring them to PCI. They found out that the final price for treating one patient can vary from EUR 8.10 to EUR 38.4 for one treatment. The treatment provided with telemedicine was cheaper.	*		
(21)	Can telemedicine detect arrhythmia in patients with palpitation?	12 FP and cardiologists, 184 patients (age 57.5±14.4 years)	FP sent ECGs twice per day in case of palpitations	61.4% of the patients did not have any HRDs. In 14.7% it was paroxysmal AF and in 6.5% ventricular tachycardia. In 88.7% their FP changed their pharmacotherapy, while 26.8% were referred to a psychotherapist.	*		
(22)	Is screening using an AliveCor Kardio monitor attached to a Wi-Fi-enabled iPod more likely to identify incident AF?	1001 patients divided into two groups (age 72.6±5.4 years)	AliveCor Kardio monitor attached to a Wi-Fi-enabled iPod versus 12-lead ECG in patients with AF	19 patients were diagnosed with AF versus 5 in the control group		*	
(23)	Is Cardio Rhythm Mobile Application accurate for AF detection?	98 patients (age 67±10 years)	Cardio Rhythm Mobile Application versus 12-lead ECG in patients with AF	The application correctly identified 93.1% of AF		*	
(24)	Can Kardia Band accurately differentiate sinus rhythm from AF compared to a standard ECG report?	100 patients (age 69±11 years), 169 simultaneous ECG and Kardia band reports	Kardia band with Apple Watch versus 12-lead ECG in patients with AF	The device showed 93% sensitivity and 84% specific in accurately differentiate AF from sinus rhythm		*	
(25)	By following guidelines for treating syncope or collapse, what kind of monitoring would doctors use?	177 physicians, ED: 33 UK, 40 Germany; cardiology: 54 UK, 50 Germany;	A qualitative survey	20% ED from the UK and 31% from Germany choose a diagnostic ambulatory ECG monitoring rather than Holter monitoring when dealing with patients having daily symptoms; but when treating patients for infrequent events (less than 1 per month) 15- 30% of them chose Holter monitoring and only 50% selected an insertable cardiac monitor. For cardiologists 6% from the UK and 10% from Germany did not choose Holter for daily symptoms but for infrequent symptoms and 80% would select an insertable cardiac monitor			*

Reference	Topic, study question	Sample size	Methods	Main results	Level of healthcare		
					Pri- mary	Second- dary	Both
(26)	By following guidelines for treating syncope or collapse, what kind of monitoring would doctors use?	199 physicians: 35 emergency doctors, 35 primary care, 30 hospitalists, 30 neurologists, 69 cardiologists	A qualitative survey	25% chose an ambulatory electrocardiogram monitoring rather than Holter for daily events, but for less frequent events 12-18% would choose a Holter, 20-34% a conventional or a mobile cardiac telemetry system and 53-65% an insertable cardiac monitor			*

#### 4 DISCUSSION

Use of telemedicine can reduce the time and cost from diagnosis to the necessary treatment. It can reduce mortality in patients with acute myocardial infarction. In addition to this, it can reduce the time to diagnose atrial fibrillation and help in diagnosing patients with heart rhythm disorders (HRD) which could not be seen, i.e. diagnosed, in the standard ECG record.

The studies have shown that the use of telemedicine can improve patient treatment on different levels of healthcare. Even though only 19 studies were found in this research, medical improvement in this field is visible. The outcomes of these studies have a great impact on the further development of digital medical techniques and algorithms for more qualitative treatments. Moreover, a cost evaluation study has also shown that telemedicine is cheaper in comparison to other, common treatments (20). All studies have proven that telemedicine is crucial for reducing unnecessary referrals to cardiologists or hospitals and essential for quicker treatment of patients that suffer from a life-threatening disease.

The fact is that there is great technological progress even in Slovenia and many sophisticated devices are available, especially in the field of treating diabetes mellitus type 2, where a similar study was conducted using the eDiabetes application for better self-management of DM type 2 patients not using insulin (28). Despite that, there is only one study running in Slovenia which includes an ambulatory ECG recording device, although old studies have shown great advantages for the use of telecardiology in the family doctor's office (29). The study uses a small body sensor measuring ECG on patients visiting their FP's and complaining about cardiac rhythm disorders. The telecardiology devices are small, portable and can normally be activated by simply pressing the button. They can be transported from one room to the other, which means that they can be taken on home visits. They are

user friendly for the physician as well as for the patient. They can be daunting due to their completeness, but users must accept and trust them. In this study there is also a part for FP's to learn how to use the ECG recording device and how to interpret the results; if in doubt, they can send the report to a consulting colleague or cardiologist. By doing so, they become more competent in interpreting the results and they can improve their quality of care. The big advantage in body sensor usage is that it is patient-controlled, and even though it can record and measure long time intervals, its benefits are short measurements sent from patients to their doctors when they feel discomfort.

The price is also an important factor when talking about telecardiology devices, because the initial input in the device can be a great obstacle for many physician's offices that operate within the public health network. Although the software is normally included in the price of the device, its management requires training and some knowledge of computer and law policies. This can be a big challenge for people who do not trust modern and proven technology.

##### 4. 1 Limitations of the Studies

A low number of well-planned intervention studies, especially on the primary level, and only a few patients included in them, were the main limitations that influenced the conclusion of this research. In our review of the literature, we find only three studies on the primary care level dealing with telecardiology (15, 20, 21). Although many patients were included, they all were treated with the help of a standard ECG, which means that there were no studies on primary care with the use of a standard ambulatory ECG. A drawback of three studies (14, 17, 19) out of thirteen included studies is the absence of control groups, which prevent an actual evaluation of cost-effectiveness of the use of telecardiology.



## 5 CONCLUSION

Telecardiology techniques can revolutionize the treatment of patients with cardiovascular diseases in FD' offices. They can also save money and surpass the gap between primary and secondary healthcare levels. Even though the telecardiology devices are user friendly, their management requires some training and knowledge about computer and law policies. That could be a challenge for future physicians. Further research is needed to assess the effectiveness and usefulness of telecardiology at the primary healthcare level.

## CONFLICTS OF INTEREST

The authors declare that no conflicts of interest exist.

## ETHICAL APPROVAL

The research carried no risk of violating ethical principles.

## FUNDING

There is no financial interest or risk.

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