



Detect, Prevent, Respond, **Recover** *Digitally*

Evidence from Applying Digital
Interventions to Past and Present for
Future Public Health Emergencies

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Design:
Diego Vapore

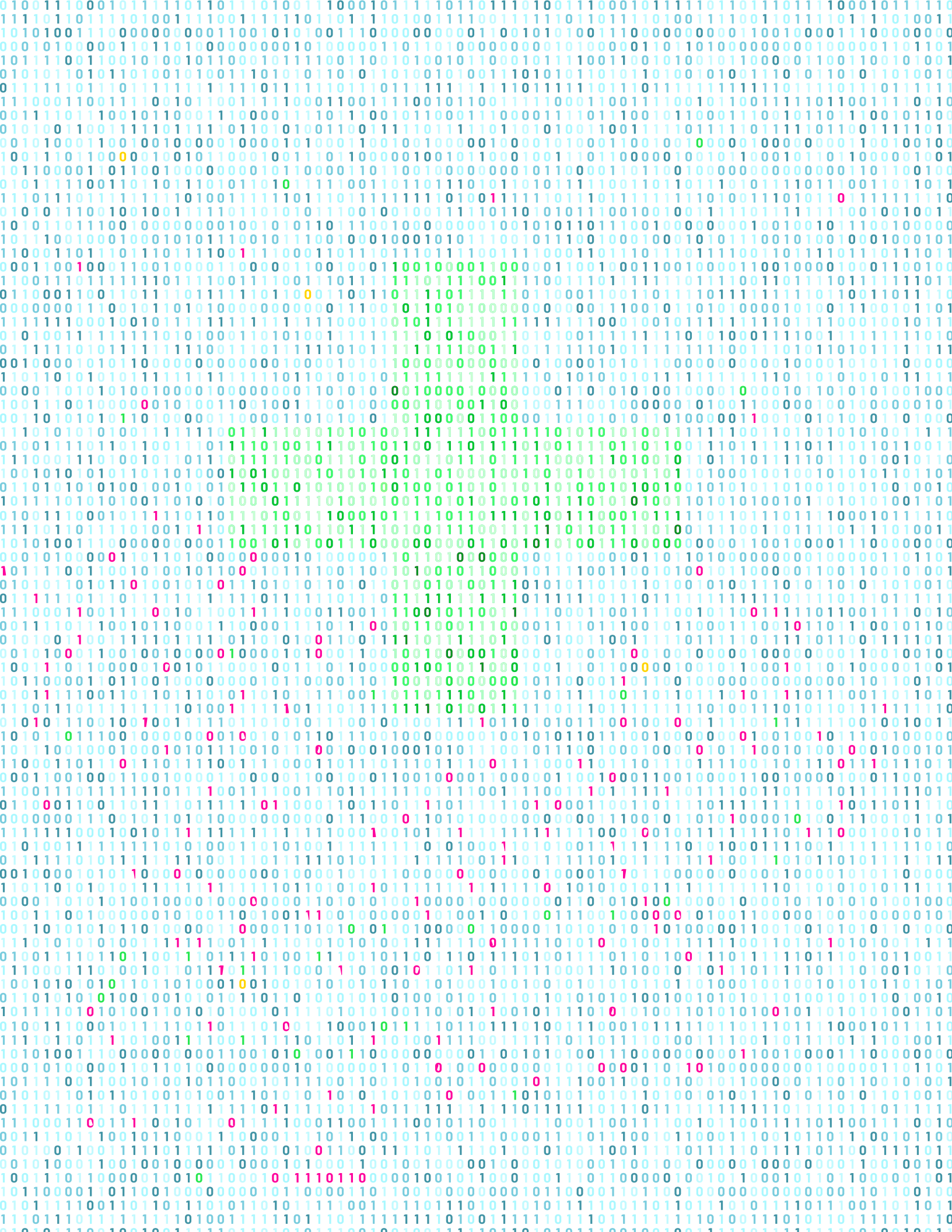


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Authors

Mihwa Park, Jennifer Nelson,
Luis Tejerina, Alexandre Bagolle.
Social Protection and Health Division, IDB



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1. Executive Summary



The objective of this brief is to examine how digital health interventions were used during past public health emergency situations from 2005-2020 to derive lessons learned and to analyze which types of digital health interventions were the most useful and relevant to deal with current and future situations.

Digital health interventions are commonly used tools to improve efficiency and quality of healthcare (Nelson et al. 2019) and they are also proven to be effective during public health emergencies (Allen et al. 2019). The need for timely and accurate information during public health emergencies is well documented; based on a literature review of 28 peer-reviewed articles focused on digital intervention on public health emergencies from Ebola, Cholera, MERS, COVID-19, and others, Information was the most frequently encountered challenge among [WHO's Health System Challenges of Digital Health Interventions](#). Main specific challenges included the lack of quality and reliable data, communication roadblocks, lack of access to information or data and insufficient utilization of data and information. An important part of the literature emphasizes the importance of stronger information systems in times of public health emergencies, especially in community-based information system.

