TELEHEALTH-USE IN THE CARE OF PATIENTS WITH MYOCARDIAL ISCHEMIA: A SCOPING REVIEW

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Abstract

Background: Heart disease is the second leading cause of death after cancer and the leading cause of hospitalization in Canada.[1] This patient population faces healthcare access issues for treatment and follow-up. Telehealth may be a possible solution.

Objective: To explore, map, and summarize the current state of literature related to telehealth use in myocardial ischemia.

Methods: A scoping review was conducted on literature available from January 2014 to January 2019. Three databases were searched, and grey literature was identified using the Google Scholar search engine. Literature was considered for inclusion if it (1) was published in English; (2) was related to patients with myocardial ischemia from common causes; (3) reported on telehealth development or use; (4) included a patient and healthcare professional interaction; and (5) was limited to adult populations.

Results: Thirteen research articles met the inclusion criteria. Randomized control trials (n=7) and systematic reviews (n=4) were most common. Most of the literature focused on North American (n=4) and European countries (n=4), although some focused on more than one geographic area (n=4). The majority of the articles used more than one type of telehealth intervention, such as a combination of: telephone, text messaging, live video chat/video conferencing, email, and physiologic measures. Three main areas of investigation were addressed through telehealth use: (1) healthcare access issues, (2) low adherence to traditional rehabilitative programs, and (3) telemonitoring of physiologic data. Future research should analyze which components of telehealth cardiac rehabilitation are most beneficial, and identify settings in which preventative efforts are deemed ineffective.

Conclusion: The existing literature suggests that telehealth is primarily used for the secondary prevention of coronary artery disease, and its use is increasing as technologies evolve and internet use becomes more commonplace. Telehealth has the potential to reduce travel burden, provide access to a wider range of specialist advice, and deliver faster and more efficient care. There are several considerations for researchers and clinicians when designing interventions to improve access and adherence to care for patients with ischemic heart disease.

Keywords: Myocardial ischemia, telehealth, telemedicine, remote consultation, telenursing

Preface

This Scholarly Practice Advancement Research (SPAR) project is original, unpublished, independent work by the author, May Dy.

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Acknowledgements

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Dedication

To my boyfriend – Adam Canning. This work would not be possible without your daily and unconditional support. From taking me to school when I was in crutches, to being a sounding board many late nights. I am incredibly grateful for everything that you do. You are my biggest cheerleader and my best friend. Thank you from the bottom of my heart.

Chapter 1: Introduction

Heart disease is the second leading cause of death after cancer and the leading cause of hospitalization in Canada.[1] An estimated 8.9 million people died from heart disease globally in 2015.[2] Coronary heart disease, also known as *ischemic heart disease*, occurs when there is reduced blood flow through the coronary arteries to the heart muscle, preventing it from receiving enough oxygen.[2] Nearly three million Canadians (8.5%) aged 20 years and older live with diagnosed ischemic heart disease.[1] This is most often caused by coronary artery disease (CAD), which can lead to acute coronary syndrome (ACS). This is an umbrella term that includes stable and unstable angina pectoris and myocardial infarction (MI).[3] All of these conditions result from progressive blockage of a coronary artery, leading to reduced oxygen supply to the heart muscle (myocardium) and may result in a myocardial infarction (death of heart muscle due to lack of oxygen).[2]

Hypertension and CAD are examples of cardiac conditions that require ongoing monitoring and patient care.[4] Chronic heart disease places a significant burden on patients and the Canadian health care system. This patient population faces healthcare access issues for treatment and follow-up, particularly patients in rural areas and those requiring additional specialized healthcare.[5] *Telehealth* may be a viable solution to access issues and rising healthcare costs.

Terminology

The terms ‘e-health’, ‘telemedicine’, and ‘telehealth’ are often used interchangeably.[7] By late 1999 the term *e-Health* appeared; it was used to describe the broad concept of electronic communication and information technology (IT) related to health care.[8] E-health is now considered an emerging field of health informatics and is concerned with the organization,

delivery, and processes related to electronic communication and IT in health care, accessible through online means (web-based).[8]

There is a lack of common taxonomy and understanding of these terms.[7] In fact, *ad hoc* telehealth terminologies, taxonomies, and glossaries have been created over decades; which has created challenges for communication and application.[7] Another term is *digital health,* which is a broad concept that includes a wide range of technologies (smart phones, social networks, and internet applications) to obtain and provide care.[8] *M-Health,* on the other hand, is concerned with the use of mobile devices (e.g. mobile phones, patient monitoring devices, personal digital assistants) to support health practice.[8]

The term *telehealth* refers to the use of electronic information and telecommunication technologies to support long-distance clinical health care, patient and professional health-related education, public health, and health administration.[8] Telehealth includes any technology-mediated communication that facilitates clinical care in which the exchange of information occurs across time or distance.[9] Telehealth includes a growing variety of applications and services including, but not limited to: two-way video, email, wireless telephones, facsimile, web-based services, remote patient-monitoring devices, transmission of still images, internet applications (including patient portals), remote vital signs monitoring, continuing health education, and call centres.[8]

Although e-Health, digital health, and m-Health are overlapping, they are too broad of terms. These terms may also involve non-clinical services, such as distance education for healthcare consumers, conference call meetings, and healthcare management.[8] This review focused on 'telehealth' as it is more suited to describing the process of providing access to clinical care (e.g. health assessment, diagnosis, intervention, consultation, supervision, and

information) via digital health technologies.[8] Telehealth is also more inclusive of all health professionals, and not just the medical profession.[8]

Telehealth Terms

A variety of other Telehealth terms can be found in the literature. The umbrella term *telehealth* also encompasses programs and services that involve provider-to-provider teleconsultation.[8] *Remote consultation* is generally for diagnosis or treatment of a patient at a site remote from the patient or primary physician via telecommunications.[10] "Virtual visits" (also known as *virtual health*), are meetings (e.g. videoconferences) between a healthcare provider and patient occurring in real-time from any location.[8] Telehealth has been successfully implemented in some specialty areas, such as *telecardiology* and *telerehabilitation*.[8]

Telehome monitoring or *telemonitoring* refers to patient-monitoring technologies with devices that remotely collect and send biometric data (e.g. electrocardiogram and blood pressure monitor) to a home health agency or remote diagnostic testing facility for interpretation by a healthcare provider.[8] Telecardiology uses telecommunications to diagnose heart disease, such as listening to digital heart sounds and sending data over video conferencing systems.[8] *Telenursing* is the use of telehealth technology to provide nursing assessment and interventions.[8] *Telecare* (also known as *telehomecare*) is telehealth interventions in the home to support the individual to remain independent in their own homes (e.g. heart failure management).[11] Telerehabilitation is the remote delivery of rehabilitation and home health care services typically existing outside of the hospital setting.[12] This review focused on the above mentioned telehealth terms that include a healthcare professional and patient interaction; with the exception of telerehabilitation, because it is more related to speech-language pathology, occupational therapy, and physical therapy.[1]

Telehealth Examples

Telehealth is used because of its potential to connect patients to clinical expertise, regardless of their geographic location. In particular, it is used in areas where access to medical or specialist care is limited, such as rural hospitals, home health agencies, prisons, and nursing homes.[8] Approximately 68% of adults from countries with advanced economies reported using the internet and owning a smartphone in 2016, making the use of telehealth for heart disease feasible in such countries.[13] There is existing evidence for the potential benefits of telehealth, such as improved access to care, decreased costs of healthcare, increased healthcare provider productivity, earlier detection of disease processes and or/health issues, caregiver reassurance, and higher patient satisfaction.[8] The United States Army has been using telemedicine, including cardiology services, since 1992.[8] One example of a successful telehealth program is the Telehealth Network used by the US Department of Defense (DOD).[8] In 1997, the World Health Organization (WHO) announced that telehealth has become part of the WHO's "health for all" strategy and should be available to all people.[8] However, there has been limited research on telehealth use in heart disease and mixed results on its effectiveness.[9]

Although the Canadian Cardiovascular Society holds the position that remote monitoring should be available for patients with cardiac implanted electronic devices[4], there are no further clinical practice guidelines or statements regarding its use in heart disease care.[4] The Ottawa Heart Institute has pioneered cardiac telehealth use, with programs in: telemedicine, interactive voice response and telehome monitoring.[14] However, telehealth is still not widely accepted, due to concerns such as added workload, privacy and security, reduced staff autonomy and unknown clinical and cost effectiveness.[4] Although telehealth technologies may help provide cardiac care, evidence is needed to determine their clinical and cost-effectiveness.[4]

Purpose and Research Questions

Although telehealth use is increasing rapidly, it is still an emerging means of healthcare delivery and has yet to be commonplace in the management of ischemic heart disease.[4] The main objective of this SPAR Project was to conduct a scoping review to explore, map, and summarize the current state of literature related to telehealth use in myocardial ischemia. The general research questions that guided this review were:

(1) What types of telehealth-use in myocardial ischemia have been reported?

