European Review for Medical and Pharmacological Sciences 2021; 25: 3386-3394

Digital health technology for remote care in response to the COVID-19 pandemic: a scoping review

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Abstract. – **COVID-19 pandemic has forced the emergency deployment of digital health technology (DHT) to provide remote care. DHT is a promising option to enable telehealth, and, by the same token, it contributes to the implementation of social distance measures. The objective of this scoping review is to investigate existing DHT solutions that have been put in place to enable remote care in response to the COVID-19 pandemic. Structured literature searches were performed in Medline (Ovid), Scopus and CINAHL with Full Text (EBSCOhost), with a mix of keywords and controlled vocabulary unique to each database. The librarian utilized the search strategy on respiratory pandemics created in April 2020 for Medline (Ovid) by Canadian Agency for Drugs and Technology in Health (CADTH). An additional search for grey literature was performed including pre-prints and reports in Google Advanced, LitCovid and MedRx. Two independent reviewers assessed the articles retrieved from the databases (n=131) based on pre-established inclusion criteria and included six articles. Analysis of the results revealed six different types of DHT, including 5 dedicated to telemedicine and one used to track activity of people who were confined to their homes. The results showed positive health-related outcomes and user behavior outcomes. This review revealed that there is limited literature on the use of DHT to enable remote care in response to a pandemic and therefore calls for more documentation of the ongoing deployment of DHTs to support patient safety and the delivery of quality care during the COVID-19 pandemic and beyond.**

Key Words:
Digital health, Telehealth, Information, COVID-19, Coronavirus, Evaluation, Physical distancing, Isolation, Confinement.

Introduction

COVID-19 has abruptly changed the world view of pandemics with direct consequences for global health and the economy. More than 7.2 million cases have occurred worldwide within only six months of the first outbreak of the disease, including more than 400,000 deaths[1]. According to statistics from the World Health Organization, the disease has spread and affected around 210 countries, with the United States confirming about half of all global cases[1]. In addition to the global health crisis, the COVID-19 pandemic has caused enormous economic losses; for example, 16% unemployment rate in the U.S.[2], more than 3 million people have suffered the loss of their jobs in Canada since the onset of the pandemic[3], and a projected global 2.4% gross domestic product loss has led to an international decline as predicted by several economists[4]. Global economic markets have experienced severe decline and volatility at the same higher levels than the economic crisis of 2008/2009[5].

In addition to high transmission rates and the lack of vaccination, many countries have adopted strict regulations to enforce physical distancing and mass closures, thus reducing adverse effects and gaining more time to develop pharmaceutical solutions. In the presence of infectious diseases, such as SARS, H1N1, and COVID-19, physical distancing has been identified as a successful non-pharmaceutical approach to disease spread control[6-8]. In fact, passively waiting for herd immunity from pandemics is not a viable option as waiting for enough people to catch the virus could take a very long time. Waiting for herd immunity

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could also place an unbearable strain on the resources of healthcare institutions and hospitals could be filled very quickly beyond their capabilities. Physical distancing is defined as the measures that reduce disease transmission by reducing the rate of human physical contact, such as closing public places (e.g., workplaces, schools, and community centers), avoiding group crowds, and maintaining a sufficient distance between people[6,9]. By reducing the probability of cross-transmission of the disease, physical distancing could significantly reduce the spread and the severity of the disease. Physical distancing measures can play a crucial role in reducing the rate of infection and delaying the peak of contamination if they are properly implemented at the early stages of a pandemic, thereby reducing the burden on healthcare systems and lowering the mortality rate[6-8]. The evidence from early adoption of physical distancing is strong in the data from China, especially when compared to evidence from countries that are less strict with the adoption of physical distancing, such as Italy which has applied more slow and sporadic physical distancing procedures.

The main measures that have been put in place by the various governments for physical distancing are border control, travel restrictions, warning citizens to stay more than 2 meters away from each other when they need to go outside for essential travel and to close public places[10-12]. However, such large-scale and aggressive measures are not easy to implement, as not all public spaces can be closed, and people still need to go outside for medical reasons, grocery, or essential work. Due to these limitations, digital health technologies (DHT) can play an important role in facilitating physical distancing practices. In particular, health institutions are places that remain open to the public and active in times of pandemics. This places patients, caregivers, and staff and healthcare professionals at imminent risks of transmission of the virus. DHT is one venue to support the policies and procedures in place for physical distancing by enabling remote care whenever possible.

