European Journal of Cardiovascular Nursing (2021) **00**, 1–11
doi:10.1093/eurjcn/zvab084

REVIEW ARTICLE

Virtual visits in cardiovascular disease: a rapid review of the evidence

Danijela Piskulic[1], Susanna McDermott [2], Lauren Seal[3], Shelley Vallaire[1], and Colleen M. Norris[1,2]*

[1]Alberta Health Services, Cardiovascular Health & Stroke Strategic Clinical Network, Alberta Health Services, Suite 300, North Tower, 10030-107 Street NW, Edmonton, AB T5J 3E4, Canada ; [2]Faculty of Nursing, University of Alberta, Level 3, Edmonton Clinic Health Academy, 11405-87 Avenue, Edmonton, AB T6G 1C9, Canada; and [3]St. Albert Public Library, 1010 880 St. Albert Trail, St. Albert, AB T8N 3Z9, Canada

Received 18 May 2021; revised 6 August 2021; accepted 1 September 2021

Given the high prevalence of cardiovascular disease (CVD) in Canada and globally, as well as the staggering cost to human life and health systems, there is an urgent need to understand the successful applications of telemedicine in cardiovascular medicine. While telemedicine in cardiology is well documented, reports on virtual care in the form of synchronous, real-time communication between healthcare providers and patients are limited. As a result of the immediate suspension of ambulatory services for cardiology in Alberta, Canada, due to the Coronavirus Disease 2019 pandemic, we undertook a rapid review on the impact of non-virtual visits in cardiovascular ambulatory settings on patients' healthcare utilization and mortality. Evidence from 12 randomized control trials and 7 systematic reviews was included in the rapid review, with the majority of papers ($n = 15$) focusing on telemedicine in heart failure. Based on our appraisal of evidence from the last 5 years, virtual visits are non-inferior, or more effective, in reducing hospitalizations and visits to emergency departments in patients with CVD compared to traditional standard in-clinic/ambulatory care. The evidence for a superior effect of virtual visits in reducing mortality was not supported in this review. While telemedicine is an appropriate tool for CVD follow-up care, more research into the efficacy of different components of telemedicine and virtual visits is required.

Keywords Virtual health • Virtual visits • Telemedicine • Cardiovascular disease • Synchronous communication

Implications for practice

- Telemedicine is an appropriate tool for follow-up care in patients with cardiovascular disease.
- Virtual visits are non-inferior to standard in-clinic follow-ups in reducing hospitalizations and emergency department visits in patients with cardiovascular disease.
- Heart failure remote monitoring programs have the potential to provide benefits for patients, their family caregivers, and health systems.

Introduction

Telemedicine, or exchange of medical information and communication using a variety of technological platforms aimed at improving patients' clinical health status,[1] has experienced a substantial surge in recent months due to the Coronavirus Disease 2019 (COVID-19) pandemic. Telemedicine is a viable platform for connecting with patients considered out of in-person reach (e.g. remote settings, high dependency settings such as long-term care). It provides continued care of patients with chronic cardiovascular disease (CVD) who are vulnerable and those clinically compromised under the COVID-19 pandemic. The use of telemedicine has quickly spread and integrated into hospital operations, healthcare providers' offices, public health agencies, and patients' homes.[2] In Canada, 1 in 12, or 2.4 million adults live with diagnosed heart disease.[3] Given that CVDs are the leading cause of death worldwide with an estimated 17.9 million deaths annually,[4] and have increasing treatment-associated costs to health systems (over 75% of CVD-related deaths occur in low–middle-income countries),[4] there is a need to understand applications of telemedicine in cardiovascular contexts globally. Applications of

* Corresponding author. Tel: 780-942-0784, Email: cnorris@ualberta.ca

telemedicine range from remote-monitoring and transmission of biometric data (i.e. teletransmission) and asynchronous communications, to synchronous, real-time assessment, and consultation via audio and video conferencing systems (i.e. virtual visits).

Telemedicine aids the clinical management of CVD patients without in-person visits and has a potential for vast clinical utility across various clinical settings in acute and ambulatory services. While the COVID-19 pandemic saw an increase in the use of virtual visits in primary care, a platform that has been underutilized in Canada prior to the pandemic,[5] there is limited evidence as to its effects on patient-level outcomes in cardiology.[6] Despite the reported usefulness of telemedicine in cardiology,[2] reports on virtual care in the form of synchronous, real-time communication between healthcare providers and patients are limited. Given the immediate suspension of ambulatory services for cardiology in Alberta, Canada, due to the COVID-19 pandemic, and a surge in telemedicine utilization, we undertook a rapid review of the evidence of the impact of virtual visits in cardiovascular ambulatory settings on patients' healthcare utilization and mortality outcomes globally. This undertaking was done as part of the broader scientific initiative, the Scientific Advisory Group (SAG), within the Strategic Clinical Networks (SCNs) at Alberta Health Services (AHS), the main health authority in the province of Alberta, Canada.

Materials and methods

The initial request for the current rapid review was issued by Alberta Health Services' (AHS) Scientific Advisory Group (SAG) that was tasked with creating high-quality, rapid evidence syntheses for the purpose of providing recommendations to support policy and operational decisions within AHS in the wake of the COVID-19 pandemic emergency response. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodology[7] as closely as possible due to time constraints associated with rapid reviews.[8,9] It is worth noting that a number of PRISMA guidelines have been adapted for the purpose of the current rapid review, including but not limited to: (i) accelerated evidence synthesis; (ii) date-restricted literature search; (iii) publication language limitations; (iv) inclusion of higher quality designs only; (v) limited outcomes; and (vi) exclusion of grey literature.

Figure 1 illustrates a flow diagram of the literature search and study selection process.[7]

A range of virtual technology interventions are utilized and described in review articles, many referring to remote monitoring and patient care using both asynchronous and synchronous provider–patient communication. Asynchronous communication refers to a one-way 'store-and-forward' transmission of health information. It includes remote monitoring (i.e. telemonitoring), or collection of clinical patient data, such as blood pressure, heart rate, heart rhythm, oxygen saturation, weight, electrocardiography, and other cardiac-related measurements with home-based teletransmission systems. For the purpose of the rapid review, we use the most frequently occurring term, 'telemedicine' to encapsulate all other related terms (e.g. telehealth, e-health, m-health etc.). In this context, *telemedicine is defined as synchronous telecommunication-based management of patients using telephone and video-based care or support, with or without additional function of teletransmission or transfer of patients' biometric information to the healthcare provider via internet connection.*[10]

Eligibility criteria

For this rapid review, *virtual visits were defined as a clinical interaction involving synchronous bi-directional communication between a healthcare provider and a patient using information communication technology*. Standard treatment, in comparison, was defined as in-clinic/ambulatory care and follow-up that does not involve telemedicine.