(2) What themes are discussed in the literature on telehealth and myocardial ischemia?

(3) What are the gaps in the current literature related to myocardial ischemia and the use of telehealth?

It was anticipated that the findings of this report would provide an indication of the size and scope of the research evidence in the area of telehealth use related to care of patients with myocardial ischemia. My goal was that this work would shed light on insights, significant issues, and gaps to inform future efforts in this area.

Chapter 2: Methods

A scoping review was identified as the best method for evaluating the literature for this SPAR. A scoping review is used to "map" the key concepts underpinning a research area as well as to clarify working definitions, and conceptual boundaries of a topic.[16] *Mapping* refers to a process of summarizing the range of evidence in order to convey the breadth and depth of a field.[15] Scoping reviews differ from systematic reviews because authors do not typically assess the quality of the included studies.[15] Instead, they examine the extent, range, and nature of research activities in a particular area.[17] A scoping review is beneficial for clarifying complex concepts and emerging evidence through a comprehensive search, including *grey literature*.[16-17]

Grey literature is a field of library and Information Science which consists of documents produced by government, academic, business, or other organizations (such as reports and conference proceedings) where publishing is not the primary activity of the producing body.[18-19] As telehealth use in patients with ischemic heart disease (such as from CAD, ACS, stable and unstable angina pectoris, MI) is an emerging subject in the literature, a scoping review was chosen to systematically examine the current state of this field. The Arksey and O'Malley Framework (2005) was used to ensure a rigorous foundation for the scoping study methodology. This is the first published methodological framework for conducting scoping studies.[20] Its six stages include: (1) identifying the research question, (2) searching for relevant studies, (3) selecting studies, (4) charting the data, (5) collating, summarizing, and reporting the results, and (6) consulting with stakeholders to inform or validate study findings.[20]

Information Sources

Considering the comprehensive nature of this project, a variety of information sources were examined. The following databases were used: The Cumulative Index to Nursing and

Allied Health Literature (CINAHL), OVID/Medline, and Web of Science. Grey literature was identified through searches conducted through the Google Scholar search engine and Web of Science database.

Search Strategy

A scoping review was conducted on current, relevant literature available from 2014 to January 2019. A comprehensive search strategy was created to identify the relevant literature. In order to find both published and grey literature, three databases and one search engine were searched. Table 1 includes the specific search strategies used for each database and search engine. A professional librarian from the University of British Columbia was consulted throughout the search strategy to ensure comprehensiveness.

Table 1. Search Strategy and Returns, by Database/ Search Engine

Source	Number	Strategy
CINAHL	n=352	(MH "Myocardial Ischemia+") OR TI (((OR cardiac OR coronary OR heart OR myocardi* OR ventricular OR atrial) N0 (disease* OR failure* OR dysfunction* OR arrhythmia* OR dysrhythmia* OR infarction* OR ischemia OR rehab*)) OR AB ((cardiac OR coronary OR heart OR myocardi* OR ventricular OR atrial) N0 (disease* OR failure* OR dysfunction* OR arrhythmia* OR dysrhythmia* OR infarction* OR ischemia OR rehab*))) OR TI (hypertensi* OR "high blood pressure*" OR "elevated blood pressure*" OR AMI OR NSTEMI OR STEMI OR "unstable angina" OR "acute coronary syndrome" OR ACS) OR AB (hypertensi* OR "high blood pressure*" OR "elevated blood pressure*" OR AMI OR NSTEMI OR STEMI OR "unstable angina" OR "acute coronary syndrome" OR ACS) AND (MH "Telehealth") OR (MH "Telemedicine") OR (MH "Remote Consultation") OR (MH "Telenursing") OR TI (Telehealth OR Telenursing OR Telemedicine OR "Telehome monitoring" OR Telecare OR Telemonitoring OR Telecardiology OR "virtual health") OR AB (Telehealth OR Telenursing OR Telemedicine OR "Telehome monitoring" OR Telecare OR Telemonitoring OR Telecardiology OR "virtual health") NOT (MH "technology, radiologic") OR (MH "teleradiology") OR (MH "Telepathology") OR (MH "Telerehabilitation") OR (MH "information systems") OR (MH "decision support systems, clinical") OR (MH "health information systems") OR (MH "Decision Support Systems, Clinical") (MH "Stroke+") OR (MH "Cerebrovascular Disorders+" OR (MH "Peripheral Vascular Diseases+) OR (MH "Vascular Diseases+) OR (MH "Vascular Malformations+") OR (MH "endocarditis+") OR (MH "heart aneurysm+") OR (MH "heart neoplasms+") OR (MH "heart rupture+") OR (MH "myocardial stunning+") OR (MH "pericardial effusion+") OR (MH "pericarditis+") OR (MH "pneumopericardium+")

		OR(MH "postpericardiotomy syndrome+") OR (MH "pulmonary heart disease+") OR (MH "rheumatic heart disease+") OR (MH "ventricular dysfunction+") OR (MH "ventricular outflow obstruction+") OR (MH "Pregnancy complications, cardiovascular+") OR (MH "vascular diseases+") OR (MH "Cardiac Tamponade+") OR (MH "Aortic Aneurysm+") OR (MH "aneurysm, dissecting+") OR (MH "aortic diseases+") OR (MH "Hypertension, Pulmonary+")
Medline	n=571	exp myocardial ischemia/ OR ((cardiac or coronary or heart or myocardi* or ventricular or atrial) adj (disease* or failure* or dysfunction* or syndrome* or arrhythmia* or dysrhythmia* or infarction* or ischemia or rehab*)).ti,ab. OR (hypertensi* or "high blood pressure*" or "elevated blood pressure*" or CVD or AMI or NSTEMI or STEMI or "unstable angina" or "acute coronary syndrome" or ACS or endocarditis).ti,ab. AND exp telemedicine/ or exp remote consultation/ or exp telenursing/ OR (Telehealth or "Telehome monitoring" or Telecare or Telemonitoring or Telecardiology or "virtual health").ti,ab. NOT technology, radiologic/ or teleradiology/ or Telepathology/ or Telerehabilitation/ or information systems/ or decision support systems, clinical/ or health information systems/ exp Stroke/ or exp Cerebrovascular Disorders/ or exp Peripheral Vascular Diseases/ or exp Vascular Diseases/ or exp Vascular Malformations/ OR exp endocarditis/ or exp heart aneurysm/ or exp heart neoplasms/ or exp heart rupture/ or exp myocardial stunning/ or exp pericardial effusion/ or exp pericarditis/ or exp pneumopericardium/ or exp postpericardiotomy syndrome/ or exp pulmonary heart disease/ or exp rheumatic heart disease/ or exp ventricular dysfunction/ or exp ventricular outflow obstruction/ or exp pregnancy complications, cardiovascular/ or exp vascular diseases/ OR