For example, wireless positioning systems can help people to keep a safe distance in an effective way by measuring the distances between people and alerting them when they are too close to each other[13]. In addition, other technologies such as Artificial Intelligence (AI) can be used to facilitate or even enforce physical distancing[14]. Also, there are hundreds of mobile apps available for tracking, screening and alerting the cases[15]. However, DHTs supporting remote care do not seem to be widely known to the decision makers as only a few solutions are documented. The objectives of this study are therefore: 1) to portray the DHT used by healthcare institutions to enable and support remote care during a pandemic, 2) to describe the initiatives that have been documented and evaluated with end-users, and 3) to identify gaps in the implementation of technology-enabled physical distancing interventions in order to inform future developments.

Materials and Methods

Study Design

Literature corresponding to the topic of DHT for remote care in response to a pandemic is emerging and disparate; therefore, a scoping review was carried out to collect published literature with a wide range of study designs and grey literature types without exclusions on the basis of country of publication or year of publication[16-18]. Results are reported following the recommendation in the literature[19].

Search Strategy

A medical librarian searched the following databases: Medline (Ovid), Scopus and CINAHL with Full Text (EBSCOhost). The initial search was constructed in Ovid Medline (Ovid MEDLINE(R)) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily) in June 2020, and then, translated to the other databases. The search was constructed with a mix of keywords and controlled vocabulary unique to each database. The librarian utilized the search strategy on respiratory pandemics created in April 2020 for Medline (Ovid) by Canadian Agency for Drugs and Technology in Health (CADTH)[20]. The search for grey literature included pre-prints and reports in Google Advanced, LitCovid and MedRx. All references were uploaded into EndNote (version X8, Clarivate Analytics, Philadelphia, PA, USA) and duplicates were removed. **Appendix 1** presents the search strategy used in this study.

Inclusion and Exclusion Criteria

To be included, manuscripts had to be written in English and presented with information on DHT used to support remote care in response to an epidemic or a pandemic, regardless of the year of publication. Manuscripts had to present empirical data of any kind and published in any of the following

Table I. Description of digital health technology classified by their use cases.

Use of digital Health technology	Digital Health Technology	Description and function	Target users	Country	Ref.
Activity tracking to monitor adherence to home confinement	Wearables	A wristwatch with an embedded accelerometer that counts steps and monitors adherence to home confinement during COVID-19. The performance of this tracker is reported to be one of the best among available devices. Wearable activity trackers for	People who were confined in homes	France	22
Remote physical examination	Mobile App	Various smartphone-based otoscopic attachments to support telemedicine for otology	Otology Patients	USA	23
Teleconsultation	Telephone	Telephone consultation and initial teleconsultation for PrEP-pre-exposure prophylaxis for HIV. Phone consultations are used to substitute or supplement face-to-face consultations for a wide range of patient needs	Populations at substantial HIV risk	Brazil	24
		Telephone follow-up may be helpful to reduce in-office visits burden. They are an effective way to decrease interpersonal contact and to overcome sudden changes to the visitation scheme	Cardiovascular patients	Poland	25
	Teleconference	WhatsApp app. An app that has video calling facility, used as a means for teleconsultation with rheumatology patients	Rheumatology patients	India	26
		Online consultation through "bedsides" or other online platforms-video/virtual visit.	Non-urgent urology patients	USA	27

formats: journal articles, abstracts, theses and project reports. Two independent reviewers performed the search and study selection. To be included, a manuscript had to be judged relevant by both reviewers. If consensus could not be reached, a third reviewer was consulted.

Results

Study Selection

Literature search identified a total of 131 manuscripts. Six manuscripts fully met the criteria for inclusion and were included in the review (Figure 1).

Publication Date, Place of Publication and Publication Channel

All manuscripts were published in 2020. Manuscripts were published in 5 countries, including 2 articles in the US, 1 in Brazil, 1 in France, 1 in Poland, and 1 in India. With regard to the publication channel, all of the manuscripts included were original peer-reviewed journal articles.

Study Designs and Digital Health Technology Readiness Level

All of the articles included were observational studies. The technology readiness level was evaluated at 9 on a scale[21] between 1 and 9 which means that the DHTs involved in the studies were "actual technology proven by successful deployment in an operational setting".

