Digital mHealth and Virtual Care Use in Pandemics: A Rapid Landscape Review of Interventions Used Internationally During COVID-19 in 4 Countries

Alison Müller, Alessandro Cau, Semakula Muhammed, Osman Abdullahi, Andrew Hayward, Richard Lester

Table of Contents

Digital mHealth and Virtual Care Use in Pandemics: A Rapid Landscape Review of Interventions Used Internationally During COVID-19 in 4 Countries

Alison Müller[1] MSc, PhD; Alessandro Cau[1] BSc; Semakula Muhammed[2] MSc; Osman Abdullahi[3] PhD; Andrew Hayward[4] MD, MSc, PhD; Richard Lester[1] MD

[1]Division of Infectious Diseases Department of Medicine University of British Columbia Vancouver CA
[2]Institute of Diseases Prevention and Control Rwanda Biomedical Centre Kigali RW
[3]Department of Public Health School of Health and Human Sciences Pwani University Kilifi KE
[4]Department of Epidemiology & Public Health University College London London GB

Corresponding Author:
Alison Müller MSc, PhD
Division of Infectious Diseases
Department of Medicine
University of British Columbia
575 - Vancouver General Hospital Research Pavilion
828 W 10th Ave
Vancouver
CA

Abstract

Background: As a result of the Coronavirus Disease-2019 (COVID-19) pandemic, significantly fewer patients are able to communicate with their health care practitioners (HCPs) as a result of internationally encouraged physical distancing. This has led to an unprecedented rapid expansion of digital tools to provide digitalized virtual care globally, especially mobile phone facilitated health interventions, called mHealth. To help keep abreast of different mHealth and virtual care technologies being used internationally to facilitate patient care and public health during the COVID-19 pandemic we did a rapid investigation of solutions being deployed and considered in 4 countries.

Objective: To evaluate mHealth, and digital and contact tracing technologies being used in healthcare among 4 countries.

Methods: This data was procured by accessing a variety of resources including grey literature, government & health organization websites, in addition to contacting our collaborators in Canada, the UK, Rwanda, and Kenya. We specifically requested information regarding various mHealth and virtual care interventions being used to facilitate patient care and public health, such as case contact tracing.

Results: We identified a variety of technology in Canada, the UK, Rwanda, and Kenya being used for patient care and public health. The afore-mentioned countries are using both video and text-message based platforms to facilitate communication with HCPs (ex. WelTel, Zoom). Nationally-developed contact-tracing apps are provided free to the public, with most of them using Bluetooth-based technology. We identified that often multiple complimentary technologies are being utilized for different aspects of patient care and public health with the common purpose to disseminate information safely.

Conclusions: Virtual care and mHealth technologies have evolved rapidly as a tool for health care support for both patient care and public health. It is evident that, on an international level, a variety of mHealth and virtual care interventions, often in combination, are required to be able to address patient care and public health concerns during the COVID-19 pandemic. Clinical Trial: N/A

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

Please make my preprint PDF available to anyone at any time (recommended).

✓ **Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all u**

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Digital mHealth and Virtual Care Use in Pandemics:

A Rapid Landscape Review of Interventions Used

Internationally During COVID-19 in 4 Countries

By Alison Müller*, Alessandro Cau*, Semakula Muhammed, Peter Lodokiyiaa, Osman Abdullahi, Sabin Nsanzimana, Miriam Bullock, Andrew Hayward, and Richard Lester

ABSTRACT

Background: As a result of the Coronavirus Disease-2019 (COVID-19) pandemic, providing health care while maintaining social distancing has resulted in the need to provide care remotely, support quarantined/isolated individuals, monitor infected individuals and their close contacts, as well as disseminate accurate information regarding COVID-19 to the public. This has led to an unprecedented rapid expansion of digital tools to provide digitized virtual care globally, especially mobile phone facilitated health interventions, called mHealth. To help keep abreast of different mHealth and virtual care technologies being used internationally to facilitate patient care and public health during the COVID-19 pandemic we did a rapid investigation of solutions being deployed and considered in 4 countries.

Objective: To describe mHealth, and digital and contact tracing technologies being used in healthcare management of the COVID-19 pandemic among two high-income and two low-middle income countries.

Methods: We compared virtual care interventions used for COVID-19 management among two high-income (HI) countries (the UK and Canada) and two low-middle (LMI) countries (Kenya and Rwanda). We focused on interventions used to facilitate patient care and public health. Information regarding specific virtual care technologies was procured from a variety of resources including grey literature, government & health organization website, and co-authors' personal experiences as implementers of COVID-19 virtual care strategies. Search engine queries were performed to find health information that would be easily accessible to the general public, with keywords including "COVID-19", "contact-tracing", "tool-kit", "telehealth", and "virtual care", in conjunction with corresponding national health authorities.

 Results: We identified a variety of technologies in Canada, the UK, Rwanda, and Kenya being used for *patient care* and *public health*. The aforementioned countries are using both video and text message-based platforms to facilitate communication with HCPs (ex. WelTel, Zoom). Nationally-

developed contact-tracing apps are provided free to the public, with most of them using Bluetooth-based technology. We identified that often multiple complimentary technologies are being utilized for different aspects of patient care and public health with the common purpose to disseminate information safely. There was negligible difference among the types of technologies used in both HI and LMI countries, although LMI implemented virtual care interventions earlier during the pandemic's first wave which may account for their effective response.

Conclusions: Virtual care and mHealth technologies have evolved rapidly as a tool for health care support for both patient care and public health. It is evident that, on an international level, a variety of mHealth and virtual care interventions, often in combination, are required to be able to address patient care and public health concerns during the COVID-19 pandemic, independent of a country's economic standing.