		exp Cardiac Tamponade/ or exp Aortic Aneurysm/ or exp aneurysm, dissecting/ or exp aortic diseases/ or exp Hypertension, Pulmonary/
Web of Science	n=846	TS=((cardiac OR coronary OR heart OR myocardi* OR ventricular OR atrial) NEAR/0 (disease* OR failure* OR dysfunction* OR arrhythmia* OR dysrhythmia* OR infarction* OR ischemia)) OR TS=(hypertensi* OR "high blood pressure*" OR "elevated blood pressure*" OR AMI OR NSTEMI OR STEMI OR "unstable angina" OR "acute coronary syndrome" OR ACS) AND TS=(Telehealth OR Telenursing OR Telemedicine OR "Telehome monitoring" OR Telecare OR Telemonitoring OR Telecardiology OR "virtual health" OR "remote consultation" OR "interactive voice response") NOT TS=(teleradiology OR Telepathology OR Telerehabilitation* OR "information system*" OR "decision support system*" OR "health information management system*" OR "clinical health information system*" OR "Clinical Decision Support System*" OR "augmented realit*" OR "specialized system" OR "application") OR TS=(stroke* OR "cerebral vascular accident*" OR CVA* OR "Cerebrovascular Disorder*" OR "Peripheral Vascular Disease*" OR "PVD" OR "Vascular Disease*" OR "Vascular Malformation*") OR TS=(endocarditis* OR aneurysm* OR neoplasm* OR rupture OR "myocardial stunning" OR tamponade* OR "rheumatic heart disease*" OR "ventricular dysfunction*" OR "ventricular outflow obstruction*" OR "cardiovascular pregnancy complication*" OR "vascular disease*" OR aneurysm*)
Google Scholar	n=9	("myocardial ischemia" AND telehealth) AND ("heart disease" AND telehealth) AND ("myocardial ischemia" AND telemedicine) AND ("heart disease" AND telemedicine) AND (site:gc.ca "myocardial ischemia" and telehealth) AND (site:gc.ca ("heart disease" and telehealth)
Total	n=1,778	

Note. Myocardial ischemia was accepted as equivalent to ischemic heart disease

Inclusion and Exclusion Criteria

The inclusion criteria consisted of papers or other grey literature items that: (1) were published in English; (2) were related to patients with myocardial ischemia from common causes; (3) reported on telehealth development or use, development or the actual delivery of remote health services using technology (existing and emerging); (4) included a patient and healthcare professional interaction; and (5) were limited to adult populations. Primary research studies, systematic reviews, and meta-analyses were included. Literature may also have contained but was not limited to include reports of: (1) clinical outcomes; (2) user satisfaction (patient and provider); (3) utility analysis; and (4) economic analysis.

Literature specific to the broader search terms (1) electronic health; (2) digital heath; and (3) mobile health were excluded from this scoping review as these concepts may also include non-clinical services or the absence of a healthcare professional and patient interaction.[8] This review also excluded literature related to: (1) opinion pieces; (2) letters; (3) editorials; and (4) study protocols. Study protocols were excluded because no actual findings were reported.

Study Selection, Categorization and Data Extraction

All articles were imported into Refworks ProQuest and then exported into an Excel worksheet to categorize and compare the literature. All titles and abstracts were screened; duplicates and articles not meeting inclusion and exclusion criteria were removed. Second, the full text of each of the remaining articles was reviewed and any not meeting the inclusion and exclusion criteria were removed. Following, general and specific information about the literature was extracted. Elements collected included: author, year of publication, journal type, title, study objective, type of study, target population, telehealth program/name, intervention, findings and geographic focus.[17] Because the focus of this scoping review was to provide a broad map of

literature on telehealth in patients with myocardial ischemia, the risk of bias and the overall quality of the items was not assessed.

Analysis

Synthesis of the articles was undertaken in order to answer the research questions. A detailed record of the literature was kept to easily identify each source. The literature was organized into categories (intervention type, purpose, sample size, etc.). The literature was critically analyzed and coded into groups with similar conceptual themes in an Excel worksheet. The findings are reported though a series of tables and figures that were created from the summarized data.

CHAPTER 3: RESULTS

The following chapter will outline the search results and summarize the selected literature. Paper characteristics will be discussed in greater detail: study designs, issues addressed, timeline evolution, geographical origin, and telehealth interventions.

Search Results and Selection of Literature

Searching the three selected databases and one search engine yielded 1,778 individual articles for possible inclusion in this scoping review. Figure 1 outlines the systematic process followed for arriving at 14 publications (related to13 studies) for review. All of these papers were published and peer-reviewed.

Summary of the Selected Literature

A majority of the literature was research-based (n=13). Publication dates ranged from 2014 to 2019, with the majority of literature published in 2015. Cardiac rehabilitation (CR) was the most common clinical context of the retrieved papers. Papers originating in North America and Europe dominated the literature, although some papers involved more than one geographical location. Tables 1, 2, and 3 provide an overview of the articles included in this scoping review.