Using the [WHO Digital Intervention System Categories](#), four key types of systems categories -ICT applications and information

systems- were most commonly found in literature: Emergency response systems, Client communication systems, Public health and disease surveillance systems, and Geographic information systems (GIS). It should be noted that mHealth tools were commonly cited in the literature and were part of the solutions included in the majority of these categories (40% of studies mentioned mHealth tools). This result implies that effective measures to share information and communicate with the public are critical for responding to public health emergencies. According to available evidence, emergency response systems, client communication systems, and geographic information systems were the most effective digital interventions, due to improvements in public health surveillance and sharing information and communication with the public (Tambo et al. 2014; Tom-aba et al. 2015; Tom-aba et al. 2018).

Most specific examples in literature were related to Ebola, Cholera, and Influenza A. For example, in Haiti, during the Cholera outbreak following the earthquake of 2010, mobile health and geospatial mapping technology were found to reduce the need for paper registries and manual data entry, which would have been costly, time consuming, and is known to increase error. Using Global Positioning System (GPS) coordinates, researchers mapped vaccine posts, population size, and vaccine coverage to understand the reach of oral cholera vaccination (OCV) campaign in

rural Haiti (Teng et al. 2014). In Nigeria, front line workers who used mobile health tools for learning and training of frontline workers during the Ebola Virus Disease improved their knowledge of the disease¹, with statistically significant improvements ($p < .05$) on questions about human transmission of the virus, common symptoms, and whether Ebola fever is preventable (Otu et al. 2016).

Existing literature also noted that the capacity of GIS to link disease information with environmental and spatial data makes it an asset in the progression of worldwide healthcare. Additionally, health organizations can now visualize, analyze, interpret and display multifaceted geo-location data with GIS tools, mapping applications and Big Data (Musa et al. 2013). These new tools have unleashed new modeling techniques previously thought impossible (Chunara et al. 2012). However, some of these technologies have raised ethical issue related to privacy of citizens, which requires further analysis as technology advances.

The increased use in digital interventions for COVID-19 implies that digital interventions are here to stay and will continue to advance. Digital interventions for emergency preparedness will continue to be more valuable tools in terms of all the aforementioned areas. So far, a ICT tools and information systems that enable public health and disease surveillance, client communication and geographic information systems have been implemented.

We should be open to adopt newly developed technologies into emergency

preparedness measures and expand the areas of usage. Additionally, it is important to note contextual differences may limit the applicability of certain digital interventions across regions, and each digital intervention should be carefully analyzed prior to replication.

Furthermore, information shared should be trustworthy and reliable, and new concepts should be taken into consideration to avoid chaos and misinformation. It is also important to note that the best way to be prepared for an emergency is to plan and develop communication strategies, infrastructure, and other measures to enhance information related emergency preparedness before the emergency, in order to respond in a timely way.

However, digital interventions alone are not enough. Often non-digital approaches –such as interviews for contact tracing– are either more important or need to be in place before digital approaches become useful. That being said, when digital interventions are incorporated in a coherent public health response, they can be very powerful and leverage substantial benefit. While doing so, we must actively monitor un-intended consequences that comes along with the rapid changes and updates with technology. Issues such as privacy, and security during public health emergencies, public perception, and ethical issues will be important areas of concern while using digital interventions. Thus, frameworks to guide policy makers and citizens navigate decisions during times of crisis should be in place prior to future outbreaks.

¹ The study noted reinforcement against risky behaviors such as contact with Ebola patients, eating bush meat, and risky burial practices

2.

What are Digital Interventions for public health emergencies and why do they matter?



The objective of this brief is to examine how digital health interventions were used during past public health emergency situations from 2005-2020 to derive lessons learned to countermeasure current COVID-19 through digital health intervention, and to analyze which types of digital health interventions were the most useful and relevant.

WHO defines a Public Health Emergency as “an occurrence or imminent threat of an illness or health condition, caused by bio terrorism, epidemic or pandemic disease, or (a) novel and highly fatal infectious agent or biological toxin, that poses a substantial risk of a significant number of human fatalities or incidents or permanent or long-term disability.”(WHO 2019)

A digital health intervention is defined as a “discrete functionality of digital technology that is applied to achieve health objectives and is implemented within digital health applications and ICT systems, including communication channels such as text messages.” (WHO 2019)

As we are all living in a more connected world than ever, we are exposed to a higher risk of pandemics. The case of COVID-19 shows how a regional outbreak can become a global phenomenon that affects not only citizens’ well-being, but also global economy. As a countermeasure to combat the outbreak, countries are adopting various digital solutions. While we recognize that

the current crisis is something that we have not seen in recent memory, this is not the first outbreak that employed digital tools. We looked at past and current research to discover lessons learned, best practices, and recommendations to apply them to current and future outbreaks.



3.

What can we learn from past experiences?



