

Use of Technologies in COVID-19 Containment in Rwanda

Musanabaganwa Clarisse^{1,*}, Semakula Muhamed¹, Mazarati Jean Baptiste¹, Nyamusore Jose¹, Uwimana Aline¹, Kayumba Malick¹, Umutesi Francine¹, Uwizihiwe Jean Paul¹, Muhire Andrew², Nyatanyi Thierry², Harvey Thom³, Hitimana Nadia⁵, Byiringiro Fidele⁶, Mutesa Leon^{2,4}, Nsanzimana Sabin¹

¹Medical Research Center (MRC), Joint Task Force, Rwanda Biomedical Centre (RBC), Kigali, Rwanda

² Rwanda Biomedical Centre (RBC), Joint Task Force, Rwanda Ministry of Health (MOH), Kigali, Rwanda

³Tony Blair Institute for Global Change,

⁴Center for Human Genetics, College of Medicine and Health Sciences, University of Rwanda, Kigali, Rwanda

⁵Clinton Health Access Initiative (CHAI), Kigali, Rwanda

⁶Rwanda Military Hospital, Kigali, Rwanda

*Corresponding author:

Ms. Clarisse Musanabaganwa
Medical Research Center
Rwanda Biomedical Centre (RBC)
Kigali – Rwanda
E-mail: clarisse.musanabaganwa@gmail.com

Received: 1 June 2020

Accepted: 25 June 2020

Published: 30 June 2020

Cite this article as:

Musanabaganwa et al. Use of Technologies in COVID-19 Containment in Rwanda, *Rw. Public Health Bul.* 2020; 2(2): 7-12.

ABSTRACT

The Coronavirus disease 2019 (COVID-19) emerged from Wuhan, China at the end of December 2019 and was thought to be an unknown pneumonia that was causing acute severe respiratory distress and respiratory failure in some patients as well as other complications. Later on, the disease showed high virulence and rapid transmission from person to person. WHO declared the disease as pandemic when the spread was affecting most countries. Different modes of technologies combined with prevention strategies were conceived to minimize the rate of transmission in Rwanda. Technology solutions that are mainly used in Rwanda include: Artificial Intelligence (AI) and robotics for patient managements and data recording in hospitals, drones in broadcasting appropriate information in regards to COVID-19 symptoms and strategies for prevention, geolocalized hotspot mapping used for contact tracing, and self-testing of unstructured supplementary services data (USSD) easily accessed by dialing *114#. This outbreak report paper discusses the use of technology in the control and surveillance of the COVID-19 pandemic in Rwanda context.

Keywords: COVID-19, Data Science, Artificial intelligence (AI), Technology

INTRODUCTION

The Coronavirus disease 2019 (COVID-19) emerged from Wuhan, China at the end of December 2019 and was thought to be an unknown pneumonia that was causing acute severe respiratory distress and respiratory failure in some patients as well as other complications [1]. Later on, the disease showed high virulence and rapid transmission from person to person. WHO declared the disease a pandemic as the spread was affecting most countries.

Different modes of technologies have helped to tackle and contain this disease [1]. COVID-19's rapid mode of transmission triggered the use of technologies on another level for control and surveillance within the health system. For instance, to strengthen community awareness about prevention measures such as maintaining social distancing, public health messages are disseminated using SMS or via the internet.

Potential Conflicts of Interest: No potential conflicts of interest disclosed by all author. **Academic Integrity:** All authors confirm their substantial academic contributions to development of this manuscript as defined by the International Committee of Medical Journal Editors. **Originality:** All authors confirm this manuscript as original piece of work, and has not been published elsewhere. **Review:** All authors allow this manuscript to be peer-reviewed by independent reviewers in a double-blind review process. © **Copyright:** The Author(s). This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY-NC-ND), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. **Publisher:** Rwanda Health Communication Centre, KG 302st., Kigali-Rwanda. Print ISSN: 2663 - 4651; Online ISSN: 2663 - 4653. **Website:** www.rwandapublichealthbulletin.org