The inclusion criteria for the rapid review included:

(1) Randomized controlled trials, systematic reviews, and/or meta-analyses published between 2015 and 2020;
(2) Study focus on adult ambulatory patients with cardiovascular disease (e.g. heart failure, acute coronary syndrome, heart attack, myocardial infarction, and arrhythmia);
(3) Studies that included provider–patient synchronous virtual or remote communication (including mention of telemedicine, telemonitoring, telecommunication, remote monitoring/consultation, and videoconferencing);
(4) Studies that reported healthcare utilization (i.e. hospitalization, emergency department visits, visits by emergency medical services) and mortality (i.e. all-cause and/or disease-specific mortality) as the primary outcomes;
(5) Articles written in English.

As this was a rapid review, grey literature was excluded from the search and published research referenced in relevant systematic reviews and meta-analyses was extracted for review only if the publication dates fell within the review's publication time frame of 5 years. Limiting the search strategy to the last 5 years was in direct response to the large volume of articles published on this research question. Finally, studies that only included and described asynchronous provider–patient communication were excluded from the rapid review.

Information search

Research questions, inclusion and exclusion criteria, and a plan for the review design were discussed with a qualified librarian (LS) prior to the search. A search was performed on 27 January 2021, on articles published between 2015 and the day of the search per the inclusion criteria (see Supplementary material online, *SA* for the comprehensive list of search headings and the search strategy by database, and Supplementary material online, *SB* for the research question and data dictionary). Using the key terms, the Librarian performed a comprehensive literature search of the following databases that focus on health sciences research: CINAHL, OVID MEDLINE, PubMed, TRIP Pro, and Google Scholar. Briefly, the Librarian used major headings such as cardiovascular disease, telemedicine, videoconferencing, telecommunications, acute care, and ambulatory care as well as a range of combinations of search terms across all databases. Title and abstract screening were initially performed independently by three reviewers: C.N., D.P., and S.M. In case of disagreements or uncertainty regarding inclusion of articles, the reviewers had a discussion until a consensus was reached. The review of full-text articles was performed by D.P. and S.M., whereby each reviewer was designated half of all articles selected for the screen. In case of uncertainty or disagreement regarding the inclusion of an article, the final decision was made by the senior author, C.N.

Data collection

Data extraction from full-text articles was performed independently by the two reviewers: D.P. and S.M. While the data extraction sheet included 14 different categories, general information relating to virtual visits and their descriptions has been outlined in *Table 1*.

Quality analysis

Quality analysis of included articles was performed using the AMSTAR 2 assessment tool for systematic reviews,[29] and the Downs and Black Checklist for randomized controlled trials.[30]

Results

Description of studies

The literature search generated 301 articles, and 4 additional articles were identified through searching the references of search-generated articles. After deduplication, 168 articles underwent a title and abstract screening. Of those, 67 studies were selected for a full-text screen, and 19 were included in the rapid review based on our inclusion criteria. Seven studies were systematic reviews (4 of which included a meta-analysis), and 12 were randomized controlled trials (RCTs). *Figure 1* shows a PRISMA diagram of the study screening and selection process. All included articles were peer-reviewed.

The active study period described in included articles ranged from 1999 and 2018. Four studies (20%) had unspecified study periods: one systematic review,[11] one systematic review and meta-analysis,[20] and two RCTs.[17,24] Of the five remaining systematic reviews, reported study periods ranged from 8 to 18 years; of the 10 remaining RCTs, study periods ranged from <1 to 6 years. The majority of studies were conducted in North America and Europe.

The most-reported cardiovascular disease (CVD) was heart failure (HF) with 15 out of 19 studies (79%) making it their focus ($n = 5$ systematic reviews, $n = 10$ RCTs) (*Table 1*). Patients in the HF group were in all stages of the disease process, with and without implantable devices, such as implantable cardioverter-defibrillators (ICD). The remaining studies ($n = 4$) described clinical outcomes of patients recovering from the acute myocardial infarction (AMI),[27] cardiovascular surgery,[11] post-operative patients requiring an ICD,[16] and chronic cardiovascular conditions.[22]

Telemedicine consultations described in the literature

Asynchronous communication

Asynchronous communication described in the included studies included remote monitoring from implantable cardiac devices ($n = 4$),[14,16,23,26] and patient-initiated data collection and transfer ($n = 9$).[15,17–19,21,24,25,27,28]

Synchronous communication: virtual visits

Synchronous, bi-directional real-time communication between patients and healthcare providers described in the included RCTs consisted of either telephone/audio conference ($n = 6$),[14,18,19,21–23] video conference ($n = 3$),[17,24,27] or the combination of both ($n = 3$).[15,16,18]

Impact of virtual visits on clinical outcomes

Clinical patient outcomes of interest included mortality (all-cause and disease-specific) and healthcare utilization. In the context of the rapid review, healthcare utilization included hospitalizations (all-cause and disease-specific), and visits to the emergency department (ED).

Healthcare utilization

The rates of hospitalizations ranged between 7% and 51% in the remote monitoring patients compared to standard care patients (8.5–55%). Studies reported effects of virtual visits on both all-cause and cardiovascular disease-specific hospitalizations. For all-cause hospitalization rates, four studies reported no difference between patients who were followed up remotely using virtual technology and patients receiving standard follow-up care.[14,21,24,25]

In contrast, three studies reported significantly reduced rate of hospitalizations in remote follow-up patients. Comin-Colet *et al.*[15] reported 25% vs. 45% hospitalization rate, mainly driven by the prevention of CVD and HF-related hospitalizations. Idris *et al.*[17] reported reductions in remote monitoring group in the first 30 days, but not at follow-up. Jimenez-Marrero *et al.*[18] reported statistically significant decreases in cardiovascular-related, HF-related, and all-cause hospitalizations among the telemedicine group.

One study, Luthje *et al.*[23] reported an increased rate of urgent care visits in the remote monitoring group due to early detection of HF decompensation; the researchers commented that patients who were not monitored remotely may have spontaneously improved, which may have explained this discrepancy in urgent care visits between the groups.