KEYWORDS: COVID-19, virtual care, public health, mHealth, contact tracing, telehealth, Canada, United Kingdom, Kenya, Rwanda, global health, apps,

INTRODUCTION

Pandemics pose a considerable threat to global health security and place an enormous strain on health care systems. The current Coronavirus Disease-2019 (COVID-19) pandemic has already claimed over 2.5 million lives, with over 112 million reported cases as of February 26, 2020 [1]. Delivering care remotely, supporting individuals on home isolation, monitoring infected individuals and their close contacts, as well as disseminating accurate information regarding COVID-19 to the public, have been major challenges [2]. Although virtual care technologies have been used in a variety of health care settings prior to COVID-19, their utilization has significantly increased as they provide solutions to address the many challenges that result from maintaining physical distancing while providing essential health care. Virtual care is a rapidly growing area that is well-positioned to alleviate many issues within various health care systems including lengthy wait times, overcrowded emergency departments, and avoidable hospital re-admittance [3-5]. Due to the COVID-19's ease of transmissibility, self-quarantining and physical distancing measures have been implemented world-wide to mitigate its spread, in addition to border closures and significantly limiting sizes of social gatherings.

In this landscape review discussing technology developed and used in COVID-19 management in Canada, the UK, Rwanda, and Kenya, we define virtual care as the remote delivery of healthcare using technology. This includes technology that facilitates video communication and text messaging between patients and their health care providers (HCP)s. This broad category encompasses eHealth, telehealth, and clinical decision support (CDS) tools in the field. Virtual care tools may provide care for patients from the time that they decide to access the healthcare system, up until the end of their care experience, facilitating health care provider-patient interactions and care throughout the entirety of the patient journey with minimal in-person interactions. Thus, virtual care strategies may improve access to care, quality of care, reduce health care costs, and empower patients to care for themselves while providing a medium through which they can comfortably

request reliable information or advice [6]. An article released by the Canadian Medical Association has found that patients are overwhelmingly satisfied with their virtual health care during the COVID-19 pandemic [7]. At the time of publication, evidence was unavailable regarding perceptions of general virtual health care in other countries discussed in this paper.

mHealth has been defined by the World Health Organization (WHO) as "the use of mobile and wireless technologies to support the achievement of health objectives" [8]. It encompasses any strategy that utilizes mobile wireless technology to deliver healthcare, including health and wellness apps in addition to digital wearable devices. Health care delivery through phone or video, also known as *telehealth*, can be classified into virtual visits and remote patient monitoring (RPM). Virtual visits, usually referred to as *telemedicine,* are online real-time interactions between care providers and patients through a virtual care platform, video conferencing service, an app, or over the phone. RPM is the remote monitoring and collection of patients' health data including vital signs and glucose levels depending on which specialized devices patients are using. The current COVID-19 health crisis is an important opportunity to provide insight in the implementation, utilization, and efficacy of virtual care approaches during pandemics.

Here we explore current virtual care strategies for both patient care and case contact tracing in four focus countries: Canada, the United Kingdom (UK), Rwanda, and Kenya. These countries were selected because our research group received urgent Canadian federal research funding to deploy and study an mHealth intervention associated with our research group and established partners in those countries related to other pandemics (HIV and TB).

Purpose

The purpose of this review is to outline and summarize the landscape of mHealth and virtual care in four countries (2 low-middle income and 2 high income) that have been purported to be used or enhanced specifically due to the COVID-19 pandemic and serve as examples from diverse regions: Canada, the UK, Rwanda, and Kenya.

METHODS

The information for this landscape review was procured by accessing a variety of resources including peer-reviewed literature, grey literature (such as press releases), government & health organization websites, and first-hand experiences of this article's authors and collaborators in Canada, the UK, Rwanda, and Kenya. We evaluated two high-income (HI) countries, classified by the World Bank as having >$12 535 USD GNI (gross national income) per capita (Canada and the UK), and two lower-middle income (LMI) countries, classified as having <$4 045 USD GNI per capita (Rwanda and Kenya) [9]. We focused on presenting rapidly published information and information procured from our collaborators to ensure information presented in this landscape review was up to date. It should be noted that there is extremely limited primary scientific literature regarding the development, implementation, and effectiveness of rapidly developed and deployed virtual care and public health interventions in nations' efforts to quell the spread of COVID-19 [10]. Authors contributed additional information regarding their country's specific COVID-19 virtual care and public health measures, many of which they were personally involved in implementing. Communication with authors and collaborators occurred via a combination of e-mailing, WhatsApp messaging, and video conferencing using Zoom. To find press releases, information about mobile applications, and commentaries pertaining to COVID-19 technologies, search engines, predominantly Google, were used. Additional information regarding specific apps were found on their supporting app stores (ex. Google Play App Store). Search engine queries were performed to find health information that would be easily accessible to the general public, with keywords including "COVID-19", "contact-tracing", "tool-kit", "telehealth", and "virtual care", in conjunction with corresponding national health authorities. We further focused on provincial health authorities in Canada only, because of the diversity of COVID-19 measures undertaken by each province. The UK, Kenya, and Rwanda had more cohesive national development and implementation of interventions, so separation by regions was not necessary. We focused on procuring information pertaining to

mHealth and virtual care technologies being used for both patient care and public health in the

COVID-19 response. This includes interventions used for patient communication, appointment

making, information platforms, and case contact-tracing, among others. We understand that this

method will invariably leave gaps, especially as information surrounding COVID-19 mHealth

resources continues to evolve as the pandemic continues. We therefore encourage readers to seek

additional sources, primary and secondary, and to contact our team regarding any errors, omissions,

or suggestions to consider.

RESULTS

Current Virtual Care Strategies

Canada

In Canada, several virtual care platforms with videoconferencing capabilities have existed

and new ones emerged to assist physicians seeing patients remotely with some platforms that are

offering their technology for free to assist with patient care during the COVID-19 pandemic. In

Canadian provinces, such as Nova Scotia and Prince Edward Island, healthcare websites highly

recommend using Zoom for healthcare while other provincial healthcare sites do not specify a

platform. The list of virtual care technologies is updated regularly with new platforms and features

being developed as the COVID-19 situation evolves. In each province, virtual care "toolkits" have

been developed to assist physicians when providing care for patients remotely (See Appendix 1).