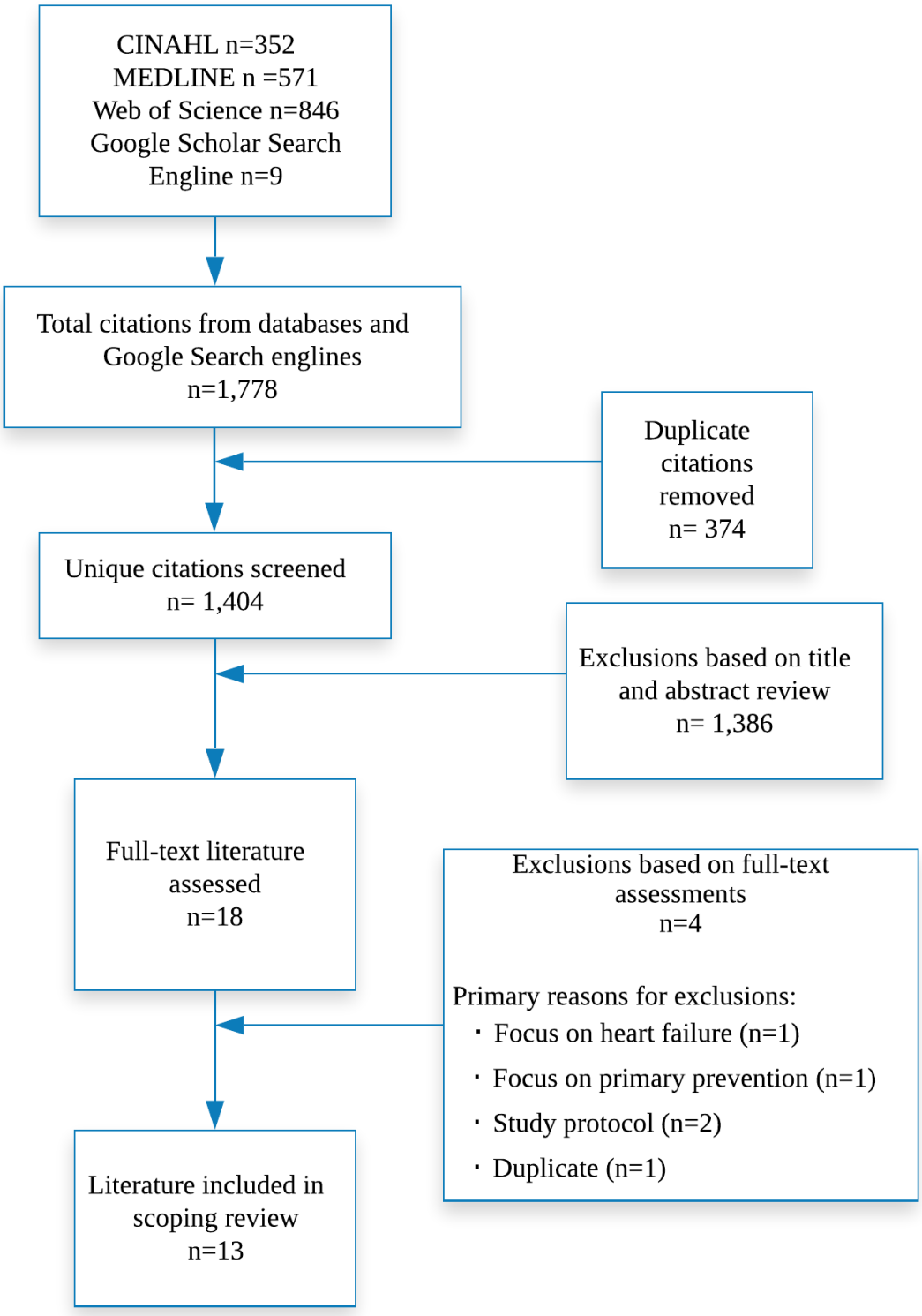

Figure 1. PRISMA diagram of literature selection

Table 1. Characteristics of included papers

#	Author	Year	Journal	Title	Study Objectives
1	Anthony et al.	2015	Journal of the American Society of Hypertension	Outpatient blood pressure monitoring using bi-directional text messaging	To evaluate a mobile phone health intervention to increase the ease and efficiency of diagnosing hypertension
2	Avila et al.	2018	Journal of Medical Internet Research	Home-Based Rehabilitation with Telemonitoring Guidance for Patients with Coronary Artery Disease (Short-Term Results of the TRiCH Study): Randomized Controlled Trial	To evaluate the added benefit of a home-based CR program with telemonitoring guidance on physical fitness in CAD patients
3	Brokmann et al.	2016	Journal of Medical Internet Research	Treatment of Acute Coronary Syndrome by Telemedically Supported Paramedics Compared with Physician-Based Treatment: A Prospective, Interventional, Multicenter Trial	To evaluate the quality of telemedically-delegated therapy and possible complications in ACS patients
4	Huang et al.	2015	European Journal of Preventive Cardiology	Telehealth interventions versus center-based cardiac rehabilitation of coronary artery disease: A systematic review and meta-analysis	To determine the effectiveness of telehealth CR compared to centre-based supervised CR
5	Huber et al.	2016	Trials	Implementation of a telephone-based secondary preventive intervention after acute coronary syndrome (ACS): participation rate, reasons for non-participation and 1-year survival	To examine the feasibility of the NAILED protocol in ACS patients
6	Jin et al.	2019	European Journal of Cardiovascular Nursing	Telehealth interventions for the secondary prevention of coronary heart disease: A systematic review and meta-analysis	To determine whether contemporary telehealth interventions can provide effective secondary prevention as an alternative or adjunct care compared with CR and UC for CHD patients
7	Kraal et al.	2017	European Journal of Preventive Cardiology	Clinical and cost-effectiveness of home-based cardiac rehabilitation compared to conventional, centre-based cardiac rehabilitation: Results of the FIT@Home study	To determine if home-based training with telemonitoring guidance could improve participation rates and enhance long-term effectiveness.

Table 1. Characteristics of included papers (con't)

#	Author	Year	Journal	Title of Paper	Study Objectives
8	Lear et al.	2014	Circulation: Cardiovascular Quality & Outcomes	Randomized trial of a virtual cardiac rehabilitation program delivered at a distance via the Internet	To test clinical effectiveness of virtual CR program delivered exclusively using internet-based technology
9	Rawstorn et al.	2016	Heart (British Cardiac Society)	Telehealth exercise-based cardiac rehabilitation: a systematic review and meta-analysis	To determine the benefits of telehealth exCR on exercise capacity and other modifiable risk factors compared with UC among CHD patients
10	Sangster et al.	2015	Journal of cardiopulmonary rehabilitation and prevention	Effectiveness of a pedometer-based telephone coaching program on weight and physical activity for people referred to a cardiac rehabilitation program: a randomized controlled trial	To determine the effectiveness of pedometer-based telephone lifestyle coaching intervention on weight and physical activity
11	Shaw et al.	2015	Computers Informatics Nursing	Willingness of Patients to Use Computers for Health Communication and Monitoring Following Myocardial Infarction	To compare different self-management strategies using home-based device-based monitoring of cardiac risk factors, an interactive web-based tool, and nurse telephone-based disease management to maximize adherence to therapies for secondary cardiac prevention.
12	Van Veen et al.	2017	Patient education and counseling	E-coaching: New future for cardiac rehabilitation? A systematic review	To provide overview of effectiveness of e-coaching as CR program
13	Whittaker & Wade	2014	Journal of Telemedicine & Telecare	The costs and benefits of technology-enabled, home-based cardiac rehabilitation measured in a randomised controlled trial	To conduct economic analysis of CAP2 programme compared to standard hospital-based programme

Note. CR=cardiac rehabilitation; CAD=coronary artery disease; ACS=acute coronary syndrome; UC=usual care; CHD=coronary heart disease; exCR=exercise based cardiac rehabilitation

Table 2. Summary of study characteristics

#	Type of Study	Year	Country/ Region of Focus	Target Population	Telehealth Program/ Name	Intervention					Findings
						Phone	Text	Live chat/ Video	Email	Physiologic Measures	
1	RCT	2015	USA	Hypertensive (above 140/90 mm Hg) at baseline visit or at any visit within 6 months	Outpatient BP Monitoring		X				N= 121 participants; patients more responsive to bi-directional text messaging compared to UC ($p<0.001$); Bi-directional mobile phone software effective for (1) obtaining BP measurements and (2) encouraging patients to record BP in EMR.
2	RCT	2018	Belgium	Low-to-moderate risk CAD in last weeks of their in-hospital ambulatory CR program	Home-based CR Program	X			X	X	N = 90; home-based telemonitoring guidance exercise program following completion of phase II CR results in further physical fitness improvement; equally effective as prolonged centre-based CR.
3	RCT	2016	Germany	Pre-hospital treated suspected ACS emergency	Telemedically -delegated Therapy	X		X		X	N = 39 teleconsultations for suspected ACS; quality of guideline-adherent therapy (i.e. correct handling of 12-lead ECG or administering aspirin, heparin, or morphine) not significantly different between groups except for oxygen administration ($p=0.007$); telemedical delegation of guideline-conforming medication and therapy by paramedics in ACS found to be feasible and safe.

Table 2. Summary of papers' characteristics (cont'd)

#	Type of Study	Year	Country/ Region of Focus	Target Population	Telehealth Program/ Name	Intervention					Findings
						Phone	Text	Live chat/ Video	Email	Physiologic Measures	
4	Systematic Review	2015	China	CAD, MI, or re-vasculari-zation	Telehealth Intervention Delivered CR	X		X	X	X	N = 15 papers (9 trials), no statistically significant difference between telehealth interventions delivered and centre-based supervised CR in exercise capacity; telehealth intervention offers alternative deliver model of CR for individuals less able to access centre-based CR.
5	RCT	2016	Sweden	ACS	Nurse-based Age-independent Intervention to Limit Evolution of Disease (NAILED) ACS Trial	X					N = 661; non-participants had higher 1-year mortality than participants ($p<0.001$); nurse-led telephone-based follow-up after ACS can be applied to a larger proportion in an unselected clinical setting; Reasons for non-participation were associated with: increased mortality, older age, multiple-comorbidities, decreased functional status, and low level of education.
6	Systematic Review	2019	Australia	CHD	Telehealth Interventions delivered alone or as an adjunct to CR	X	X	X		X	N = 32 papers (30 unique trials); telehealth associated with lower rehospitalisation or cardiac events compared with non-intervention groups ($p<0.0001$); telehealth interventions could be offered to patients who cannot attend CR, or as adjunct to CR for effective secondary prevention.