Most people worldwide are benefiting from technology as one of the efficient tools applied to gain knowledge about this pandemic [2]. Technology is key in streamlining the workflows in healthcare and in public health settings. Artificial Intelligence and data science are seen as influential tools for control and surveillance of COVID-19 worldwide, currently used in fast-tracking diagnosis, containing, analyzing and predicting COVID-19 in a fast, scalable and efficient manner [3]. The COVID-19 pandemic stimulated the need to develop and position various applications such as health maps that present the worldwide pandemic outbreak situation in real-time [4]. Robotics utilization in healthcare management for COVID-19 has been deployed and is so far assisting healthcare practitioners as well as the epidemiologists [5]. The prime use of such robots is to lessen contact from person to person, to engage in hospital sterilization along with cleaning and to assist in patient monitoring with the overall goal to minimize viral spreading to doctors and medical staff actively engaged in COVID-19 management. Robots not only facilitate healthcare professionals but also improve overall healthcare facility efficiency by decreasing their workload in managing the pandemic [6]. The robots used in healthcare facilities are primarily categorized based on their design and applications. There are now 12 category of robots used in healthcare facilities, which are hospital nurse robots, receptionist robots, ambulance robots, hospital serving robots, cleaning robots, radiologist robots, disinfection/ spraying robots, telemedicine robots, surgical robots, food robots, outdoor delivery robots and rehabilitation robots [7]. COVID-19 propagates not only from person to person in close contact through respiratory droplets but also its virus can persist on non-living surfaces such as plastics, metals and glasses for days. Fortunately, robots engage in disinfection with the help of ultraviolet (UV) and provide disinfected surfaces at hospitals. Nowadays, assisted or automated appropriate robots are being used in the collection of oropharyngeal and nasopharyngeal swab samples which speeds up the diagnosis process [8]. The use of robotics in fighting COVID-19 has significantly improved the safety and quality of healthcare providers that are actively engaged with patients. In most African countries and low- and middle-income countries where the majority of the populations do not own TV sets and smart phones, messages are sent on mobile phones and by radio

to educate people about the pandemic, symptoms and prevention measures [9].

Rwanda, as one of the advanced countries in promoting IT in the region, kept the momentum in applying technologies in surveillance and control of epidemics especially in COVID-19 containment [10]. For example, when the first COVID-19 case was identified in the country, several containment measures were put in place including technologies that promote community awareness and streamline data management from community to central level. In addition, machine-learning is being applied in Rwanda to examine the community health impacts, and test potential treatments as well as individual diagnoses [11]. Rwanda and Tunisia are the African countries using this technology to reduce the pandemic transmission. Tunisia used police robots that helped to ensure that the lockdown was applied by asking people why they are out, checking if they have permission to be outside of their homes, ensuring social distance, and educating people about measures to minimize COVID-19 transmission [12]. In Rwanda, healthcare workers take the temperature measurements of patients in isolation rooms using robots that were offered by the Ministry of Health with support from the United Nations Development Programmed (UNDP-Rwanda). They are programmed to communicate appropriately, keep medical records of patients, educate healthcare workers and patients on the dangers of the virus and how to stay safe. They also minimize physical contact by carrying foods and medications to the patients [13]. This report discusses different technologies being applied in Rwanda setting.

TECHNOLOGIES IN CONTROL AND SURVEILLANCE OF COVID-19 IN RWANDA

Early detection and diagnosis of the infection

At the beginning of the pandemic, an AI system (Health Map) from Boston Children's Hospital was used to identify different information about the pandemic that was available online to detect, visualize and monitor any new outbreaks [14]. This website helps in identifying the new unknown pneumonia that was reported to start from Wuhan, China. The first AI epidemiologist to warn against a new outbreak was a Canadian tech Blue Dot