Digital Health Technology

Six different DHTs have been identified and classified into three types as described by the authors (activity tracking, n=1; remote physical examination, n=2; and teleconsultation, n=4) (Table I). Each of the articles included

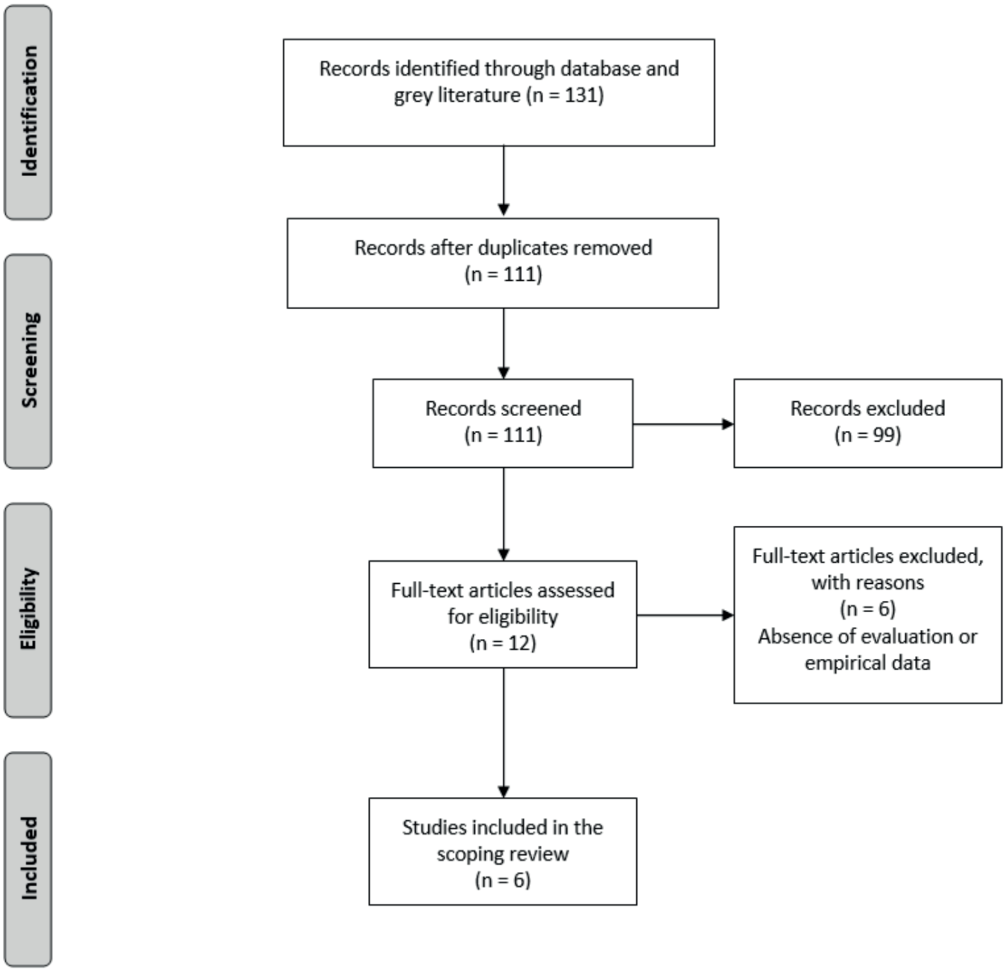

Figure 1. Article selection process[19].

described only one DHT and each article included a different DHT.

Digital Health Technology Outcomes

Clinical focus and health-related outcomes measures

Five DHTs focused on promoting communication between physicians and patients on different teleconsultation needs during the pandemic (Rheumatology[26], Otology[23], non-urgent urology[27], patients at substantial HIV risk[24], and cardiology[25]). None of the studies involved healthcare professionals other than physicians. Effective remote care was evaluated through 3 types of outcomes: "number of outpatient visits", "number of patients consulted", and "number of follow-up with patients" (Table II). DHTs all positively affected the outcomes they were designed to achieve, i.e., attracting patients for teleconsultation, successful remote diagnosis and patient referral.

Only one DHT was used to monitor the adherence to home confinement (activity tracker[22]) which was assessed by observing the "absolute level of physical activity", "increase in the number of steps" and "compliance with lockdown rules" (Table II). The use of the activity tracker resulted in overall good compliance with lockdown rules.

User Behaviour-Related Outcome Measures

Only three DHTs were evaluated for use and user behaviour[23,26,27] by patients' acceptance and satisfaction. The use of DHT was viewed positively by users, both patients and healthcare professionals, with good to high acceptance and satisfaction.

Table II. Digital health technology outcomes.