Table 2. Summary of papers' characteristics (cont'd)

#	Type of Study	Year	Country/ Region of Focus	Target Population	Telehealth Program/ Name	Intervention					Findings
						Phone	Text	Live chat/ Video	Email	Physiologic Measures	
7	RCT	2017	The Nether-lands	Low-to-moderate cardiac risk patients	Home-based CR with tele-monitoring guidance	X				X	N=90; satisfaction was higher in the home-based group versus centre-based group (p=0.02); home-based telemonitoring guidance can be an alternative to centre-based training for lower-to-moderate cardiac risk patients
8	RCT	2014	Canada	Cardiac patients with low or moderate risk (ACS or revascularization procedure)	CR Using the Internet			X	X	X	N=78; greater increase in maximal time on the treadmill stress test by 45.7 seconds (95% CI) compared to UC (p=0.045); vCRP found safe and effective
9	Systematic Review	2016	New Zealand	Diagnosed CHD (atherosclerosis, angina pectoris, MI, or coronary revascularization	Telehealth exercised-based CR (exCR)	X		X	X	X	N=11 trials; telehealth CR was more effective for physical activity level (p<0.01), exercise adherence (p=0.56), diastolic blood pressure (p=0.08), and cholesterol (p=0.04); telehealth found as effective as UC for improving modifiable cardiovascular risk factors
10	RCT	2015	Australia	Patients referred to outpatient CR	Pedometer-Based Telephone Coaching program	X					N=313; participants with telephone coaching decreased weight compared to UC (p=0.05); telephone-based interventions are feasible delivering lifestyle interventions for underserved rural communities or as adjunct to CR

Table 2. Summary of papers' characteristics (cont'd)

#	Type of Study	Year	Country/ Region of Focus	Target Population	Telehealth Program/ Name	Intervention					Findings
						Phone	Text	Live chat/ Video	Email	Physiologic Measures	
11	Cross-sectional Analysis	2015	United States of America	Post MI	Secondary Prevention Risk Interventions via Telemedicine and Tailored Patient Education (SPRITE) Study	X		X			N=259 were computer users; n=209 read health information online monthly; Participants considered using a website: to email doctors (n=275); share medical information (n=302); send biological data (n=308); look at medical records (n=321); track health conditions (n=332); share health information with family (n=181); and for support groups (n=223).
12	Systematic Review	2017	The Nether-lands	MI, ACS	E-coaching as a CR program	X		X			N=19 RCTs; complex e-coaching as a CR program was more effective than UC for physical capacity, clinical status, and psychosocial health
13	Cost-benefit analysis	2014	Australia	Patients post STEMI or NSTEMI referred to phase 2 rehabilitation	Care Assessment Platform (CAP2) Programme;	X	X	X		X	telehealth intervention cost was slightly lower compared to UC; telehealth intervention could be delivered for $1633 per patient compared to $1845 for UC; patient travel costs were substantially less than UC ($80 vs. $400); comparisons were made for costs relating to: education, assessment coaching and mentoring, gymnasium, communications, facility, technology, administration, and patient travel.

Note. RCT=randomized control trial; USA=United States of America; BP=blood pressure; UC=usual care; EMR=electronic medical record; CAD=coronary artery disease; CR=cardiac rehabilitation; ACS=acute coronary syndrome; ECG=electrocardiogram; MI=myocardial infarction;

CHD=coronary heart disease; vCRP=Virtual Care Rehabilitation Program; CI=confidence interval; exCR=exercise based cardiac rehabilitation; STEMI=ST-Elevation myocardial infarction; NSTEMI=Non-ST-elevation myocardial infarction

Table 3. Summary of papers, by issue addressed

#	**Issue 1: Healthcare Access Issues**	**Issue 2: Low Adherence/ Participation in Traditional Rehabilitative Programs**	**Issue 3: Telemonitoring of Physiologic Data**
1			
2		X	X
3			X
4	X	X	X
5		X	
6	X		
7		X	X
8	X	X	X
9	X	X	X
10	X		
11	X	X	X
12	X	X	
13	X	X	X

Timeline: Evolution of the Literature

The number of articles related to telehealth use in ischemic heart disease was the highest in 2015 (see Figure 2). Using telehealth as an alternative or adjunct to in-hospital CR emerged in the literature in 2014, and has been a regular topic since then. Quantitative research studies, such as randomized control trials (RCTs), on telehealth use in ischemic heart disease appeared beginning in 2014. Systematic reviews on secondary prevention for coronary artery disease (CAD) are evident in the literature in 2015. This highlights a certain level of maturation of the state of literature. One Systematic Review was already present on the topic at the time our literature search ended in January 2019.

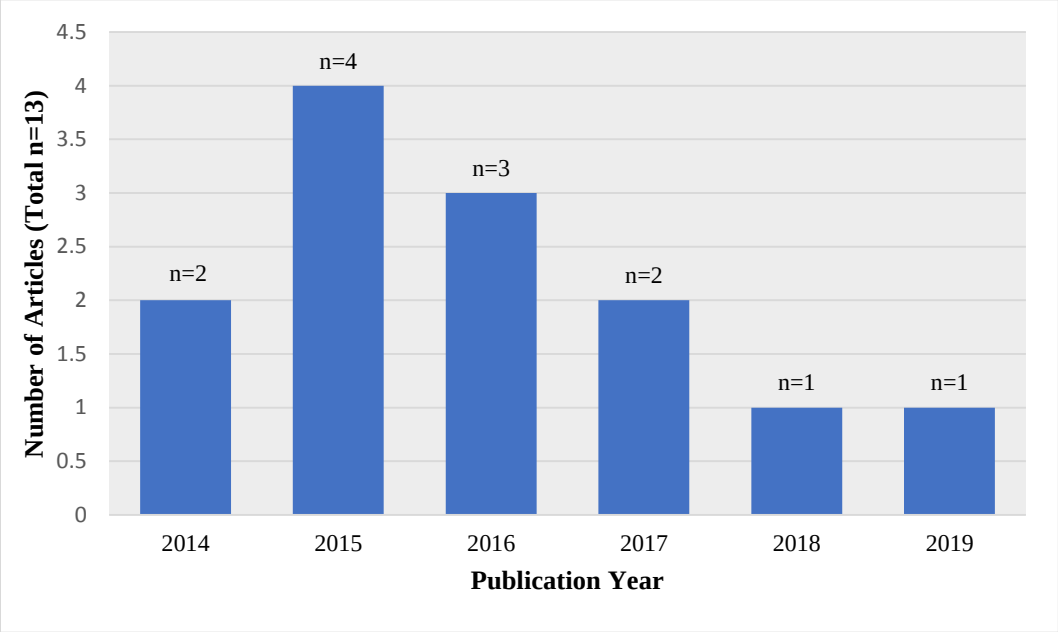

Figure 2. Included papers, by year of publication
*Up to January 26, 2019

Type of Studies

All 13 (100%) studies were research-based, employing various methodologies. Seven (54%) of those articles were RCTs[21-23, 25,27-28,30] and four (31%) were systematic reviews and meta-analyses.[24,26,29,32] Articles classified as "other" (n=2, 15%) included: (1) a cross-sectional analysis of the Secondary Prevention Risk Interventions via Telemedicine and Tailored Patient Education (SPRITE) Study;[31] and (2) a cost-benefit analysis of a previous RCT of a technology-enabled, home-based CR, named the Care Assessment Platform (CAP2) Programme.[33-34] No qualitative studies were found. Figure 3 displays the number of articles found for each category. Figure 4 displays the types of methods used each year up to January 2019.