These can be accessed from provincial health authority websites easily found using internet search

engines.

The federal government developed a nation-wide contact-tracing app called COVID-Alert. It

was developed in partnerships with Shopify, Blackberry, and the Canadian Digital Service and

launched July 31, 2020 [11]. It is a free app using Bluetooth technology that uses Google and Apple

Inc.'s Exposure Notification API to notify an individual who is in proximity of one who has self-

identified as being COVID-positive on the app. The app specifications indicate that it does not use

GPS technology to track the user's location. Specifications also indicate that COVID-Alert does not access private phone information, including the phone's contacts, or access to health information of the user or other nearby users. As of October 19, the app has been downloaded 4.7 million times, which is ~16% of the Canadian population [12]. COVID Alert can also be used to report a COVID-19 diagnosis in most provinces, excluding British Columbia, Alberta, Nunavut, and the Yukon and Northwest Territories. In Alberta, *ABTraceTogether*, another Bluetooth based "exposure notification app" for digital case contact tracing was released May 2, 2020. This app also allows COVID-19 positive patients in Alberta to provide Alberta Health Services access to facilitate contact tracing [13]. An exposure notification app by the artificial intelligence group Mila in Quebec was released in May, features additional information such as alerting potentially infected users, and providing relevant, personalized recommendations to improve understanding of infection risks [14]. These preliminary platforms have yet to demonstrate their superiority to traditional case contact tracing strategies when it comes to being effective while maintaining anonymity. Another app available for download by the Canadian public is the Canada COVID-19 app, powered by Canadian company Thrive Health. It allows the user to track symptoms and contains a self-assessment tool, in addition providing timely updates with important news and updates from Canada's Ministry of Health.

The Government of Canada has also provided a variety COVID-19 resources to assist in evidence-based decision making on the Canadian Institutes of Health Research (CIHR) site [15]. Numerous Canadian universities have synthesized COVID-19 evidence in the efforts to support policy and decision-making. McMaster University has COVID—END, which provides resources for decision-makers, researchers, presentations and products, and working groups. The seven working groups, made up of international experts, focus on different aspects of COVID-19 knowledge translation: scoping, engaging, digitizing, synthesizing, recommending, packaging, and sustaining [16]. Ryerson University has developed a COVID-19 misinformation site to consolidate many internet resources focused on monitoring COVID-19 misinformation. They provide tools for

reporting misinformation, fact-checking resources, and a misinformation and bots-watching dashboards, as well as a slideshow presentation debunking common COVID-19 claims [17]. The SPOR Evidence Alliance focuses on promoting evidence-informed health policy, practice, and service to ensure that decision makers have access to up-to-date scientific evidence. They provide an online form for those seeking specific evidence to inform decisions related to health policy, practice, and/or service for COVID-19 to facilitate acquisition of relevant, accurate, and timely data [18]. Several provincial health authorities have also engaged with companies that provide assistance with COVID-19 case-contact monitoring but information on these was not yet public or readily available.

United Kingdom

In the UK, many common in-person medical communications have transitioned into virtual communications. For example, testing centres are booking COVID tests online and care homes are arranging all their regular resident and staff testing virtually. For those who are self-isolating, the NHS has provided information to local authority helplines if self-isolating individuals require practical/social support, support for someone a patient cares for, and/or financial support. The NHS is also supporting a virtual clinic service powered by medio.link that is video-link based [19]. They are working with Barts Health NHS Trust to accomplish their goal of forming a national network of sites providing virtual care. The video consultations have been able to be adapted for a variety of settings, including across the entire prison estate. Additionally, video observed therapy (VOT or VDOT) is being substituted for in-person directly observed therapy to ensure patients with tuberculosis take their medication [20,21]. Digital risk assessment has been established where analysis of primary care has been linked to mortality data permitting the risk of death during the first wave to be automatically calculated in providing appropriate advice to guide patients. The UK also has a locally developed app called Babylon Health which is paid for by the client in order to consult virtually with medical staff affiliated with Babylon Health, not necessarily their primary care provider. Additionally, various symptom checker apps such as COVID Symptom Study, Ask NHS,

and Symptomate are available for the public to use to assess whether or not they could be exhibiting COVID-19 symptoms. There is also Zoe Symptom Tracker, an app that allows for syndromic surveillance and assessment of symptom profiles.

With regards to other tracking options, the UK is also working on an app to track COVID patients, which has completed trials on the Isle of Wight. Initially release of the app saw low download rates, with The Guardian reporting only 10% of population in both England and Wales [22]. In addition to using Bluetooth technology similar to Canada's contact tracing app, it enables QR code scanning at venues so that if an individual who recently attended the venue reports a COVID-19 positive test result, other patrons of the venue get automatically notified. In addition to the app, the NHS are providing NHS Test and Trace, a free service that helps trace recent contacts of those testing positive for COVID-19 and notifying them, advising them to self-quarantine. There has also been an increase in digital surveillance throughout the UK, especially with venues and large employers. For example, daily surveys of hostel managers were performed to facilitate rapid testing and University College London (UCL) is launching a program, Connect to Protect. UCLs program facilitates people to report symptoms and positive tests to identify clusters in class, buildings, and residences [23].