Digital technology	Target users	Health-related outcome measures	Health-related outcomes	Usage-related outcome measures	Usage-related outcomes	Ref.
WhatsApp app	Rheumatology patients	Number of outpatient visits	Compared with the previous 6-month average of 170 (range 140–240) outpatient visits daily, these 7 days had 67.3 (range 29–117) outpatient visits daily. A moderate positive correlation (r2 = 0.67, p = 0.025) existed between the proportion of patients opting for teleconsultation and the total number of COVID-19 cases reported.	Acceptance of teleconsultation	In the 7 days, 975 out of 1469 appointments were offered teleconsultation of which 723 (74%) agreed, while a total of 275 cancelled or rescheduled appointments. The average number of cancelled appointments rose from 25 to 39 per day (56%)	[26]
				Satisfaction with teleconsultation	Overall median satisfaction was 9 (IQR 8–10) on the NRS scale. The respondents scored median 9.5 (IQR 8–10) on the NRS scale in recommending the continuation of teleconsultation. Under normal conditions, each patient would have brought a median 1 (range 1-2) accompanying persons	
				Ad hoc post-teleconsultation survey	Felt that doctor missed something important in video consultation. Definitely n-5, Maybe n=17, Not sure n=10, Unlikely 11, n= 57	
					Believed that physical distancing will help reduce Pandemic n=92	
					Depended on others for use of WhatsApp video conferencing n=51	
					Availability of personal vehicle n=46	
					Alternative course had telemedicine not been available Come to clinic n=26	
					Stop medicine n=44	
					Self-medicate n=30	
					Seek help elsewhere n=0	
Various smartphone-based otoscopic attachments	Otology Patients	3 patient cases are discussed	* Case 1 was taken to the operating room on prior imaging) on an urgent basis. * Case 2: Ototopical antibiotic/steroid drops were prescribed with a plan for follow-up via a telehealth visit and repeat home otoendoscopy in 10 days. * Case 3: The app-based audiogram revealed markedly improved air conduction thresholds. In-person evaluation was deferred, and follow-up in 3 months with a formal audiogram was scheduled.	Post-implementation qualitative evaluation	Affordable, available, and relatively simple to use. It is incumbent upon physicians, when recommending the use of such devices, to offer guidance to their patients on safe technique and strategies for visualization while avoiding injury.	[23]

Table continued

Table II. ***(Continued).*** Digital health technology outcomes.

Digital technology	Target user	Health-related outcome measures	Health-related outcomes	Usage-related outcome measures	Usage-related outcomes	Ref.
Telemedicine in pediatric urology	Non-urgent urology patients	number of patients consulted	Since the launch of telemedicine program in November 2017 through February 2020 (pre-COVID), completed 973 VVs in 750 unique patients.	Patient satisfaction	Nearly all families were satisfied or very satisfied with their VV experience (97.7%) and would meet with their provider in a VV in the future (97.4%; 47.6% family survey response rate).	27
Telephone consultation and initial teleconsultation for PrEP-pre-exposure prophylaxis for HIV	Populations at substantial HIV risk	3,779 participants are under follow-up	Since the implementation of the telemedicine procedures in March 23, 2020 until June 05, 2020, 564 participants completed the telephone consultation and the initial teleconsultation. The average time spent at the service was reduced in 2 hours (from 3 hours to 1 hour).			24
Wearable Activity Trackers for Monitoring Adherence to Home Confinement during COVID-19	People who were confined in homes	Absolute level of physical activity	Under total home confinement in European countries is around twofold that in China cause of strict rules. In some countries, such as France and Spain, physical activity started to gradually decrease even before official commitment to lockdown			22
		Increase in the number of steps	Physical activity began to increase again in the last 2 weeks, suggesting a decrease in compliance with confinement orders. Countries with partial or no lockdown policies had marginal or no changes in walking habits.			
		Compliance with lockdown rules	In fully locked-down countries, with the exception of Ireland, the number of steps decreased below the maximum on weekends; this shows overall good compliance with lockdown rules.			
teleconsultation	Cardiovascular patients	Patients consulted	Teleconsultations were performed during a 3.5-week period (13.03.2020 to 01.04.2020). Of the 400 patients planned for visits in the ACIM, 349 were consulted by phone. 299 patients confirmed stable health. 14/349 patients reported some symptoms, and 4/349 patients were hospitalized; 2/349 patients changed their primary ACIM and were no longer under our care, 1/349 patient was undergoing quarantine, 15/349 patients required additional intervention			25

Discussion

To our knowledge, this is the first review of the digital health technologies that have been deployed to enable remote care in response to the COVID-19 pandemic. Literature on the topic is very limited, including only six articles. The first objective of this scoping review was to portray the DHTs that were deployed and evaluated to enable and support remote care during an epidemic or a pandemic. DHTs are emerging and therefore present in hundreds on the market. However, the ones that are only a few documented ones. Only six DHTs were identified in the scoping review. Global priority is clearly geared towards the creation of different solutions, usually supported by the technology to manage the spread of the virus at the meso, macro and micro levels. Documenting the outcomes of DHT solutions is therefore more likely to be less of a priority at this stage. However, the DHT assessment is still needed to extract the lessons learned so far from the COVID-19 pandemic, to adjust accordingly and to keep documented material for the post-pandemic future.