For disease-specific (including device-specific) hospitalizations, a number of studies (n = 5) reported a significant reduction in disease-specific hospitalization rates in patients receiving the remote monitoring.[14,15,18,19,26] According to Boriani *et al.*,[14] the 38% reduction in HF-related hospitalizations in their study was mainly affected by a reduction of in-clinic visits. In contrast, the remaining studies ($n = 4$) reported no group differences in hospitalization rates,[21,23,27] or ED visits.[24]

Mortality

Mortality rates reported in the literature ranged 6–15% with no statistically significant difference between patients receiving virtual visits and those receiving standard care. This was true for studies that reported all-cause mortality,[14–17,19,21,25,26] and CVD-specific mortality.[14,21,23] One study reported decreased all-cause mortality (12% vs. 6%) and decreased CVD-related mortality (9% vs. 4%) among the telemedicine group in comparison to standard care.[18]

Findings from systematic reviews and meta-analyses

From 2017 to 2020, seven systematic reviews and meta-analyses evaluated the effects of telemedicine on clinical outcomes of patients with HF (*Table 1*). Findings from critical appraisals of the evidence vary widely, ranging from no effect of telemedicine technologies on clinical health outcomes and mortality to reduced healthcare utilization and mortality rates in patients undergoing telemonitoring compared to those assigned to standard care.

Aronow *et al.*[12] examined the benefits and harms of non-invasive communication technology (i.e. telemonitoring, structured telephone support, videoconferencing) from 58 empirical research studies on patients' survival and hospital admissions; structured telephone support was found to have improved patients' survival and prevented HF-related hospitalizations compared to usual care. Similarly, a systematic review by Kotb *et al.*[20] included 30 RCTs on telemonitoring

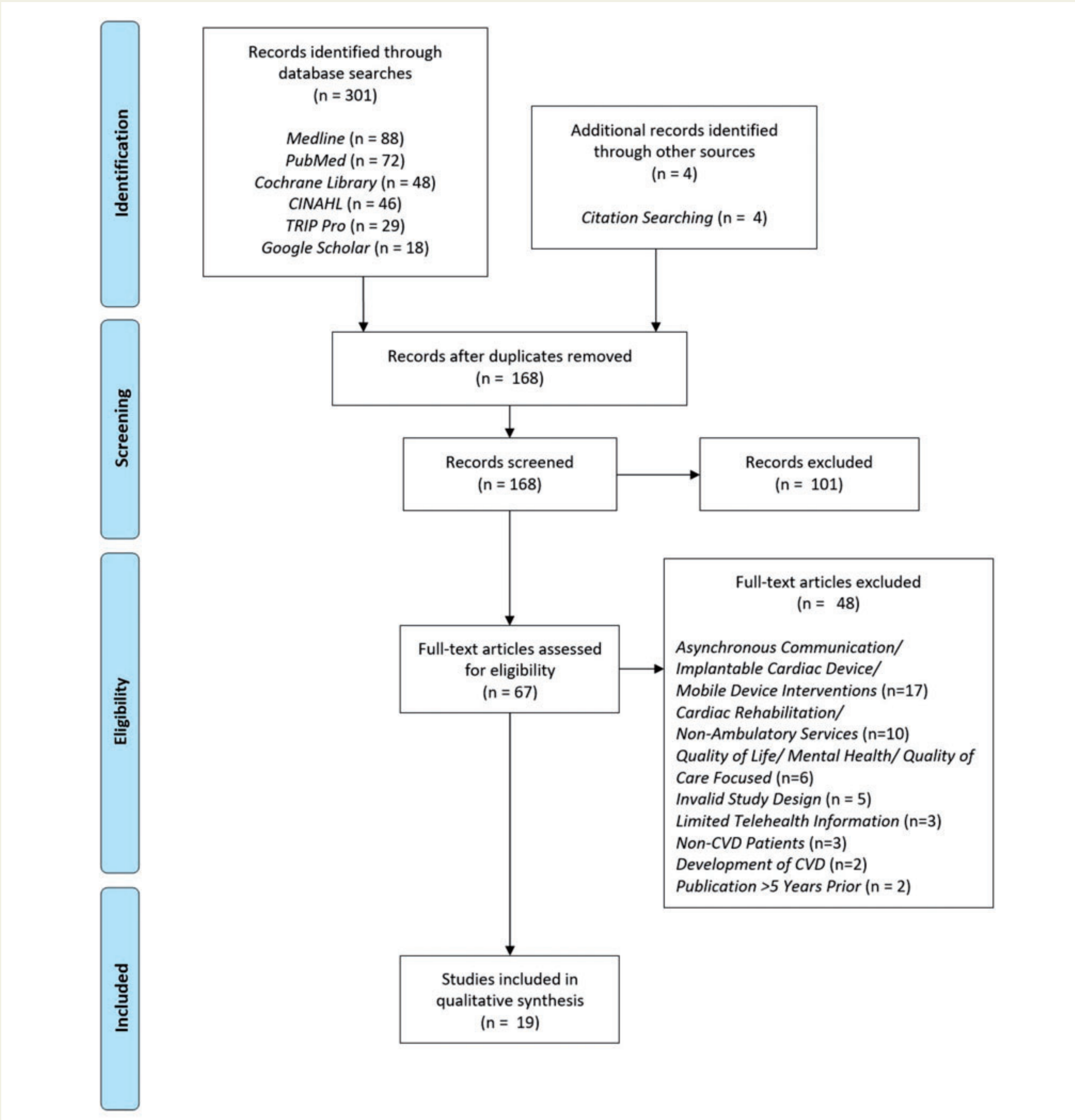

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Flow chart displaying the identification, screening, eligibility, and inclusion of studies in the current rapid review.

interventions in patients with HF concluded that structured telephone support and telemonitoring were successful at reducing the risk of death and hospitalizations due to HF compared to standard care. A similar conclusion was reached by Kruse *et al.*[22] who critically appraised 20 studies and reported that telemedicine successfully reduced readmissions, hospitalizations, and mortality rates of patients with chronic CVD. In contrast, Lin *et al.*[10] reviewed 39 studies on effects of telemedicine in patients with chronic HF, and reported that nurse-led telephone-supported care was no different from standard care at improving clinical outcomes in HF patients, with the exception of reducing HF-related hospitalizations. The authors reported also that teletransmission was successful at improving clinical patient outcomes.[10] Two other systematic reviews by Bashi *et al.*[13] and Zhu *et al.*[28] concluded that telemedicine was associated with a significant reduction in the total number of all-cause and disease-related hospitalizations and mortality.