Rwanda

Rwanda utilizes a number of existing virtual and mHealth solutions in its ecosystem. To assist in monitoring and supporting patients (cases and contacts) directly under home-based isolation and quarantine, they rapidly deployed the WelTel mHealth platform which they had previously been using to support patients attending HIV clinics for adherence support. WelTel is an integrated virtual care and two-way patient engagement digital health intervention that acts as a hub for healthcare providers (HCP) to communicate with their patients. As it is primarily used for SMS-based text messaging, patients do not need a smartphone or internet access in order to communicate with their HCPs. WelTel was launched in the Rwanda national EOC for the COVID-19 response in mid-March,

within a week of identifying the opportunity of using SMS to reach patients as previous technologies to reach out to Ebola contacts that were online had limited uptake due to accessibility of the internet. Currently, the WelTel platform is being used for virtual home-based care of COVID-19 patients who are asymptomatic. Above 80% of people who tested COVID-19 positive in Rwanda are asymptomatic. This platform enable daily follow up of patients at their home as well as their contacts. The program was rolled out and Rwandan COVID-19 response teams were trained. The WelTel platform offers several options to interact with patient through SMS chatting, email or video call. In addition, at the beginning of outbreak WelTel was used to communicate COVID-19 testing results, mainly those who tested negative. Furthermore, Rwanda uses DHIS2 tracker to record everyone going to have COVID-19 test and it is linked to laboratory systems that push results to the patient's mobile number and email. The data gathered through Weltel is stored at the Rwanda National Data Center. Rwanda has implemented an additional mHealth technology to help its citizen's access HCPs. For example, robots have been implemented in health care centers to collect important patient information including temperature screenings, vital readings, deliver video messages, and instruct people not wearing masks to put on a mask. Most importantly, robots play a key role in reducing exposure time of healthcare professionals with COVID-19 patients [24]. Two robots have even been deployed at the Kigali International Airport for screening and informs security of abnormalities [25]. The Government of Rwanda has recently signed (Feb 2020) a 10-year partnership with Babylon's Rwanda-focused virtual care subsidiary, Babyl. Appointments are being paid for by the government's health insurance scheme. The service includes physician consults, and prescriptions and lab test codes. There are currently 2 million users. Instructions for Rwandans who might suspect they have COVID are instructed to call 114, dial *114# for automated screening, send an e-mail, or a WhatsApp message [26]. WelTel is also being expanded for remote virtual care for HIV and maternal child health due to access issues under COVID-19.

Kenya

Kenya has a few different resources for virtual care using mHealth technology. mDaktari is providing virtual access to primary care via teleconsulting. Patients can access virtual care either through the app or web account, choose an available physician from a directory, and/or consult an expert using online video or voice calling [27]. A recent Kenyan start-up, mTIBU focuses on connecting patients to health care affordably without them having to leave home by using the mTIBU mobile app. They offer a variety of medical care including COVID-19 tests, medical consultation, and sample collection, all within the comfort of a patient's home [28]. In Samburu County, a rural area of northern Kenya, the cStock approach is being used by combining mobile technology, user-friendly dashboards, and quality improvement teams. It is customized for reporting and resupplying health products managed at the community level. Specifically, it is being implemented by the Samburu County Department of Health to supply COVID-19 primary protective gear with support by John Snow International. WelTel is also being used in Samburu county to assist HIV+ patient care and maternal, neonatal, and child health care. COVID-19 healthcare data is being reported using the DHIS2 tool. Safaricom is being used to send free text messages to educate the community on COVID-19. Training for health care workers are provided free courses on COVID-19 accessible via smartphones or computers. COVID-19 healthcare data is being reported using the DHIS2 tool. Safaricom is being used to send free text messages to educate the community on COVID-19.

There is a national mobile technology focused group, called mHealth Kenya, that has developed a National Emergency System meant to capture, report, and view emerging epidemics. During COVID-19, the app Jitenge was developed which allows registered users, either through self-registration or by Ministry of Health officials, to receive daily reminds and prompts to report their health status. The Jitenge system, represented in Figure 1, manages and monitors home-based care management, self-quarantine for contacts, post-isolation follow-up, and the monitoring of long-distance truck drivers [29].
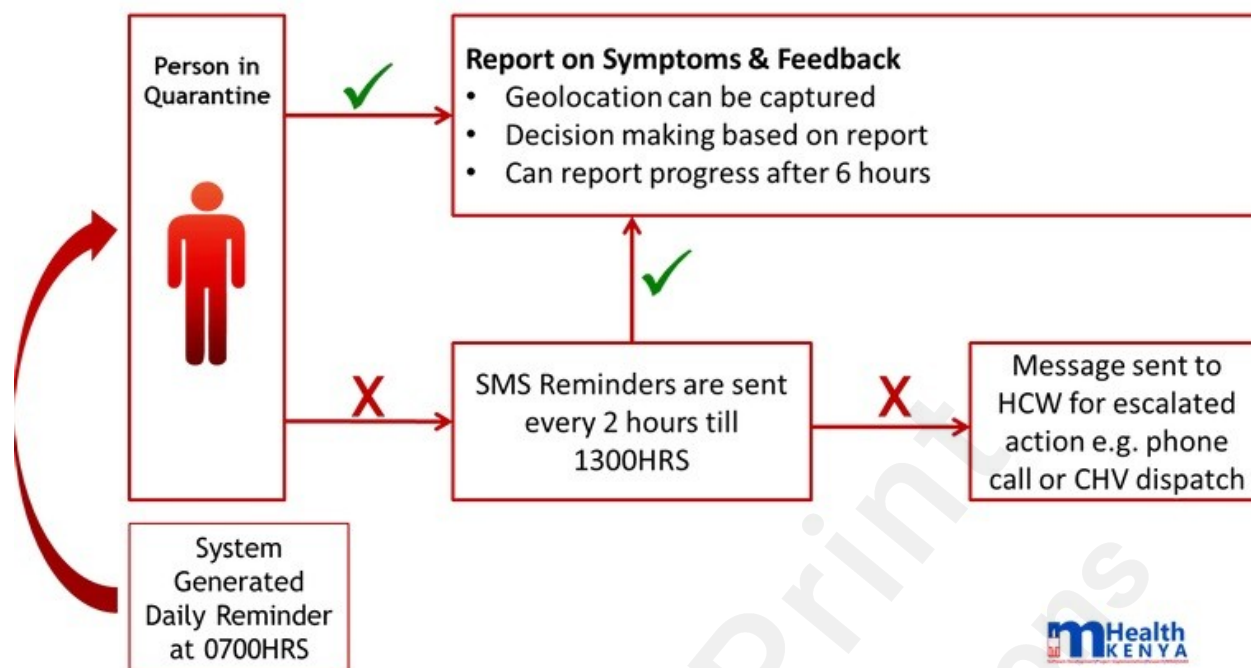
Report on Symptoms & Feedback
- Geolocation can be captured
- Decision making based on report
- Can report progress after 6 hours

Person in Quarantine

SMS Reminders are sent every 2 hours till 1300HRS

Message sent to HCW for escalated action e.g. phone call or CHV dispatch

System Generated Daily Reminder at 0700HRS

Figure 1: Schematic of the basic functionality of Jitenge on how it works with individuals in quarantine. Image used with permission provided by mHealth Kenya.