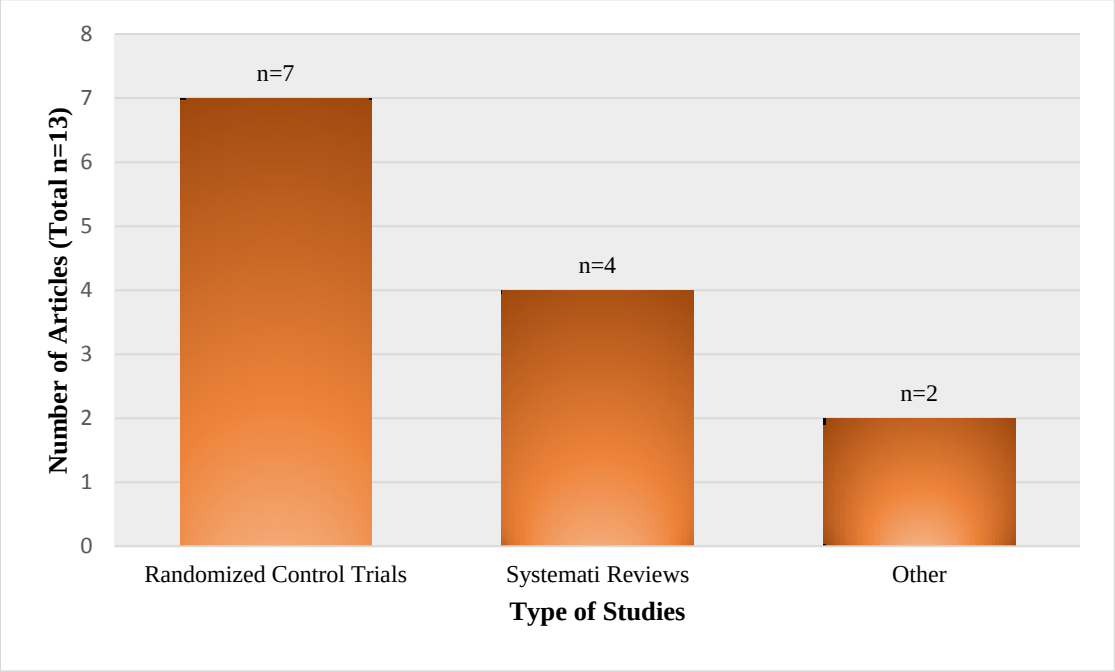

Figure 3. Included papers, by type of publication

Geographical Origins of Included Papers

Most of the literature originated in Europe (n=4, 31%) or more than one geographic area (n=4, 31%). These were followed by North America (n=3, 23%), Australia (n=2, 15%) and Asia (n=0, 0%). Systematic reviews and meta-analyses examining telehealth use in CR were published in Europe, Australia, and Asia, but focused on more than one geographical area (n=4, 31%). One review specified the settings: United Kingdom, Italy, Denmark, Canada, and China within their review.[24] The other two systematic reviews were not specific in geographical focus.[26,29] Figure 4 highlights the number of papers originating from each geographical region.

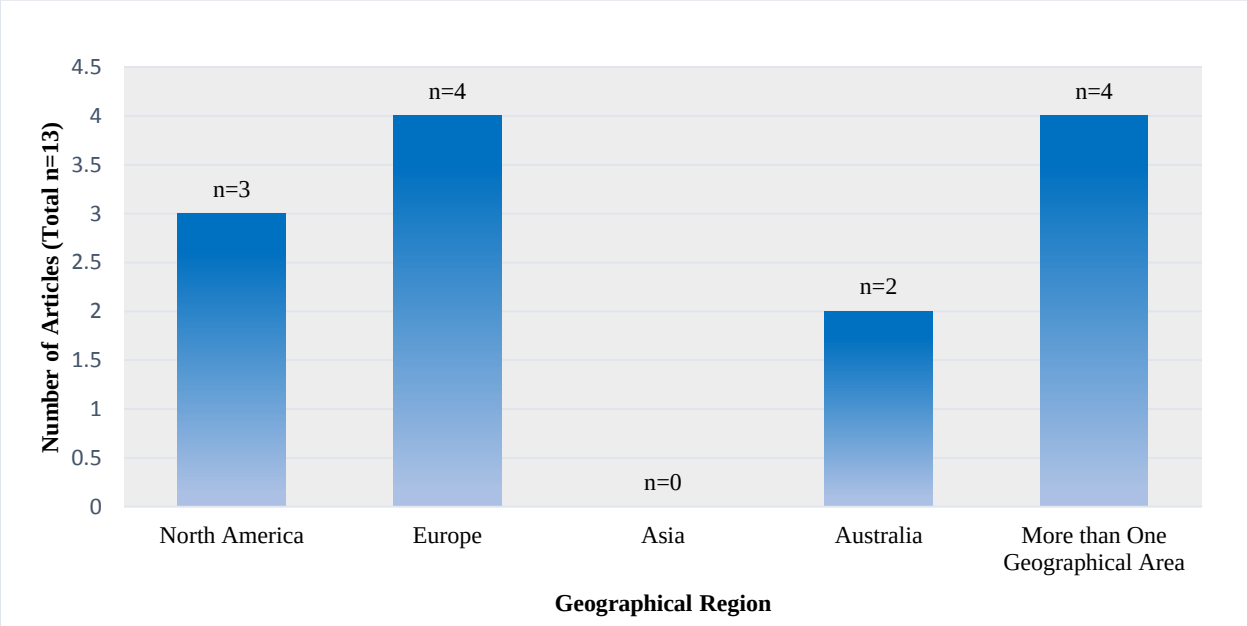

Figure 4. Number of papers, by geographic origin

Telehealth Interventions Employed

The majority of articles used more than one type of telehealth intervention, such as a combination of telephone support, videoconferencing, and monitoring physiologic data. One study included telehealth delivery via mobile phone and the internet with software tools (i.e., Step Counter and WellnessDiary (WD) and a WellnessDiary Connected (WDC) portal.[33-34] Telephone-based interventions for secondary prevention of CAD were reported the most (n=11, 85%).[24] Telehealth delivered via telephone alone was more prominent in the earlier literature (up to 2017, n=5, 38%). Telemonitoring of physiologic data was commonly found in the literature (n=8, 62%) (see Figure 5-6). Only one study focused on a Virtual Care Rehabilitation Program (vCRP) delivered exclusively using Internet-based technology.[28] Figure 5 illustrates the number of articles found in each category of types of telehealth delivery. Figure 6 presents the types of telehealth delivery used each year up to January 2019.