Table 1 Cardiovascular conditions and virtual visit definitions

Study	Design	Patient population	Implantable device monitoring (Yes/No)	Virtual visit definition
Ajibade *et al.*[11]	Systematic Review.	Cardiac and vascular surgery patients.	Not applicable	Telemonitoring including synchronous and asynchronous communication, and remote monitoring.
Aronow *et al.*[12]	Systematic Review and Meta-Analysis.	Patients with chronic, congestive heart failure.	Not applicable	Non-invasive information technologies including telemonitoring; structured telephone support; and use of personal digital assistants, videophone and conferencing, or interactive voice. Telemonitoring included a remote monitoring of patient biometrics[a] with a digital transmission of the objectively collected data to a monitoring centre with or without video monitoring.
Bashi *et al.*[13]	Systematic Review.	Patients with heart failure.	Not applicable	Telemonitoring (the collection and transmission of clinical data through a remote interface), home telehealth (remote health care delivery or monitoring outside of clinical settings), mobile phone-based monitoring, and videoconferencing.
Boriani *et al.*[14]	Randomized Controlled Trial.	Patients with heart failure.	Yes	Telemonitoring via implantable cardiac devices, including automatic alert transmissions to the healthcare provider, and alternating in office/remote follow-up checks via telephone communication every four months for the duration of the study (i.e. 24 months).
Comin-Colet *et al.*[15]	Randomized Controlled Trial.	Patients with congestive heart failure.	No	Automated telemonitoring of daily biometrics and symptoms and clinical management by means of video or audio conference and/or telephone calls.
Dalouk *et al.*[16]	Prospective Follow-Up Registry Study.	Post-operative patients requiring an ICD.	Yes	Synchronous provider-patient communication for follow-ups via video and audio conferencing through a telemedicine video conferencing clinic, in addition to remote monitoring via ICD.
Idris *et al.*[17]	Randomized Controlled Trial.	Patients with systolic heart failure.	No	Telemonitoring of daily biometrics. The monitored group received standard care in addition to daily remote monitoring; the monitored group received weekly video calls to discuss care issues, answer questions, and monitor compliance with medication regimens and office visits as well.
Jimenez-Marrero *et al.*[18]	Sub-Analysis of a Randomized Controlled Trial.	Patients with chronic heart failure and LVEF $\geq$ 40%.	No	Post-discharge video conference or audio conference calls in addition to remote self-monitoring of HF signs and symptoms. Automated algorithms looked for early signs of decompensation which were reviewed by nurses on a daily basis.
Koehler *et al.*[19]	Randomized Controlled Trial.	Patients admitted to the hospital with worsening heart failure.	No	Telemonitoring of daily biometrics and self-rated health status. The monthly telephone interviews with healthcare providers were an integral part of the remote patient management intervention. Weekly video calls were also implemented to discuss care issues, answer patients' questions, and monitor patient compliance with medication regimens.
Kotb *et al.*[20]	Systematic Review and Meta-Analysis.	Patients with heart failure.	Not applicable	Telephone support, telemonitoring, video monitoring, or electrocardiographic monitoring.
Kraai *et al.*[21]		Patients with worsening heart failure and	No	Telemonitoring of daily biometrics via an electronic health-monitor. In case of deviations in biometric

Continued

Table 1 Continued

Study	Design	Patient population	Implantable device monitoring (Yes/No)	Virtual visit definition
	Randomized Controlled Trial.	underlying structural heart disease.		measurement, the HF nurse contacted patients via telephone to discuss symptoms and possible treatments.
Kruse et al.[22]	Systematic Review.	Patients with cardiovascular disease.	Not applicable	Telehealth was defined as the delivery of health care services using information and communication technologies.
Lin et al.[10]	Systematic Review and Meta-Analysis.	Patients with heart failure.	Not applicable	Teletransmission of biometric data using a home telemonitoring system. For some studies, video consultation equipment (video-based telecare) for a two-way video conference and the telephone-supported care was used.
Luthje et al.[23]	Randomized Controlled Trial.	Patients with heart failure in need of an ICD or CRT-D.	Yes	Telemonitoring of implantable cardiac devices via Medtronic CareLink transmissions and remote follow-up checks via telephone communication at 3, 6, 9 and 12 months, replacing patients' in-office visits.
Nouryan et al.[24]	Randomized Controlled Trial.	Patients with heart failure.	No	Telemonitoring of daily biometrics and a weekly home telemonitoring (i.e. HTM) video visits with a nurse for the assessment of symptoms, vital signs and lung sounds using an electronic stethoscope.
Ong et al.[25]	Randomized Controlled Trial.	Patients receiving active treatment for decompensated heart failure.	No	Telephone coaching calls over a 6-month period, generally from the same call centre nurse, who had access to patients' medical histories and medication records.
Sardu et al.[26]	Randomized Controlled Trial.	Patients with chronic heart failure who received ICD therapy.	Yes	Telemonitoring of transmitted data from the implantable device, followed by a telephone call between study investigator and patients re. clinical parameters. The frequency of telephone consultations was left to the discretion of the investigators.
Treskes et al.[27]	Randomized Controlled Trial.	Patients hospitalized with AMI.	No	Virtual visits (i.e. e-visit) consisted of a video communication meeting between a nurse practitioner and a patient. This mode of virtual communication replaced regular follow-up visits at one and six months.
Zhu et al.[28]	Meta-Analysis.	Patients with heart failure.	No	Telemedicine treatments included: telephone support, telemonitoring involving interactive vocal response monitoring, and monitoring by ECG.

AMI, acute myocardial infarction; CRT-D, implantable cardiac resynchronization therapy defibrillator; ECG, electrocardiogram; ICD, implantable cardioverter-defibrillator; LVEF, left ventricular ejection fraction.
[a]Biometrics = blood pressure, weight, pulse oximetry electrocardiography, and other characteristics.

Healthcare provision and monitoring

Healthcare provision and monitoring for patients in the virtual visit groups differed by provider type, the information provided during virtual visits, and frequency and length of follow-up (*Table 2*). Treatment providers ranged from physician specialists, primary care physicians, study clinicians, to nurse practitioners and registered nurses. Mode of communication during virtual visits between providers and patients included telephone follow-up and videoconferencing technology. While some virtual visits were scheduled consultations as per follow-up protocol, other calls occurred at the discretion of healthcare providers, often based on patients' clinical data and symptoms.