With regards to contact tracing COVID-19 patients, an app is available called KoviTrace. It was developed at Mount Kenya University that uses geo-sensing technology to track a patient's location over a 14-day period when they test positive for COVID-19. If an individual is in close proximity to a COVID-positive patient, SMS messages are sent with instructions and contacts a COVID-19 response team, depending on the contact's location [30]. Crowdsourcing movement in Red Zones using social media is also being implemented to aid in contact tracing.

DISCUSSION

With an urgent, international emphasis on minimizing in person communication, development and implementation of mHealth technologies has undoubtedly increased in response to the current COVID-19 pandemic. It is evident that a wide variety of mHealth and virtual care tools with parallel functionality are being used in different sectors of health care throughout North America, Europe, and Africa. The key advantage that these technologies have is that they facilitate both the dissemination and collection of important health information while maintaining safe physical distancing. The most consistently used method of patient care involves tele- and/or video-conferencing where patients are able to directly communicate with their health care practitioner. A few major players being used internationally include WelTel and Babylon Health, both emphasizing the importance of expedient and accurate delivery of health information and care.

Virtual care tools that facilitate direct communication with HCPs provide a secure way to disseminate/renew prescriptions and provide referrals, common patient needs that are easily addressed without the need for an in-person visit. There is also the added advantage of conversations between patients and HCPs being accessible by either party, especially in text-message based interactions where having access to prior conversations can help with care, verify details, and

facilitate remembering. Traditionally, access to a patient's health information is held by their HCP, but having patients be able to refer to conversations is not only useful for them, but also for other HCPs to understand what was discussed with the patient. This feature is especially useful for patients communicating with a clinic where different staff are responsible for monitoring a patient's care.

Public health is also of primary concern and all the countries discussed in this review are investing resources into national case contact tracing technologies to be able to track COVID-19 infections among their populations. A combination of locally developed smart phone apps and government implemented technology is being used in order to understand, and hopefully mitigate, the spread of COVID-19. Although a variety of different technology is being used, there is an emphasis to ensure that those within the vicinity of potentially COVID-19 positive patients are notified and asked to self-isolate. Encouraging self-isolation is occurring at an international level, although regular contact with those in self-isolation varies amongst the countries we looked at. In general, contact tracing apps can provide more information than just COVID-19 proximity notifications. Data is generated whenever a COVID-19 notification is presented on an individual's phone, including how many individuals are in proximity of a positive case as well as when the notification occurred. This information can be useful in figuring out trends of when higher instances of potential exposures are happening most often. Due to the nature of most apps, this information is available immediately and can be used to provide useful information for health authorities to inform decision-makers about how best to mitigate transmission. Also, depending on the location privacy of contact-tracing apps, it could be possible to identify zones where transmissions frequently occur. This information can also be stored for future reference.

The type of technology used to manage COVID-19 between the HI and LMI countries was similar; however, Kenya and Rwanda had a more comprehensive approach when using novel technology. Assessments evaluating technical efficiency and overall performance of national COVID-19 management have consistently criticized the UK and Canada as underperforming despite

have access to exceptional resources [31-33]. In fact, the Lowy Institute assessed the performance during the first-wave of 98 countries by evaluating various parameters including confirmed cases and deaths per million people and confirmed cases as a proportion of tests [32]. Their evaluation ranked Rwanda as 6th, Kenya as 48th, Canada as 61st, and the UK as 66th, indicating that many LMI countries were more effective in managing the initial impact of the COVID-19 pandemic than HI countries. It is challenging to determine exactly how Rwanda and Kenya's mHealth and virtual care interventions played a role in providing efficient COVID-19 management, but their early development, adoption, and utilization of these tools likely contributed to their effective response to the first wave of the pandemic. In fact, a healthcare worker based in the UK responded to an international evaluation assessing COVID-19 management strategies stating that 'There was a national plan but it was not effectively put into action' [33].

Implementation and utilization of mHealth and virtual care interventions has grown rapidly during the COVID-19 pandemic as a result of maintaining social distancing measures while providing much needed health care. Although it is not yet known which interventions are the most effective, it is evident that there is consistency with direct virtual health care provider and patient interactions as well as with case contact tracing to notify individuals in efforts to prevent the spread of COVID-19. Studies evaluating patients' satisfaction with virtual care and mHealth technologies, both pre- and during COVID-19, have been overwhelmingly positive, strengthening the likelihood that these interventions will become integrated as a regular component of patient care [34-38]. A significant observation of these studies was that patient care was comparable between in person and virtual consultations, however increased convenience for both the HCP and patient and decreased overall cost for virtual consultations were consistently noted as incentives for adopting mHealth interventions [34,36-38]. The staggering international increase of adoption of mHealth and virtual care interventions facilitates researching and comparing their efficacy, paving the way to incorporating them into everyday healthcare globally.

CONFLICT OF INTEREST

Principal Investigator Dr. Richard Lester has a financial and professional interest in WelTel Incorporated, a company for which he is Chief Scientific Officer. WelTel Incorporated is subcontracted to provide the SMS software platform and maintenance for the project. WelTel Incorporated is a company founded by the Dr. Lester's wife. The company develops software and related technologies to support mobile health (mHealth) through SMS-based, patient engagement platforms. WelTel Inc. has been contracted by this research project to provide the software and the implementation service. As Chief Scientific Officer of WelTel Inc., Dr. Lester advises on the research and development aspects of WelTel Inc. and communicates with the scientific and customer communities concerning the evidence ¬base and utility of the software.