whose algorithm scours foreign language news reports and gave a warning about a danger zone [15]. The former used AI software “Infer vision” for lung cancer and diagnosis from CT scan images was also changed to detect pneumonia using previous data on SARS and the diagnosis was made faster in different hospitals. Proper screening and diagnosis are difficult especially when there is a large number of infected persons [16]. Therefore, early diagnosis of this disease is very crucial in management. On the other hand, even if CT scan is not the gold standard for diagnosis it was shown to be the most effective, reliable, rapid way of the virus detection in the early stages of the disease compared to the RT-PCR [16]. Different applications and monitoring devices are available and help people who are asymptomatic or have mild symptoms to be screened using different questions and tests such as breathing tests

and thermoscan machine that are used for fever screening and detecting arriving passenger with high fever. This data is manipulated and also used to assess the rate of infection in certain populations including those people with mild disease who are not followed at the hospital. Rwanda has put in place a self-screening app (USSD) to facilitate early detection of the infection in the population. Rwanda uses geological hotspot mapping in contact tracing (Figure 1) [17], and also uses drones to broadcast the appropriate information to the public in regards to the pandemic outbreak by informing them on the mode of transmission, preventive measures and sensitizing the public to get tested for COVID-19 at their nearest public health centers. This helps to rapidly spread accurate information on prevention measures as well as bust myths and clear misinformation about the COVID-19 pandemic [18].

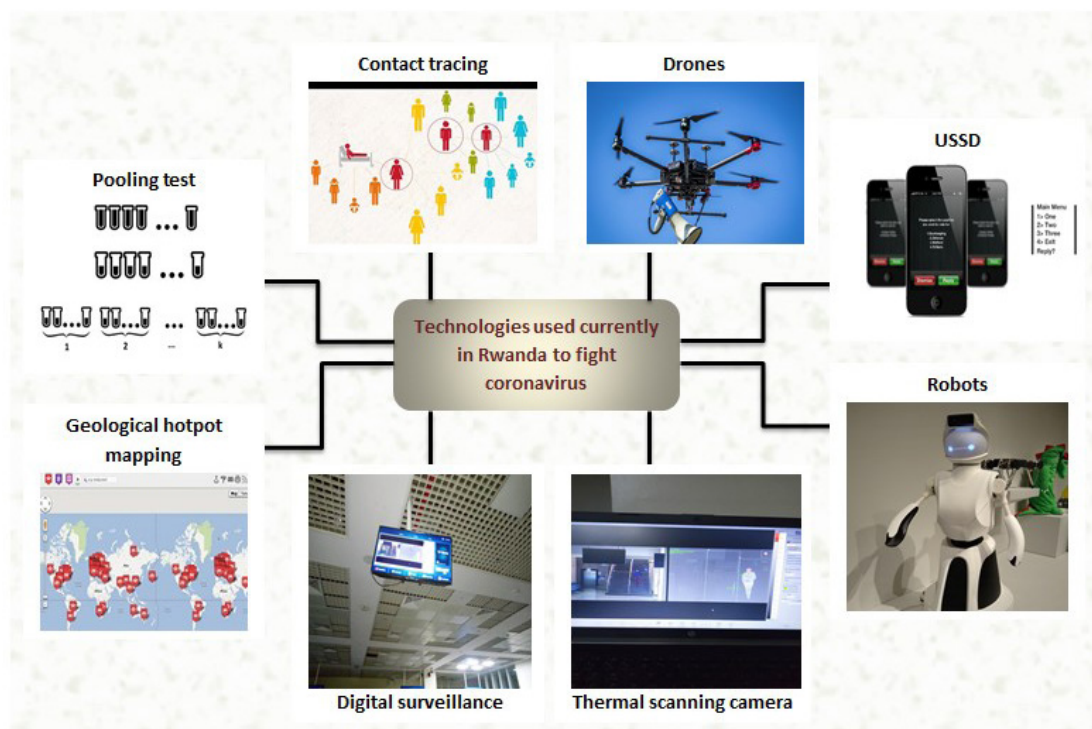


Figure 1: Technologies used in Rwanda to fight against COVID-19 as per May 2020.