Facilitators and barriers of virtual visits

Patient-level factors were reported as major facilitators of successful virtual visits. These included high adherence to the intervention protocol which was reported as a facilitator in $n = 4$ studies,[15,23–25] and patient empowerment due to inclusion in care decision making ($n = 3$).[17,19,27] Other facilitators included technology-related factors, such as the reliable transmission of biometrics and alerts ($n = 1$) and simplicity of the technology, and healthcare provider-level factors, such as flexible monitoring time by healthcare providers.[21] Non-adherence to intervention protocol, by both patients and healthcare providers, was a single most frequently reported barrier to virtual

Table 2. Provider of Care, Structure of Virtual Visit, and Follow-Up Parameters of Randomized Controlled Trials

Study	Care provider	Information collected during virtual visits	Follow-up parameters
Boriani *et al.*[14]	Cardiology Centres (Multi-Centre)	Automatic alert transmission (alerts set for lung fluid accumulation, atrial tachyarrhythmia, and system integrity) to the healthcare provider.	Median follow-up of 24 months; follow-up appointments in-office. Patients in the intervention group received remote checks alternating with in-office visits.
Comin-Colet *et al.*[15]	Heart Failure Outpatient Clinic (Single-Centre)	Home Tele-Healthcare platform consisted of tracking of patient biometrics[a] questionnaire- prompted self-report of symptoms, warning alarms and alerts (abnormal biometric data, system integrity).	6-month follow-up. Patients in the control group received telemonitoring and in-person follow-ups; patients in the intervention group received telemonitoring and synchronous, structured video conference/audio conference follow-up appointments.
Dalouk *et al.*[16]	Cardiology Centres (Multi-Centre)	Provider–patient communication regarding ICD function and optimization of therapy. Data collected with remote monitoring were unspecified.	Postoperative patients in the intervention group had remote video conferencing follow-ups. The mean duration of follow-up was 4.8 years.
Idris *et al.*[17]	Outpatient Clinic with Cardiologist Referrals (Single-Centre)	Telemonitoring of daily biometrics (oxygen saturation, blood pressure, heart rate, and weight).	3-month follow up. Patients in the intervention group received daily remote monitoring of biometrics, as well as weekly video conference follow-up calls, in addition to standard care.
Jimenez-Marrero *et al.*[18]	Primary Care Centre (Single-Centre)	Remote monitoring via patient self-reporting of biometrics and cardiovascular symptoms; an automated algorithm automatically identified early signs of decompensation.	Follow-up for 6 months. Patients in the intervention group had remote structured follow-ups via video and audio conferencing, in addition to self-monitoring of biometrics and cardiovascular symptoms.
Koehler *et al.*[19]	Hospitals and Cardiology Centres (Multi-Centre)	Daily transmission of weight, blood pressure, heart rate, analysis of heart rhythm, SpO2, and a self-rated health status (scale range one to five) to the telemedical centre.	Follow-up for a minimum of 24 months to a maximum of just over 12 months. Patients in the intervention group received monthly structured telephone calls from a nurse and in-person follow-ups every 3 months (at months 3, 6, 9, and 12) from their local GP or cardiologist.
Kraai *et al.*[21]	*Hospitals:* Intensive Care/Coronary Care/Cardiology Wards (Multi-Centre)	Patients asked to record weight and blood pressure once a day, and an ECG in case of starting or up titration of Beta-blockers. Daily questionnaires were computer-generated and based off of patients' reported biometrics.	9-month follow-up. The intervention groups consisted of one group receiving ICT-guided DMS with CDSS without telemonitoring, the other group received ICT-guided-DMS with CDSS and telemonitoring. There was no control group. Patients in the telemonitoring intervention group were only permitted to visit the cardiologist/HF nurse in-person in case of absolute need for intervention.
Luthje *et al.*[23]	Cardiology Centre (Single-Centre)	Fluid monitoring of all patients via OptiVol Fluid Index; telemonitoring of implantable cardiac devices.	15-month follow-up. Patients receiving CRT-D or DR-ICD implants received RM including OptiVol ON (remote arm) vs. RM OFF (standard arm). Remote follow-up checks were conducted via telephone.
Nouryan *et al.*[24]	Hospitals, Cardiology Centres, Heart Failure Clinics (Multi-Centre)	Daily remote monitoring of symptoms and vital signs. Patients received a video monitor, blood pressure cuff, stethoscope, weight scale, and SpO2 monitor. Weekly virtual nursing visits consisted of checking vital signs and	6-month follow-up. The intervention group received home telemonitoring (HTM) and the control group received comprehensive outpatient management (COM). Daily symptoms and vital sign monitoring were transmitted to a nursing provider station. COM

Continued

Table 2. Continued

Study	Care provider	Information collected during virtual visits	Follow-up parameters
		listening for any abnormal lung sounds using stethoscope, discussion of lifestyle interventions.	patients (standard care/control group) were followed by their primary cardiologist or HF clinic.
Ong *et al.*[25]	Medical Centres, Major Heart Transplant Centres (Multi-Centre)	Home telemonitoring of weight, blood pressure, heart rate, and symptoms. Patients received a weight scale, blood pressure and heart rate monitor, integrated with a device that could display text questions and send simple text responses.	Follow-up for 6 months. Intervention patients were scheduled to receive 9 telephone calls over a 6-month period; calls started 2–3 days post-discharge, initially weekly, until after the first month and were then conducted monthly.
Sardu *et al.*[26]	Medical Centres (Multi-Centre)	All patients received a CRT-D and a small portable patient device to record and transmit data.	12-month follow-up. Transmitted data (TM group) were reviewed by a central monitoring unit of nurses and physicians. All patients were scheduled for in office follow-up visits 10 days after clinical discharge and after 1, 3, 6, and 12-months by the treating physician.
Treskes *et al.*[27]	Cardiology Department (Single-Centre)	Patients received smartphone-compatible devices (weight scale, blood pressure monitor, rhythm monitor, and step counter). Patients were asked to record their steps continuously, their BP and weight daily, and their ECG daily and to record symptoms of possible cardiac origin.	12-month follow-up. Follow-up visits at months 1-, 3-, 6-, and 12-months post-AMI. In the intervention group, follow-up visits at months 1 and 6 were conducted virtually via videoconference with a nurse practitioner.