REFERENCES

1. Digital contact tracing can slow or even stop coronavirus transmission and ease us out of lockdown. University of Oxford: Our Research - Coronavirus Research. 041620. Available from: https://www.research.ox.ac.uk/Article/2020-04-16-digital-contact-tracing-can-slow-or-even-stop-coronavirus-transmission-and-ease-us-out-of-lockdown

2. Willan J, King AJ, Jeffery K, Bienz N. Challenges for NHS hospitals during covid-19 epidemic. BMJ 2020;368:368.

3. Noel K, Messina C, Hou W, Schoenfeld E, Kelly G. Tele-transitions of care (TTOC):A 12-month, randomized controlled trial evaluating the use of Telehealth to achieve triple aim objective. BMC Family Practice 2020;21(1):27.

4. Kvedar J, Coye MJ, Everett W. Connected health: A review of technologies and strategies to improve patient care with telemedicine and telehealth. Health Affairs 2014;33(2):194-199.

5. Vest JR, Kern LM, Silver MD, et al. The potential for community-based health information exchange systems to reduce hospital readmissions. J Am Med Inform Assoc 2014;22(2):435-442.h

6. Hamine S, Gerth-Guyette E, Faulx D, et al. Impact of mHealth chronic disease management of treatment adherence and patient outcomes: a systematic review. JMIR 2015; 17(2): e52 PMID: 25803266

7. Virtual Care is real care: National poll shows Canadian are overwhelmingly satisfied with virtual health care. Canadian Medical Association. 8 June 2020. Available at: https://www.cma.ca/news/virtual-care-real-care-national-poll-shows-canadians-are-overwhelmingly-satisfied-virtual

8. MHealth: New horizons for health through mobile technologies. World Health Organization. Global Observatory for eHealth Series 2011;3

9. Data - World Bank Country and Lending Groups. The World Bank. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

10. Knottnerus JA, Tugwell P. Methodological challenges in studying the COVID-19 pandemic crisis. J Clin Epidemiol 2020;121:A5-A7.

11. COVID Alert. Wikipedia. 3 Nov 2020. Available at: https://en.wikipedia.org/wiki/COVID_Alert

12. Download COVID Alert Today. Government of Canada. Last updated 21 October 2020. Available from: https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/covid-alert.html (webcaching site failed)

13. ABTraceTogether. Government of Alberta. Available from: https://www.alberta.ca/ab-trace-together.aspx

14. A smart and ethical contact-tracing app to fight COVID-19. Mila. 23 May 2020.

https://mila.quebec/en/a-smart-and-ethical-contact-tracing-app-to-fight-covid-19/

15. COVID-19 Resources: Evidence-informed decision making. Canadian Institutes of Health Research. Government of Canada. 23 July 2020. Available at: https://cihr-irsc.gc.ca/e/52083.html

16. COVID-END: COVID-19 evident Network to Support Decision-Making. McMaster University. Available at: https://www.mcmasterforum.org/networks/covid-end

17. COVIDmisinfo.org. Ryerson University: Ted Rogers School of Management – SocialMediaLab.ca. Available at: https://covid19misinfo.org/

18. Strategy for Patient-Oriented Research (SPOR) Evidence Alliance. Canadian Institutes of Health Research. Available at: https://sporevidencealliance.ca/

19. Medio.Link. NHS Video Conferencing. Available from: https://medio.link/nhs-video-conferencing/

20. Fraser H, Keshavjee S. Video-observed therapy for tuberculosis: strengthening care. Lancet 2019;393(10177):1180-1181.

21. Sotry A, Aldridge RW, Smith CM, et al. Smartphone-enabled video-observed versus directly observed treatment for tuberculosis: a multicentre, analyst-blinded, randomised, controlled superiority trial. Lancet 2019;393(10177):1216-1224.

22. Boseley S. Take-up of NHS contact-tracing app could only be 10%. The Guardian 24 Sept 2020. Available from: https://www.theguardian.com/world/2020/sep/24/take-up-of-nhs-contact-tracing-app-could-be-only-10

23. UCL launches connect-to-protect reporting tool. UCL News. 17 Sept 2020. Available from: https://www.ucl.ac.uk/news/2020/sep/ucl-launches-connect-protect-reporting-tool

24. Clarisse M, Muhamed S, Jean Baptiste M, et al. Use of technologies in COVID-19 containment in Rwanda. Rw Public Health Bul 2020;2(2):7-12.

25. Robots use in Rwanda to fight against COVID-19. World Health Organization: Africa. 31 July 2020. Available from: https://www.afro.who.int/news/robots-use-rwanda-fight-against-covid-19

26. Babylon Team. Rwanda will be the world's most advanced country for digital health. Babylon. 04 Mar 2020. Available from: https://www.babylonhealth.com/blog/business/rwanda-will-be-the-worlds-most-advanced-country-for-digital-health

27. mDaktari – Affordable convenient access to primary care: Virtual care combined with physical support. mDaktari. Available from: https://connectmed.co.ke/

28. Kirui D. Kenya launches KoviTrace app to curb COVID-19. IT Web Africa. 18 Jun 2020. Available at: https://itweb.africa/content/mQwkoq6PgWk73r9A

29. Tibu. 29 Oct 2020. Available at: https://tibu.africa/home

30. mHealth Kenya. 29 Oct 2020. Available at: https://www.mhealthkenya.org/

31. Breltenbach MC, Ngobeni V, Aye G. Efficiency of healthcare systems in the first wave of COVID-19 – a technical efficiency analysis. MPRA Paper No. 101440 2020.

32. Leng A, Lemahieu H. Lowy Institute: Covid Performance Index - Deconstructing Pandemic Responses. [retrieved 01-30-2021] https://interactives.lowyinstitute.org/features/covid-performance/

33. Tartaglia R, La Regina M, Tanzini M, et al. International survey of COVID-19 management strategies. Int J Qual Health Care 2021;33(1):1-3.