Patient care and treatment monitoring

Robots and machinery are used to store the data of patients during diagnosis and treatment. In addition, AI through the use of robotics is crucial for the routine follow-up of patients as they improve. Evidence reports positive impact in the use of robotics for example in the reduction of unnecessary contacts between healthcare providers

and patients and has shown great efficacy in maximizing safety for healthcare providers [14].

In addition, as the disease rapidly contaminated many people, which required a big number of health providers in a short period, the technology has helped to reduce the workload of healthcare providers by easing the diagnosis procedure,

rapid intervention, and patient monitoring [19]. It has assisted the physicians and students to learn more about the new disease in a short time. It has also reduced the risks of infection by minimizing physical contacts with the patients. Patients have been given the capacity to have control over their care, with access to their records especially for those patients who are discharged from the hospital but still need observation.

Those patients are attended by the doctor virtually and still stay with their families which speeds up recovery [20].

Rwanda started to use robots in healthcare facilities as soon as the pandemic outbreak was announced by the World Health Organization (WHO).

Robots are now used to fight the virus pandemic and their role is to work hand in hand with healthcare providers as they do not get infected by the virus [13]. These robots have different roles including vital signs measurements such as blood pressure and body temperature as well as oxygen saturation of severely ill patients who are on ventilator machines. They are also used for food and medicine transportation and patients monitoring [21]. Recently, the United Nations Development programmed donated five high-tech robots in order to minimize contact between infected patients with nurses and doctors thus reducing their risk of exposure to infection. The robots were given Rwandan names which are Akazuba, Ikizere, Ngabo, Mwiza and Urumuri (Figure 2) [22].



Figure 2: Robots in Rwanda to fight COVID-19

Pooling testing strategies for mass screening has also been incorporated and approved in Rwanda. This method has shown promising results. Therefore, it has been applied in survey testing that led to lockdown easing on 1st May 2020; the survey was conducted in 30 districts of Rwanda in 3 percent of healthcare facilities [23].

Logistical planning and economic interventions

The pandemic has created a need for various and numerous equipment: personal protective equipment (PPE), masks and gowns, test kits, ventilators, and ICU beds used in healthcare facilities [4].

Therefore, data science techniques have emerged to support the supply chain management for healthcare supplies. By using data of hospitalization rate and lab results, the health system is able to predict the needed supplies in real-time [24].

Rwanda is adopting step by step the use of data science techniques in all services to determine the best economic proceedings at a high level of granularity primarily in analyzing and harmonization of COVID-19 containment strategies [25].

When a vaccine becomes available, collecting data on transportation and storage conditions will be crucial to efficiently distribute them. Suboptimal conditions could lead to these temperature-sensitive vaccines becoming less effective. While RBC is currently monitoring storage locations, Internet of Things (IoT) remote monitoring technology could be incorporated into systems to not only monitor conditions in real-time, but also to use SMS to alert key stakeholders of dangerous changes, which can save lives and potentially reduce healthcare costs.

Furthermore, IoT remote monitoring could offer broader support to healthcare systems, combined with RFID technology, to automate the tracking of PPE items to easily monitor both location and quantities in real-time. This would allow the Government of Rwanda to better understand stock levels, and combined with machine-learning algorithms, forecast project future needs affordably and at scale.

DISCUSSION

Technologies used in Rwanda for suppressing the pandemic dissemination are similar to those used globally and great outcome has been observed by accelerating use of technology in Rwanda [26]. Technology solutions that are currently used to mitigate the virus spread in Rwanda include: Artificial Intelligence (AI) and robotics for patient management and data recording in hospitals, drones in broadcasting appropriate information in regard to COVID-19 symptoms and strategies for prevention, geolocalized hotspot mapping for contact tracing, self-testing of unstructured supplementary services data (USSD) that can easily be accessed by dialing *114# [27]. Digital contact tracing is widely used with the help of mobile applications in order to contact any person who interacted with an infected person within two weeks of contact and send a warning signal to the concerned personnel or authorities to trace the person and offer them the required care and this slows down the pandemic propagation [28].