AMI, acute myocardial infarction; BP, blood pressure; CDSS, computer decision support system; COM, comprehensive outpatient management; CRT-D, implantable cardiac resynchronization therapy defibrillator; ECG, electrocardiogram; ED, emergency department; GP, general practitioner; HF, heart failure; HTM, home telemonitoring; ICD, implantable cardioverter-defibrillator; ICT-guided DMS, information communication guided disease management system; IQR, interquartile range; OptiVol, OptiVol fluid index; RM, remote monitoring; SpO2, peripheral capillary oxygen saturation; TM, telemonitoring.
[a]Biometrics = weight, heart rate, and blood pressure.

Table 3 Critical appraisal results of included systematic reviews using the AMSTAR 2 critical appraisal tool

Study	Design	Quality	Assessment tool
Ajibade *et al.*[11]	Systematic Review	Critically Low	AMSTAR 2
Aronow *et al.*[12]	Systematic Review and Meta-Analysis	Moderate	AMSTAR 2
Bashi *et al.*[13]	Systematic Review	High	AMSTAR 2
Kotb *et al.*[20]	Systematic Review and Meta-Analysis	Moderate	AMSTAR 2
Kruse *et al.*[22]	Systematic Review	Critically Low	AMSTAR 2
Lin *et al.*[10]	Systematic Review and Meta-Analysis	High	AMSTAR 2
Zhu[28]	Meta-Analysis	Moderate	AMSTAR 2

visits ($n = 6$).[15,21,23–26] Multiple comorbidity conditions were reported as a barrier in a single study.[14]

Quality assessment

Systematic reviews

Table 3 summarizes the quality assessment of systematic reviews.[29] Of the 7 systematic reviews, quality levels ranged from critically low to high: 22 studies were rated as high,[10,13] 3 were rated as moderate,[12,20,28] and 2 were rated as critically low.[11,22]

Randomized controlled trials

Quality assessment of RCTs is shown in *Table 4*. Of the 12 RCTs, quality index scores ranged from 18 to 25 on a scale of 1–28 (see Supplementary material online, *SC* for the comprehensive item list). A

Table 4 Critical Appraisal Results of Included Randomized Controlled Trials using the Downs and Black Checklist

Study	Design	Quality index (out of 28)	Assessment tool
Boriani *et al.*[14]	Randomized Controlled Trial	25	Downs and Black Checklist
Comin-Colet *et al.*[15]	Randomized Controlled Trial	23	Downs and Black Checklist
Dalouk *et al.*[16]	Prospective Follow-Up Registry Study	20	Downs and Black Checklist
Idris *et al.*[17]	Randomized Controlled Trial	19	Downs and Black Checklist
Jimenez-Marrero *et al.*[18]	Sub-Analysis of a Randomized Controlled Trial	18	Downs and Black Checklist
Koehler *et al.*[19]	Randomized Controlled Trial	23	Downs and Black Checklist
Kraii *et al.*[21]	Randomized Controlled Trial	23	Downs and Black Checklist
Luthje *et al.*[23]	Randomized Controlled Trial	19	Downs and Black Checklist
Nouryan *et al.*[24]	Randomized Controlled Trial	18	Downs and Black Checklist
Ong *et al.*[25]	Randomized Controlled Trial	19	Downs and Black Checklist
Sardu *et al.*[26]	Randomized Controlled Trial	22	Downs and Black Checklist
Treskes *et al.*[27]	Randomized Controlled Trial	21	Downs and Black Checklist

Item 27 of the Downs and Black checklist was scored out of 1 for a total maximum score of 28. A score of 26–28 is considered excellent; 20–25 is considered good; 15–19 is considered fair; and ≤14 is considered poor. See Supplementary material online, *SC* for the comprehensive item list.

score of 26–28 is considered excellent; 20–25 is considered good; 15–19 is considered fair; and ≤14 is considered poor. Seven RCTs scored within 18–21,[16–18,23–25,27] and 5 scored within 22–25.[14,15,19,21,26]

Discussion

In this rapid review, we summarized the evidence on the impact of virtual visits on clinical outcomes of ambulatory patients with CVD. We reviewed twelve randomized-control trials (RCTs), including 5508 participants, of whom 1726 were female and 3782 were male, ranging between 58.5 and 84.9 years of age. Ten RCTs (83%) focused on telemedicine in HF. Evidence from 7 systematic reviews, spanning 232 RCTs and systematic reviews, was included. Five (71%) of the systematic reviews focused on HF in telemedicine.

Based on our appraisal, virtual visits are either non-inferior, or more effective, in reducing hospitalizations and ED visits in patients with CVD. As suggested by Nouryan *et al.*,[24] higher adherence to telemonitoring protocol in their study resulted in fewer all-cause hospitalizations and ED visits compared to patients receiving standard care. This is in line with reports regarding medication adherence whereby high adherence significantly improved survival of HF patients while low adherence,[31] or non-adherence, to medication protocols correlated with risk of mortality and CVD-related hospitalizations.[32] In the current review, adherence to the telemedicine intervention protocol was identified as a facilitator of favourable clinical outcomes in CVD patients, alongside patient empowerment. In other words, patient involvement in treatment, bi-directional dialog, and rapport with healthcare providers, as well as increased decision-making capacity, promoted favourable clinical outcomes. The evidence for a superior effect of virtual visits in reducing mortality was not supported in this rapid review. While the rapid review reflects what has been reported in the previous systematic reviews on the impact of telemedicine to reduce healthcare utilization of patients with CVD compared to standard treatment,[10–13,20,22,28] we found no evidence to suggest that virtual visits are superior in reducing mortality apart from a single report by Lin *et al.*[10] who reported decreased mortality as a result of virtual visits.