34. Robb JF, Hyland MH, Goodman AD. Comparison of telemedicine versus in-person visits for persons with multiple sclerosis: A randomized crossover study of feasibility, cost, and satisfaction. Mult Scler Relat Disord 2019:36:101258

35. Finkelstein SM, Speedie SM, Demiris G, et al. Telehomecare: quality, perception, satisfaction. Telemed J E Health 2004;10(2):122-128 PMID:15319041

36. Agha Z, Schapira RM, Luad PW, et al. Patient satisfaction with physician-patient communication during telemedicine. Telemed J E Health 2009;15(9):830-839 PMID:19919189

37. Buchanan AH, Datta SK, Skinner CS, et al. Randomized trial of telegenetics vs in-person cancer genetic counseling: cost, patient satisfaction and attendance. J Genet Couns 2015;24(6):961-970 PMID:25833335

38. Portnoy JM, Waller M, De Lurgio S, et al. Telemedicine is as effective as in-person visits for patients with asthma. Ann Allergy Asthma Immunol 2016;117(3):241-245 PMID:27613456
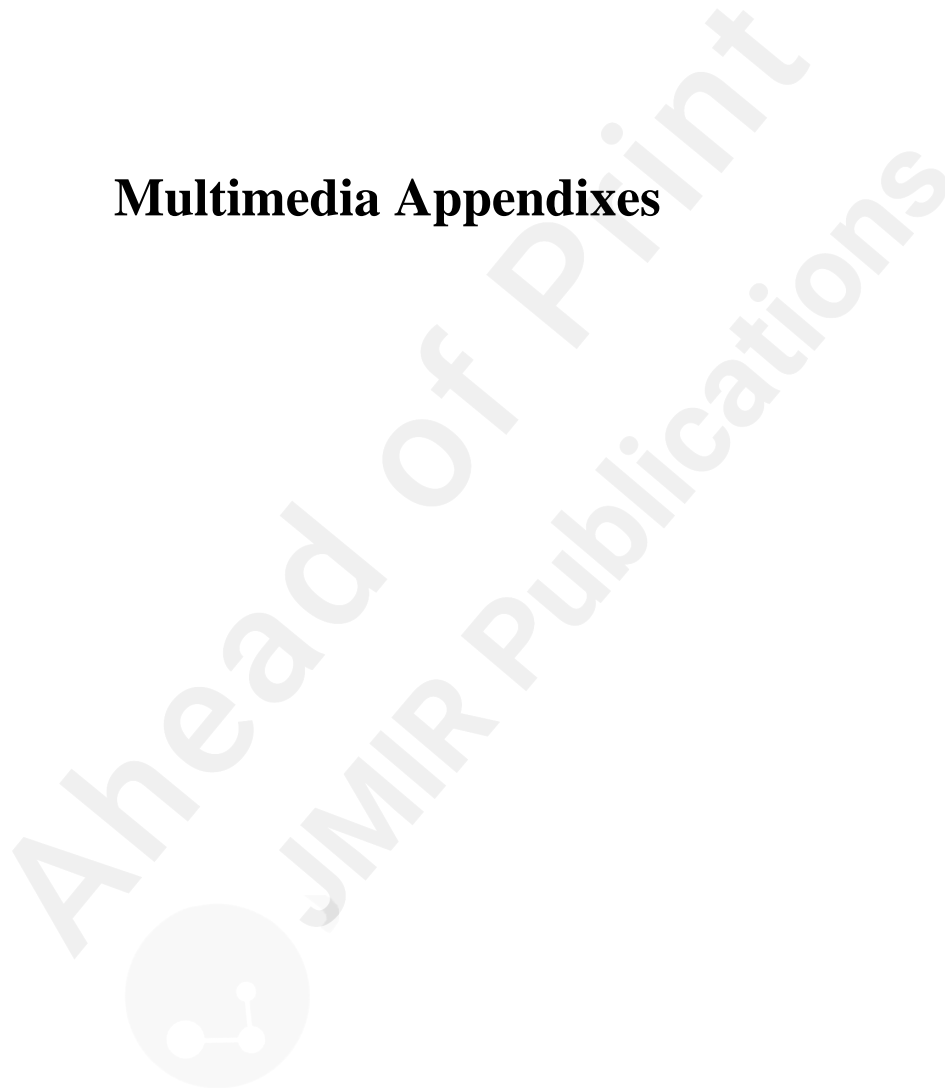
Supplementary Files
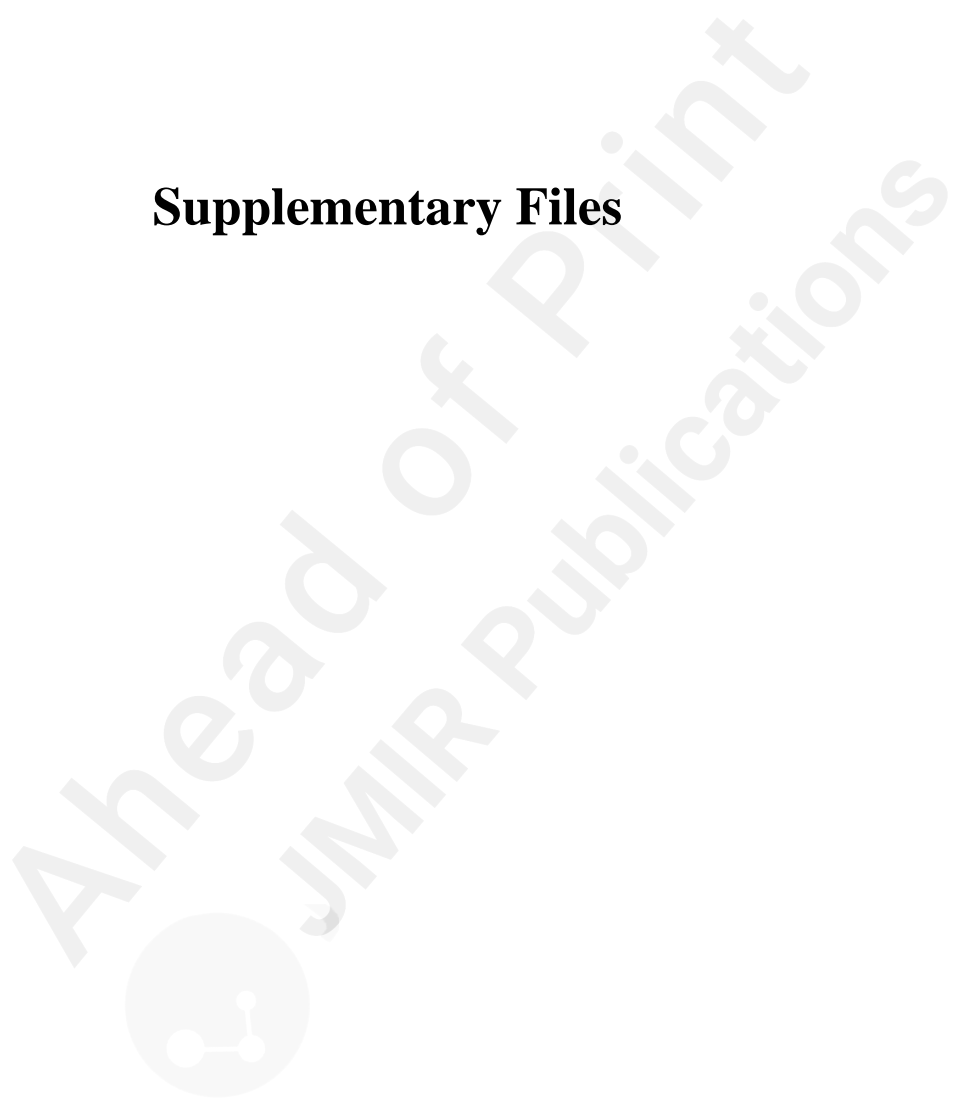
Figures