Robots are playing a tremendous role in the battle to fight COVID-19 where they work hand in hand with the doctors. These robots operate in the most infectious wards thus reducing the doctor's risk of catching the virus by avoiding direct contact with the patients [13].

The robots are also involved in monitoring some patient's clinical parameters such as heart rate, oxygen saturation, respiration rate and blood pressure [7].

Disinfection robots are equipped with ultraviolet light that kills the slightest microbes and germs on the hospital surfaces. Drones are mainly used for delivering blood, medication and food. These drones are also involved in warning and informing the public about various strategies to fight the pandemic such as wearing masks, social distancing and washing hands [29]. High-tech wearable devices are also implemented, and they function by monitoring patients for symptoms of COVID-19 with the help of wireless biosensor systems [16].

Policy implications in Rwanda

Although Rwanda has put considerable efforts in the use of technology in COVID-19 containment, additional steps may be considered to bridge the remaining gaps. For example, integration of wearable devices to ease and monitor physiological changes, software development such as human interaction tracking systems which identifies potential areas of infection of known outbreaks and predict the unknown outbreak, IoT remote monitoring systems to share real-time data on medical supply chains, development of software and tools based on open source computer simulation programs that are developed for tracking, simulation and COVID-19 forecast, use of artificial intelligence algorithm that accurately predicts COVID-19 without testing, facial recognition software that identifies faces even partially covered with masks and single out people who are not wearing masks at building entrance, technologies in development of drugs and vaccines [4]. In addition, Rwanda may enforce the use of technology by developing different software that will be used in hospitals, for simulation and tracking COVID-19 incidents. Wearable devices may also be approved and applied in order to easily detect any physiological change and online health assessment. Lastly, use of technologies in drug and vaccine development may be given a priority in Rwanda and Africa settings.

The use of robots may be implemented in different areas such as street patrol and surveillance [30].