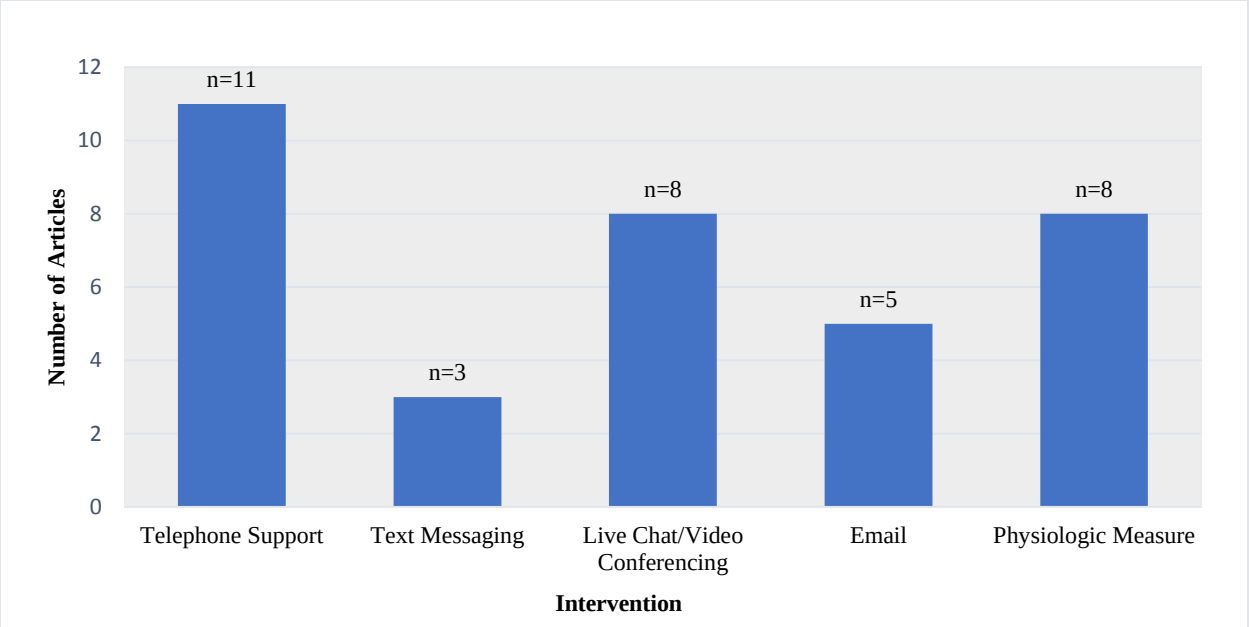

Figure 5. Number of papers, by type of telehealth intervention

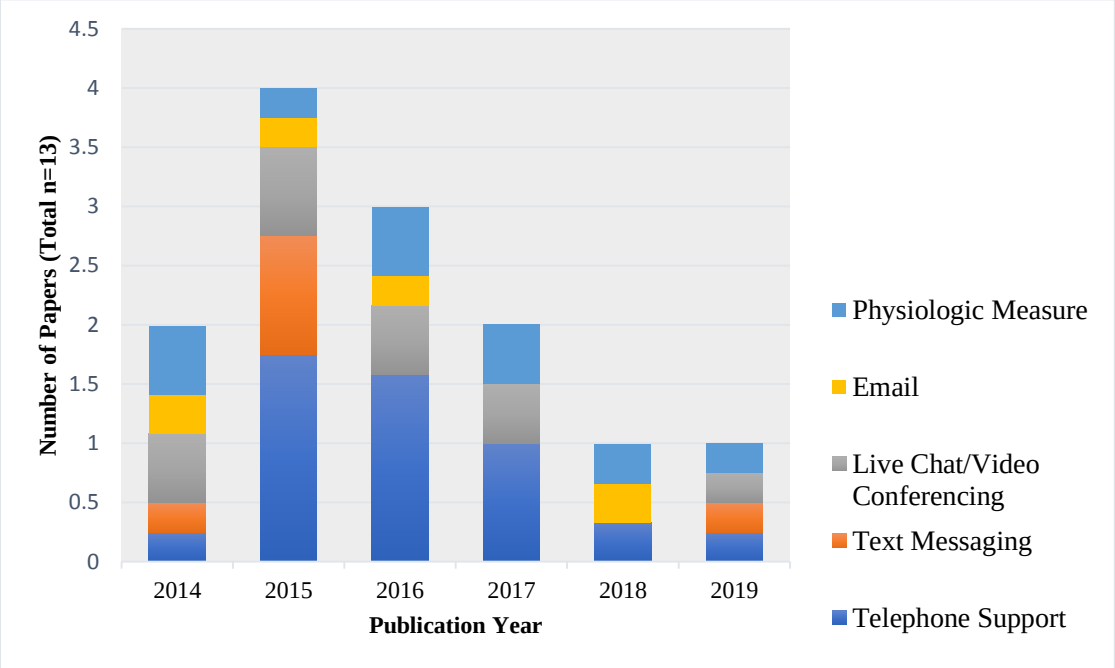

Figure 6. Number and type of interventions, by year

Issues Addressed in the Literature

Figure 7 summarizes the issues that investigators have attempted to tackle through telehealth use in ischemic heart disease. Eight articles focused on telehealth use for healthcare access issues, particularly related to traditional centre-based CR.[24,26,28-33] Eight articles reported on low adherence to traditional CR programs.[22,24,27-29,31-33] Eight studies included telemonitoring of physiologic data.[22-24,27-29,31,33-34] Eight papers (62%) overlapped into more than one category; therefore, the total number for Figure 7 is 24.

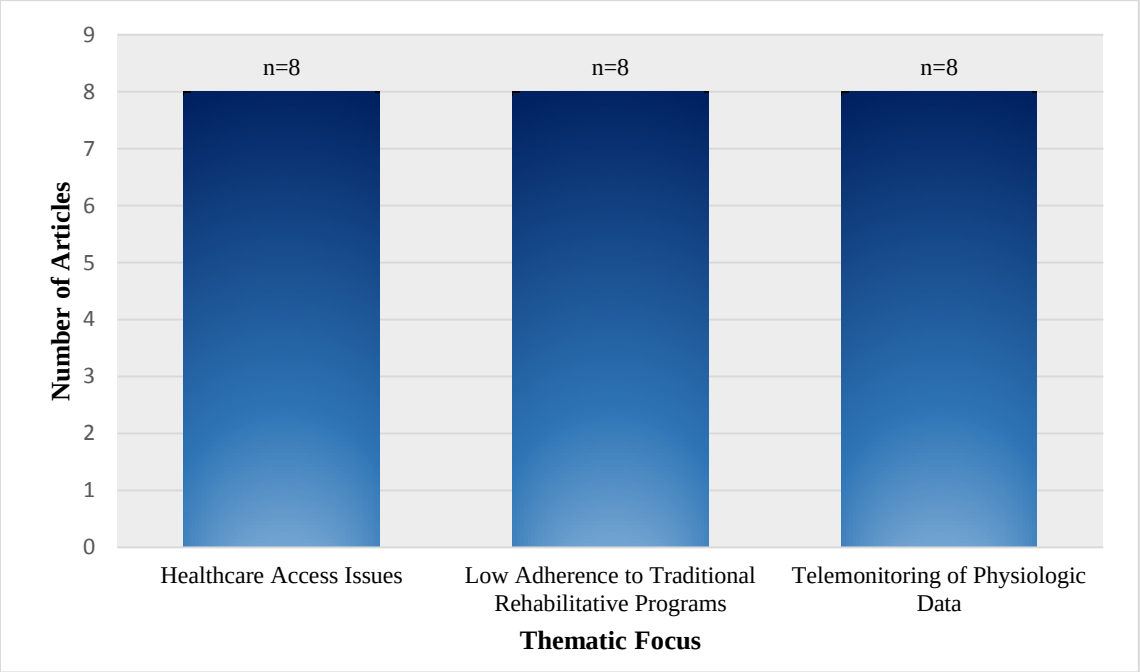

Figure 7. Included papers, by issue addressed

Chapter 4: Discussion

Key Findings

All of the literature retrieved was research-based, with majority being randomized control trials (RCTs) and systematic reviews. The studies aimed to address three main issues with telehealth use for ischemic heart disease: healthcare access, low adherence to traditional cardiac rehabilitation (CR) programs, and telemonitoring of physiologic data within telehealth programs. All three issues have had a significant presence in the literature with some themes overlapping.

Healthcare access issues. Traditional centre-based CR has low participation rates - on average, less than 50%.[23,26,32] Several highlighted geographic accessibility as a barrier.[24,26,28-29,31-34] One RCT found that all participants attending the hospital-based program lived within a 45 kilometer radius.[33-34] Telehealth approaches were successful in overcoming access barriers related to flexible and convenient program availability and scheduling.[29] Two articles focused on lack of communication between patients and providers in general, and not specifically in relation to CR programs.[31-32]

Low adherence to traditional rehabilitation programs. Adherence was a commonly reported outcome in the literature for comparing the centre-based and telehealth CR programs (n=3, 23%)[27,32-34], with emphasis placed primarily on exercise[29] and medication adherence[32]. As well, traditional centre-based CR was found to have drop-out rates as high as 35%.[28] but for telehealth programs, adherence improved attendance and training frequency.[27,32] Adherence barriers mentioned were self-motivation, social composition, and support.[24] One study described poor adherence leading to difficulty for CR patients to retain the positive benefits of centre-based CR.[22] In a systematic review, telehealth groups maintained regular exercise six months after completing CR more than centre-based programs.[32]

Monitoring physiologic data. Physiologic data monitoring was frequently used, with the most common physiologic data monitoring reported being heart rate (n=7, 54%).[22, 24,27,29,32-34] Blood pressure (n=3, 23%),[28,31,33-34] electrocardiogram (ECG) (n=2, 15%),[23-24] biosensor (accelerometry) (n=1, 8%)[29], and maximal oxygen uptake (VO2max, ml/kg/min) (n=4, 31%)[22,24,27,32] monitoring were also consistently reported. One article described telemonitoring use for real-time vital signs and 12-lead ECGs data transmission from paramedics to tele-emergency medical services (EMS) physicians for delegated medication and treatment of acute coronary syndrome (ACS) cases.[23] Physiologic data monitoring enables healthcare teams to safely monitor patients' health through uploaded or transmitted information (i.e. heart rate, blood pressure, etc.).[8] Telemonitoring-use was beneficial for assessing for adverse events and injuries[22,24,27-29,31,33-34], providing exercise prescription and coaching[22,24,27-29,33-34], and measuring outcomes between centre-based and home-based interventions.[24,27,29,33-34] Telehealth benefits and barriers will be discussed further below.