Telemedicine is a communication modality that is useful as an intervention; however, technology alone cannot be expected to alter CVD patient outcomes.[28] Zhu *et al.*[28] noted that telemedicine reflects complex healthcare strategies, which cannot be limited to a simple amassing of data. Telemedicine is heterogeneous in its clinical parameters and interventions. The interventions are often ill-defined, making comparisons among studies difficult. The heterogeneity of communication technology, interventions, and communication parameters in reported studies indicates insufficient standardization of telemedicine for remote monitoring—including terminology for technologies and communications, healthcare provider involvement, follow-up parameters, and intervention modes. With the increase of CVD prevalence globally,[33] and in addition to its treatment and management complexity, patient monitoring needs to be timely to reduce reliance on patient self-efficacy, and to mitigate healthcare system strain. Heart failure dominant telemedicine-focused research in CVD and detrimental effects of HF on patient and health-system level outcomes indicate that affected patients are significant users of healthcare resources. Therefore, making HF monitoring programs more accessible with virtual options may benefit patients, their family caregivers, and health systems.[28] While the current evidence suggests that telemedicine can complement and promote healthcare delivery, monitoring, and management of patients with CVD, more guidance regarding intended applications of telemedicine is required.[34] In the context of the COVID-19 pandemic and its effect on telemedicine in healthcare, it is worth mentioning that virtual visits in Canada increased from ≈1% pre-pandemic to 70% 4 weeks into the pandemic.[35] In response, the Canadian Medical Association (CMA) Virtual Care Task Force provided recommendations for virtual care in Canada, stating that the aim is to improve access and establish excellence that upholds care quality while supporting care continuity within healthcare teams.[36]

Lastly, it is important to note potential limitations of the rapid review, which by virtue of its methodology (mainly the rapid synthesis of evidence) required streamlining of PRISMA guidelines.[9] While the review focused on studies with strong methodologies, such as RCTs and systematic reviews, the timeline was restricted to the last 5 years and excluded grey literature. This was done due to a large volume of literature addressing the rapidly changing, heterogeneous definitions and practices that fall under the umbrella terms of virtual visits in CVD. As our goal was a rapid review to inform practice on the safety and efficacy of virtual care, we inadvertently excluded a number of potentially informative studies, thus acknowledging that we may have excluded studies outside of our 5-year inclusion criteria. The outcomes of interest in the rapid review were limited to health utilization and mortality and did not include other patient-level outcomes, such as treatment satisfaction and quality of life, or health-system level outcomes. Additionally, treatment provision of care was broad and not restricted to a single healthcare provider. It is therefore unclear if provider type affects virtual visits within patient-level outcomes. Finally, there is the heterogeneity of virtual visit definitions, which reflects a lack of consensus in the literature on definitions of telehealth, telemedicine, and virtual visits. It is imperative to define the meaning of virtual visits across studies being compared to better discern if differences in clinical outcomes are due to virtual visit parameters or the communication modality.

Conclusions

With the increase in rates of CVD prevalence and the COVID-19 pandemic, patient monitoring has moved towards telemedicine. In this rapid review, we summarized the evidence on the impact of virtual visits compared to in-clinic visits on clinical outcomes of ambulatory patients with CVD. Based on our appraisal of evidence, virtual visits are either non-inferior to- or more effective than traditional care in reducing hospitalizations and ED visits in patients with CVD. The evidence for a superior effect of virtual visits in reducing mortality was not supported in this rapid review. Given that HF patient care dominates telemedicine-focused research in CVD, making HF monitoring programs more accessible has the potential to benefit patients, their family caregivers, and health systems. While more research is needed, telemedicine is an appropriate tool for CVD follow-up care.

Supplementary material

Supplementary material is available at *European Journal of Cardiovascular Nursing.*

Data Availability

Manuscripts used in this review were retrieved via the University of Alberta library and are also available through Google Scholar a freely accessible web search engine that indexes the full text or metadata of scholarly literature across formats and disciplines.

Acknowledgements

The authors would like to thank senior knowledge management consultants Patricia Hanson and Meenakshi Kashyap with Knowledge Resource Services at Alberta Health Services for providing expert resources for conducting the literature search.

Conflict of interest: none declared.

Funding

Funding for this work was provided by the Cardiovascular Health and Stroke Strategic Clinical Network™, Alberta Health Services.

References

1. Nikus K, Lähteenmäki J, Lehto P, Eskola M. The role of continuous monitoring in a 24/7 telecardiology consultation service—a feasibility study. *J Electrocardiol* 2009;**42**:473–480.
2. Molinari G, Molinari M, Biase MD, Brunetti ND. Telecardiology and its settings of application: an update. *J Telemed Telecare* 2018;**24**:373–381.
3. Heart Disease in Canada. Canada: Public Health Agency of Canada; 2017.
4. World Health Organization. Cardiovascular diseases. https://www.who.int/health-topics/cardiovascular-diseases/#tab=tab_1 (accessed 27 January 2021).
5. Owens B. Telemedicine on the rise but lagging in Canada. *CMAJ News* 2018;**190**:E1149–E1150.
6. Modayil M, Cook C, Cook L, Lunney M, Golonka R. *Rapid Review: Virtual vs In-person Care*. AB, Canada: Alberta Health Services; 2020.
7. Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;**6**:e1000097.
8. Dobbins M. *Rapid Review Guidebook*. Hamilton, ON: National Collaborating Centre for Methods and Tools; 2017.
9. Moons P, Goossens E, Thompson DR. Rapid reviews: the pros and cons of an accelerated review process. *Eur J Cardiovasc Nurs* 2021;**20**:515–519.
10. Lin M-H, Yuan W-L, Huang T-C, Zhang H-F, Mai J-T, Wang J-F. Clinical effectiveness of telemedicine for chronic heart failure: a systematic review and meta-analysis. *J Investig Med* 2017;**65**:899–911.
11. Ajibade A, Younas H, Pullan M, Harky A. Telemedicine in cardiovascular surgery during COVID-19 pandemic: a systematic review and our experience. *J Card Surg* 2020;**35**:2773–2784.
12. Aronow WS, Shamliyan TA. Comparative effectiveness of disease management with information communication technology for preventing hospitalization and readmission in adults with chronic congestive heart failure. *J Am Med Dir Assoc* 2018;**19**:472–479.
13. Bashi N, Karunanithi M, Fatehi F, Ding H, Walters D. Remote monitoring of patients with heart failure: an overview of systematic reviews. *J Med Internet Res* 2017;**19**:e18.
14. Boriani G, Da Costa A, Quesada A, Ricci RP, Favale S, Boscolo G, Clementy N, Amori V, Mangoni di S. Stefano L, Burri H; on behalf of the MORE-CARE Study Investigators. Effects of remote monitoring on clinical outcomes and use of healthcare resources in heart failure patients with biventricular defibrillators: results of the MORE-CARE multicentre randomized controlled trial. *Eur J Heart Fail* 2017;**19**:416–425.
15. Comín-Colet J, Enjuanes C, Verdú-Rotellar JM, Linas A, Ruiz-Rodriguez P, González-Robledo G, Farré N, Moliner-Borja P, Ruiz-Bustillo S, Bruguera J. Impact on clinical events and healthcare costs of adding telemedicine to multidisciplinary disease management programmes for heart failure: results of a randomized controlled trial. *J Telemed Telecare* 2016;**22**:282–295.
16. Dalouk K, Gandhi N, Jessel P, MacMurdy K, Zarraga IG, Lasarev M, Raitt M. Outcomes of telemedicine video-conferencing clinic versus in-person clinic follow-up for implantable cardioverter-defibrillator recipients. *Circ Arrhythm Electrophysiol* 2017;**10**:e005217.
17. Idris S, Degheim G, Ghalayini W, Larsen TR, Nejad D, David S. Home telemedicine in heart failure: a pilot study of integrated telemonitoring and virtual provider appointments. *Rev Cardiovasc Med* 2015;**16**:156–162.
18. Jiménez-Marrero S, Yun S, Cainzos-Achirica M, Enjuanes C, Garay A, Farre N, Verdú JM, Linas A, Ruiz P, Hidalgo E, Calero E, Comín-Colet J. Impact of telemedicine on the clinical outcomes and healthcare costs of patients with chronic heart failure and mid-range or preserved ejection fraction managed in a multidisciplinary chronic heart failure programme: a sub-analysis of the iCOR randomized trial. *J Telemed Telecare* 2020;**26**:64–72.
19. Koehler F, Koehler K, Deckwart O, Prescher S, Wegscheider K, Kirwan B-A, Winkler S, Vettorazzi E, Bruch L, Oeff M, Zugck C, Doerr G, Naegele H, Störk S, Butter C, Sechtem U, Angermann C, Gola G, Prondzinsky R, Edelmann F,