CONCLUSION

As COVID-19 pandemic disseminates, the integration of technology deployment is

REFERENCES

- [1] Jebri, N. M. T. World Health Organization declared a pandemic public health menace : A systematic review of the coronavirus disease 2019 “ COVID - 19 ”, up to 26 th March 2020. 1–18 (2020).
- [2] Aslam, F. COVID-19 and Importance of Social Distancing. Preprints (2020) doi:10.20944/preprints202004.0078.v1.
- [3] WHO. ITU-WHO Joint Statement: Unleashing information technology to defeat COVID-19.
- [4] Javaid, M. et al. Industry 4.0 technologies and their applications in fighting COVID-19 pandemic. *Diabetes Metab. Syndr. Clin. Res. Rev.* 14, 419–422 (2020).
- [5] Tavakoli, M., Carriere, J. & Torabi, A. Robotics For COVID-19 : How Can Robots Help HealthCare in the Fight Against Robotics For COVID-19 Update June 5 , 2020 How Can We Help Right Now ? Telehealth to assist frontline healthcare workers. (2020).
- [6] Note, L. Digital technologies and the COVID- 19 pandemic. (2020).
- [7] Khan, Z. H., Siddique, A. & Lee, C. W. Robotics utilization for healthcare digitization in global COVID-19 management. *Int. J. Environ. Res. Public Health* 17, (2020).
- [8] CDC. Interim Guidelines for Collecting, Handling, and Testing Clinical Specimens for COVID-19. <https://www.cdc.gov/coronavirus/2019-ncov/lab/guidelines-clinical-specimens.html>.
- [9] Hopman, J., Allegranzi, B. & Mehtar, S. Managing COVID-19 in Low- and Middle-Income Countries. *JAMA - J. Am. Med. Assoc.* 323, 1549–1550 (2020).
- [10] Nsengiyumva, B. C. How local Non-Government Organizations in Rwanda (NGOs) are affected by COVID 19 ? 1–24 (2020).
- [11] Organization, W. H. First Case of COVID-19 confirmed in Rwanda. <https://www.afro.who.int/news/first-case-covid-19-confirmed-rwanda> (2020).
- [12] Tralac. Innovative tech and connectivity key to fighting COVID-19 in Africa. <https://www.tralac.org/news/article/14549-innovative-tech-and-connectivity-key-to-fighting-covid-19-in-africa.html>.
- [13] Novinite. Rwanda Fights the Coronavirus with the Help of Robots. <https://www.novinite.com/articles/204653/Rwanda+Fights+the+Coronavirus+with+the+Help+of+Robots%21>.
- [14] Bormann, U. & Brauchitsch, B. Von. Artificial Intelligence and Robotics and Their Impact on the Workplace. (2017).
- [15] Niler, E. An AI Epidemiologist Sent the First Warnings of the Wuhan Virus. <https://www.wired.com/story/ai-epidemiologist-wuhan-public-health-warnings/>.
- [16] Kritikos, M. Ten technologies to fight coronavirus. 1–20 (2020) doi:10.2861/58070.
- [17] Christou, T., Sacco, M. P., Scheltema, M. & Bana, A. Digital Contact Tracing for the COVID-19 Epidemic: A Business and Human Rights Perspective. *SSRN Electron. J.* (2020) doi:10.2139/ssrn.3618958.
- [18] Ashimwe, E. Rwanda deploys drones to raise Covid-19 awareness in communities. 2020 April ,12.
- [19]. Jacobstein, N. & Kragic, D. Combating COVID-19 — The role of robotics in managing public health and infectious diseases. 1–3 (2020).
- [20] Dubov, A. & Shoptaw, S. The Value and Ethics of Using Technology to Contain the COVID-19 Epidemic. *Am. J. Bioeth.* 5161, (2020).
- [21] Africa, U. UNDP and Government of Rwanda Deploy Smart Anti- Epidemic Robots to Fight Against COVID-19. <https://www.africa.undp.org/content/rba/en/home/presscenter/articles/2020/undp-deploys-smart-anti-epidemic-robots-to-fight-against-covid-.html>.
- [22] Sharif Makhmal Zadeh, B., Niro, H., Rahim, F. & Esfahani, G. Ocular delivery system for propranolol hydrochloride based on nanostructured lipid carrier. *Sci. Pharm.* 86, (2018).
- [23] Mutesa, L. et al. A strategy for finding people infected with SARS-CoV-2 : optimizing pooled testing at low prevalence. <https://www.medrxiv.org/content/10.1101/2020.05.02.20087924v2>
- [24] Usman, M., Iqbal, W., Mary, Q. & Qadir, J. Leveraging Data Science To Combat COVID-19 : A Comprehensive Review. (2020) doi:10.13140/RG.2.2.12685.28644/4.
- [25] Latif, S. et al. Leveraging Data Science To Combat COVID-19 : A Comprehensive Review. *TechRxiv. Prepr.* 1–19 (2020).
- [26] For, N. C. Republic of Rwanda national council for science and technology. 1–7 (2018).
- [27] Ashimwe, E. Rwanda Deploys Drones to Raise COVID-19 Awareness in Communities. 2020 April ,12 <https://allafrica.com/stories/202004120035.html>.
- [28] Schneidman, M. Project Appraisal Document Global Financing facility, Rwanda-PAD.
- [29] Republic of Rwanda, office of the prime M. Statement on cabinet decisions of 2nd June 2020. (2020).
- [30] Nguyen, T. T. Artificial Intelligence in the Battle against Coronavirus (COVID-19): A Survey and Future Research Directions Artificial Intelligence in the Battle against Coronavirus (COVID-19): A Survey and Future Research Directions. (2020) doi:10.13140/RG.2.2.36491.23846.