Analysis of the literature in this scoping review suggests that telehealth is being used on a regular basis for ischemic heart disease for patients with mild-to-moderate coronary artery disease (CAD) or ACS. It is used in upper-middle and high-income countries,[35] with European, North American, Australian, and Asian countries being the most common geographical focus of the literature. Telephone-based interventions had the greatest weight of evidence for telehealth interventions (n=11, 85%),[24] though the majority of the articles involved a combination of telephone support, videoconferencing, and physiologic data monitoring. Telehealth interventions within this review were found to be an emerging and effective alternative model for CAD risk factor reduction and secondary prevention.[24] Telehealth use in ischemic heart disease has both benefits and barriers to be considered.

Benefits

Positive effects attributed to telehealth use in ischemic heart disease are those related to feasibility[23], safety[28], and effectiveness.[22,28-29] Telehealth use for secondary prevention is expected to increase as internet and mobile phone use is almost ubiquitous[26] and internet use in older populations is growing.[28] The internet is commonly available in people's homes and the technology is readily scalable to large patient populations.[28] One study described text messaging between patients and providers as feasible, with pay-as-you-go phones requiring little bandwidth.[21] Telehealth home-based programs further reduced timing-related barriers and staff-time.[26]

Home-based telehealth CR was found to produce similar clinical outcomes to a hospital-based CR program.[8, 32-34] This aligns with the results from other similar studies on home-based care models.[33-34,36-38] Physical activity and exercise adherence had extensive evidence for telehealth program effectiveness.[27-29] Only 15% to 50% of patients maintain regular exercise after centre-based CR completion; in contrast, exercise maintenance in telehealth programs was found to be as high as six months after CR completion.[32] Home-based telehealth CR also showed trends towards reductions in recurrent cardiac events, cholesterol, blood pressure, and smoking status (however, these were not statistically significant changes).[26]

Telehealth programs were found effective in access[33-34], adherence[25,32-34], and costs[21,26-27,33-34] compared to usual care. Telehealth programs had a broad appeal for difficult to reach groups, such as those in rural locations.[30] Access and adherence were superior in the telehealth groups because patients did not need to travel to one central location[28], thus giving participants flexibility to work or travel.[33-34] One RCT found that the completion rate for patients in the home-based telehealth program (80%) almost twice that of the centre-based program (47%).[33-34]

Home-based groups received personal feedback and coaching in a manner not readily available in the traditional centre-based programs.[33-34] Patient satisfaction was found to be higher in home-based telehealth programs.[27] Home-based telehealth programs' costs were less than centre-based programs, based on: absenteeism from paid work[27], staff expenditures[26,33-34], facilities, and patient travel.[33] Costs were predicted to be reduced further if the number of participants increased.[33-34] Thus, home-based CR was found to be feasible as an adjunct or as an alternative to centre-based CR programs.[22,24]

Barriers and Concerns

Barriers to telehealth CR included: older age[25,27-29,31], lower economic status[31], language, technical skills[33-34], education, and disability.[25] Technology competency[7] and privacy[8,21,28] were at the forefront of providers' concerns. Cellphone adoption was found to be increasing among older adults, but smartphone adoption was only 18%.[21] Staff found that text messaging was ambiguous, and patients found smart phones unintuitive and over complicated (e.g. installing and updating apps).[21] One group of authors argued that low adoption of patient-focused technology is due to: lack of evidence to support technology in delivering healthcare, slow processes of policy changes, and resistance to moving to more consumer-based healthcare.[28] Legal and regulatory challenges (such as licensure, credentialing, and privileging) are among the greatest barriers to telehealth adoption, and [8] privacy and confidentiality are fundamental when using technology for the transmission of health data and live video presentation. It was recommended that the requirements for ensuring confidentiality privacy must be the same as those for in-person encounters.[8]

Gaps and Potential for Future Research

Research demonstrates that telehealth in ischemic heart disease is emerging. Adoption of

technology in the past has targeted administrative uses, such as electronic medical records, rather than patient-focused uses.[28] The uptake of technology is required to improve access and adherence to secondary prevention efforts. It is necessary to identify settings in which preventative efforts are ineffective.[25] Efforts must be made to match the needs, technology access, and preferences of those identified to have low CR uptake, such as the following groups: low socioeconomic status[25,31], low education, older, disabled, those with multi-moribidities[25], women, and those living in rural areas.[30] Further analysis of which components of telehealth CR are most beneficial (e.g. exercise, coaching, etc.) is needed. From there, modifications and improvements could be made to telehealth CR interventions (such as exercise prescription dose and intensity).[26,29]

There is a need to conduct primary research studies to test aspects of telehealth use in low and middle-income countries. Since no literature focused on the geographical areas of South America, Africa, or the Middle East; we have no information on the prevalence of telehealth use in ischemic heart disease, types of use, or barriers to use in those areas. We also have no information on the patients' experiences with telehealth interventions, as no qualitative studies were found in this search. Future qualitative or mixed-method studies would be beneficial to provide insight on whether or how the healthcare system can support telehealth interventions in ischemic heart disease. This would provide evidence for implementation strategies addressing the different barriers that have been recognized.

Implications

The findings of this scoping review may advance nursing practice and healthcare by offering beginning understandings of the use, issues, and gaps in current literature related to telehealth in ischemic heart disease. Further primary research studies followed by full systematic

reviews would be beneficial in providing evidence for policy and practice recommendations. Further research is necessary to identify which patients may need additional encouragement and interventions to increase telehealth uptake and adherence and what the most effective mechanisms are for telehealth delivery in ischemic heart disease.

Using telehealth for other purposes should be considered. Telehealth may be potentially used as a method for clinical data collection. Data collected in the included studies within this review did not upload into the patients' electronic medical record (EMR). However, the interoperability of these systems could effectively streamline healthcare providers' workflow and improve healthcare efficiency.[8] Ideally, providers should have access to the patients' health records at the time of telehealth encounter (in the same way as in-person interactions).[8]

Nursing and other healthcare professionals will need to consider telehealth competencies, guidelines, standards, and ethics. Practitioners' expertise and comfort with telehealth should be assessed before implementing any telehealth program. Telehealth competencies must be met, such as having an understanding of how to use videoconferencing equipment.[8] The patient's diagnosis should be appropriate for telehealth intervention[8] and the program should be suitable for telehealth delivery.[39] The client-provider relationship should meet the standards and quality of face-to-face services.[39] Backup plans and safeguards need to be established for risks (e.g. glitches, change in appropriateness, etc.). Further telehealth considerations include: infrastructure, testing and validation, human resources, education, and equipment.

Limitations

Limitations of this review include the following. Although the majority of articles found in this review process were published in English-speaking countries, language bias exists due to the exclusion of non-English articles. Common to other scoping reviews, there is no

methodological appraisal of the quality of the included studies.[16] Literature published since January 26, 2019 (the date of our final search) is not included. In terms of the limitations of the included literature itself, the following apply. Most home-based telehealth CR versus centre-based CR programs cannot be blinded.[22,27] Risk of bias exists with several of the studies having too restrictive inclusion criteria[25-26] and lack of blinding of group allocation.[27] Many of the studies had small sample sizes, associated with low statistical power.[26,28] Studies of telehealth CR may have missed patients who were not referred or enrolled into CR.[25] Several studies in the included literature only involved single centres and all of the studies targeted low-to-moderate risk CAD. Thus, findings may not be representative of the general CR populations[27], those living in rural areas,[30] and patients with severe comorbidities, high risk CAD, and heart failure.[24]

Conclusion

This scoping review provides a descriptive map of the literature on telehealth use in ischemic heart disease. Telehealth is primarily used for secondary prevention of CAD, and its use is increasing as internet use becomes more commonplace. Issues addressed, benefits, and barriers have been highlighted in this review. Telehealth reduces travel burden, provides access to a wider range of specialist advice, and delivers faster and more efficient care.[39] Privacy and security, licensure, standards, and lack of integration with other systems[8] must be considered for widespread adoption and sustainment to be achieved. Finally, researchers and clinicians must be considerate in designing interventions that include ischemic heart disease patients of diverse backgrounds (low socioeconomic status, older, etc.) to improve their access and adherence to care.[31]

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