Spethmann S, Schellong SM, Schulze PC, Bauersachs J, Wellge B, Schoebel C, Tajsic M, Dreger H, Anker SD, Stangl K. Efficacy of telemedical interventional management in patients with heart failure (TIM-HF2): a randomised, controlled, parallel-group, unmasked trial. *Lancet* 2018;**392**:1047–1057.
20. Kotb A, Cameron C, Hsieh S, Wells G. Comparative effectiveness of different forms of telemedicine for individuals with heart failure (HF): a systematic review and network meta-analysis. *PLoS One* 2015;**10**:e0118681.
21. Kraai I, de Vries A, Vermeulen K, van Deursen V, van der Wal M, de Jong R, van Dijk R, Jaarsma T, Hillege H, Lesman I. The value of telemonitoring and ICT-guided disease management in heart failure: results from the IN TOUCH study. *Int J Med Inform* 2016;**85**:53–60.
22. Kruse CS, Soma M, Pulluri D, Nemali NT, Brooks M. The effectiveness of telemedicine in the management of chronic heart disease - a systematic review. *JRSM Open* 2017;**8**:2054270416681747.
23. Lüthje L, Vollmann D, Seegers J, Sohns C, Hasenfuß G, Zabel M. A randomized study of remote monitoring and fluid monitoring for the management of patients with implanted cardiac arrhythmia devices. *Eurospace* 2015;**17**:1276–1281.
24. Nouryan CN, Morahan S, Pecinka K, Akerman M, Lesser M, Chaikin D, Castillo S, Zhang M, Pekmezaris R. Home telemonitoring of community-dwelling heart failure patients after home care discharge. *Telemed J E-Health* 2019;**25**:447–454.
25. Ong MK, Romano PS, Edgington S, Aronow HU, Auerbach AD, Black JT, De Marco T, Escarce JJ, Evangelista LS, Hanna B, Ganiats TG, Greenberg BH, Greenfield S, Kaplan SH, Kimchi A, Liu H, Lombardo D, Mangione CM, Sadeghi B, Sadeghi B, Sarrafzadeh M, Tong K, Fonarow GC. Better Effectiveness After Transition–Heart Failure (BEAT-HF) Research Group. Effectiveness of remote patient monitoring after discharge of hospitalized patients with heart failure: the better effectiveness after transition—heart failure (BEAT-HF) randomized clinical trial. *JAMA Internal Med* 2016;**176**:310–318.
26. Sardu C, Santamaria M, Rizzo MR, Barbieri M, di Marino M, Paolisso G, Santulli G, Marfella R. Telemonitoring in heart failure patients treated by cardiac resynchronisation therapy with defibrillator (CRT-D): the TELECART study. *Int J Clin Pract* 2016;**70**:569–576.
27. Treskes RW, van Winden LAM, van Keulen N, van der Velde ET, Beeres SLMA, Atsma DE, Schalij MJ. Effect of smartphone-enabled health monitoring devices vs regular follow-up on blood pressure control among patients after myocardial infarction: a randomized clinical trial. *JAMA Netw Open* 2020;**3**:e202165.
28. Zhu Y, Gu X, Xu C. Effectiveness of telemedicine systems for adults with heart failure: a meta-analysis of randomized controlled trials. *Heart Fail Rev* 2020;**25**:231–243.
29. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J, Moher D, Tugwell P, Welch V, Kristjansson E, Henry DA. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non randomised studies of healthcare interventions, or both. *BMJ* 2017;**358**:j4008.
30. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998;**52**:377–384.
31. Wu J-R, Moser DK, De Jong MJ, Rayens MK, Chung ML, Riegel B, Lennie TA. Defining an evidence-based cutpoint for medication adherence in heart failure. *Am Heart J* 2009;**157**:285–291.
32. Fitzgerald AA, Powers JD, Ho PM, Maddox TM, Peterson PN, Allen LA, Masoudi FA, Magid DJ, Havranek EP. Impact of medication nonadherence on hospitalizations and mortality in heart failure. *J Card Fail* 2011;**17**:664–669.
33. Thomas H, Diamond J, Vieco A, Chaudhuri S, Shinnar E, Cromer S, Perel P, Mensah GA, Narula J, Johnson CO, Roth GA, Moran AE. Global atlas of cardiovascular disease. *Glob Heart* 2018;**13**:143–163.
34. Kuehn BM. Telemedicine helps cardiologists extend their reach. *Circulation* 2016;**134**:1189–1191.
35. Wosik J, Fudim M, Cameron B, Gellad ZF, Cho A, Phinney D, Curtis S, Roman M, Poon EG, Ferranti J, Katz JN, Tcheng J. Telehealth transformation: COVID-19 and the rise of virtual care. *J Med Inform Assoc* 2020;**27**:957–962.
36. Virtual Care Task Force. *Virtual Care: Recommendations for Scaling-up Virtual Medical Services.* Canada: Canadian Medical Association; 2020.