Schematic of the basic functionality of Jitenge on how it works with individuals in quarantine. Image used with permission provided by mHealth Kenya.
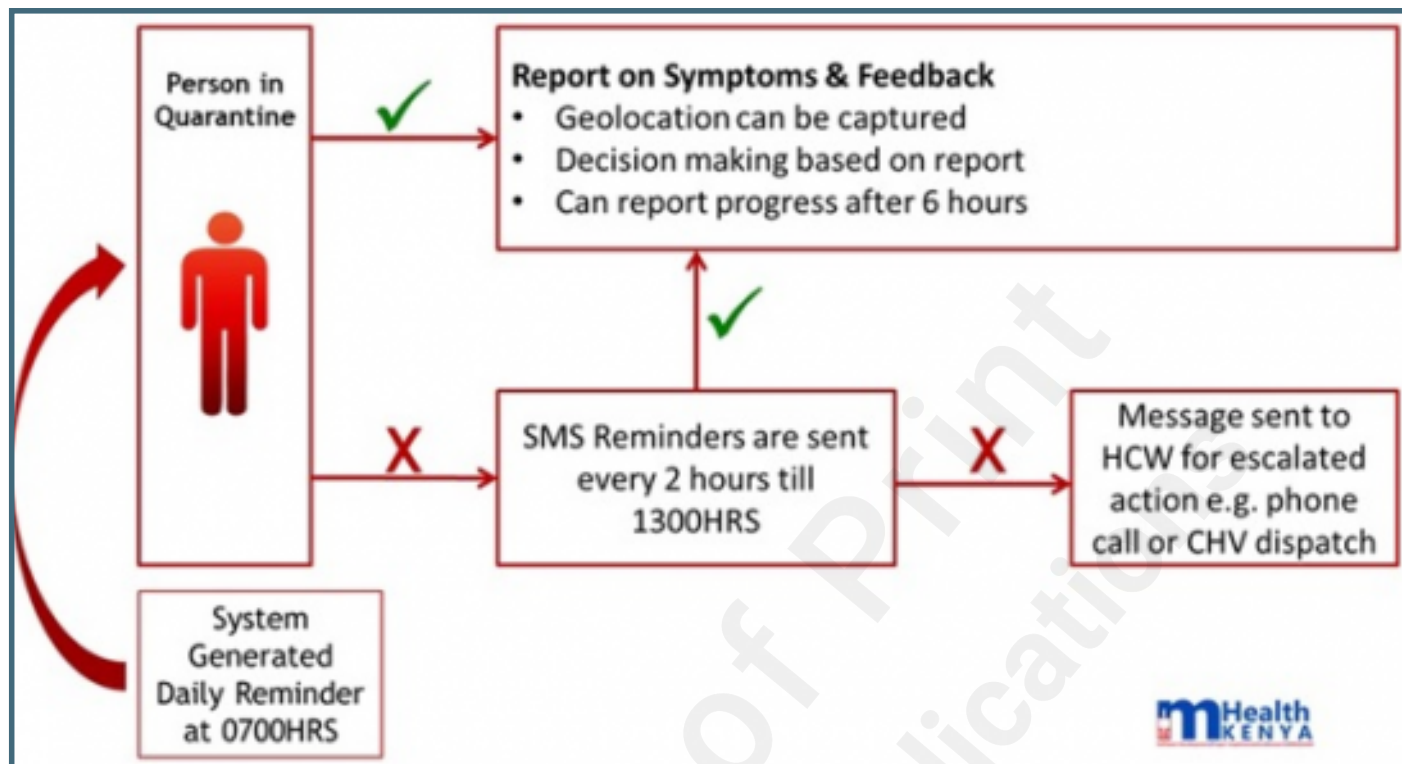
Multimedia Appendixes

Summary of online resources available to the public to access virtual care and public health resources in Canada, the UK, Rwanda, and Kenya, during the initial wave of COVID-19.
URL: http://asset.jmir.pub/assets/e4ff764b7a1899fdcf99c198deeaede2.docx