The second objective of this scoping review was to describe the initiatives that have been documented and evaluated with end-users. Six different DHTs were identified, including one activity tracker used to track persons at home and different DHTs for remote physical examination and teleconsultation. These DHTs are not complex in nature and are all existing and well-known technologies. Activity trackers are widely used in the field of sport[28] and rehabilitation[29] fields. Telephone and teleconference platforms are widely used for general professional and personal purposes and in telemedicine and telerehabilitation[30]. At this stage, the DHTs implemented involved the deployment of existing information and communication technology in healthcare settings. The necessity of finding assistance to manage a pandemic explains this, and digital solutions are more likely to be the most promising of our time. Surprisingly, there was no documentation available at the time for more advanced. Despite the challenges that these digital solutions face, AI implementation has yet to be reported in the literature[14]. Social robots are another promising communication medium that is likely to be used but not yet documented[31]. Adherence, privacy and protection, as well as standardization and incorporation, are all public issues that must be addressed in order to understand the potential utility of DHT, and related real-world evidence (RWE) used by patients and healthcare providers. In this unprecedented global health emergency and future digital transformation, addressing these challenges will increase the value of data from DHT to inform RWE and enhance patient empowerment and clinical management.

The third goal of this study was to identify gaps in the implementation of technology-enabled physical distancing so that potential progress could be directed. The DHTs were not evaluated in any systematic way. DHT are emerging technologies that have not been well documented in academic publications or governmental reports, so the amount and quality of evidence are still being compiled. The majority of the articles concentrated on optimistic and promising health-related and consumer outcomes. The amount of data and knowledge overlap among the papers included prevents generalizations about discrepancies and potential directions. The information available is based on innovations that are already well-known outside of the medical field (activity trackers, telephone and teleconference platforms). As a result, it is understandable that when reporting on DHT implementation, researchers do not necessarily rely on validated technology assessment methods and tools (e.g., such as the Mobile App Rating Scale[32]).

Although research and technology assessment may not be high on the priority list, the use of DHT to allow and support remote care needs for those who need remote health services should be reported. In the post-COVID world, collecting data on DHT implementation activities will be crucial in bringing about payer-based and legislative changes to promote digital transformation and allow wider DHT use. Practical guidance based on real-world data (RWE) on the use of DHT for remote treatment in response to the COVID-19 pandemic is required due to a lack of evidence. This will allow for the extraction of practical lessons from the healthcare system's experience with the COVID-19 pandemic. Due to consumer demands and a high priority on addressing an urgent public health problem, DHTs are new technologies, and their growth and implementation are significantly faster than clinical trials. The 21st Century Cures Act allows the U.S. Food and Drug Administration (FDA) to recommend the use of RWE over randomized controlled trials when taking actions quickly is the priority[33]. The FDA defines RWE as "data … from electronic health records, claims and billing data, … product and disease registries, patient-generated data … and … other sources that can inform on health status, such as mobile devices"[34]. This scoping review looked at various DHT technologies, but it might be a little early to thoroughly explore the facts of the implementation of DHT. The findings were derived from published literature, but they should not be used to restrict the quantity or efficiency of current deployments. This paper aimed to emphasize the importance of continually documenting and exchanging the lived experiences with DHT during pandemics and disasters. Such a global approach to knowledge sharing would foster joint research and opportunities for collaborative learning about the best remote care interventions based on real-world evidence, leading to enhanced global remote treatment.

Conclusions and Recommendations for Further Research

This review of the use of DHT to enable remote care in response to the COVID-19 pandemic has revealed limited literature on the topic. User research is also very limited in this literature. There is a need to report the current deployment of DHTs to enable remote care in response to the COVID-19 pandemic. Mixed methods are also encouraged in this research and documentation to bring together different perspectives. Future research will have to evaluate DHT through digital health-evidence frameworks, such as the National Institute for Health and Care Excellence's regulatory framework for digital health technologies[35] and address the public concerns about ethics, privacy and security.

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