We conducted a literature review of studies with evidence regarding digital health and public health emergencies from 2005-2020 found in Google Scholar. We started at 2005 given that major outbreaks prior to 2005 did not have sufficient digital technology to be implemented as digital interventions. We included studies that examined health outcomes and impacts; cost effectiveness; and social issues. Specific key words included “Digital technologies”; “ICT & public health”; “public health emergency response”; “pandemic”; “epidemic”; “surveillance”; and then looked at specific diseases (see below) and the words “digital”; “ICT tools”; and “response”.

In order to select types of diseases to include in our study, we analyzed the most frequently reported disease in [WHO's emergency responses](#) (WHO, n.d.) from 2005 to 2020, and selected top 13 most frequently reported, which included: Avian influenza, Cholera, Ebola virus disease, Human infection with avian influenza A (H7N9), Influenza A (H1N1), Marburg virus disease, Measles, Meningococcal disease, Middle East Respiratory Syndrome Coronavirus (MERS-COV), Novel Coronavirus (COVID-19), Polio, Yellow Fever, and Zika virus infection.

It is important to note that interventions during epidemic and pandemic situations vary depending on the disease. In this brief, we focus mainly on population-based interventions including: Emergency

response mechanisms; Risk communication and public engagement; Case finding; contact tracing and management (including quarantine and isolation); and Surveillance. We did not include case management and related ICT interventions, such as telemedicine or interventions for individual behavior change, as the focus on this brief is population level interventions. In total, 28 studies were found. 26 studies were included, while 2 were discarded due to difference in focus of the studies.

We categorized the literature based on the following criteria for qualitative analysis: year of study, year of outbreak, region/country of outbreak, name of the disease, number of population affected, description of issues/problems, digital intervention description, description of findings, [WHO's Classification of Digital Health Interventions](#) (WHO 2018): Health system challenges, and System Categories, Type of results, Type of study, and [WHO's 8 pillars from COVID-19 Strategic Preparedness and Response Plan](#) (WHO 2020).

[WHO's Classification of Digital Health Interventions](#) categorize the “different ways in which digital and mobile technologies are being used to support health system needs” (WHO 2018). The interventions are organized into four groups based on targeted primary users:

1. Clients;
2. Healthcare providers;
3. Health system or resource manager; or
4. Data services.

These interventions are used to address one or multiple health system challenges. Health system challenges are used to “articulate how technology is addressing identified health needs, and they provide an overview of needs and challenges faced in health systems to assist program planners to express what they expect to achieve through implementation of a digital health intervention”(WHO 2018). It consists of 8 themes;

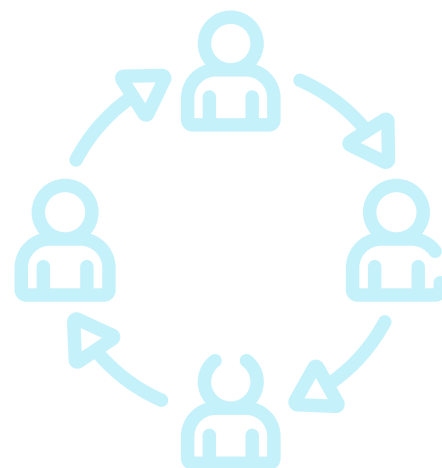
1. Information;
2. Availability;
3. Quality;
4. Acceptability;
5. Utilization;
6. Efficiency;
7. Cost; and
8. Accountability.

The types of ICT applications and information systems designed to deliver one or more digital health interventions are called System categories (WHO 2018). There are 25 different types of system categories. ([Click here to see full list of System categories](#)) In our analysis, we used health system challenges to categorize types of challenges during public health emergencies, and system categories to see which types of ICT applications and information systems were used to address these challenges. We did not use four types of digital intervention groups given that health system categories are the combination of various digital interventions. Based on the details of each study, we assigned WHO’s classifications.

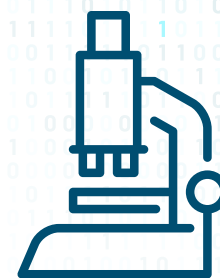
In order to support country preparedness and response in times of public health emergencies, especially targeting COVID-19, WHO provides operational planning and guidelines through [WHO’s COVID-19 Strategic Preparedness and Response Plan](#) (WHO 2020). There are 8 pillars in this plan, which include:

1. Country-level coordination, planning, and monitoring;
2. Risk communication and community engagement;
3. Surveillance, rapid response teams, and case investigation;
4. Points of entry;
5. National laboratories;
6. Infection prevention and control;
7. Case management; and
8. Operational support and logistics.

([Click here to see full definition of the pillars](#)) Though this document is dedicated to strategic preparedness and response to COVID-19 specifically, we used these pillars to categorize how past digital interventions could apply to current COVID-19 interventions.



4. What do we know from evidence?



As seen in Table 1, among the 8 health system challenges listed by the [WHO's Classification of Digital Health Interventions](#) (WHO 2018), *Information* was the most frequently encountered challenge (22 times out of 28 publications) in times of public health emergencies. Information related challenges were found especially in infectious disease outbreaks such as Ebola (in West Africa), Cholera (in Haiti), Zika

(in Latin America), Influenza A (global), and COVID-19. Specific information challenges included: lack of quality and reliable data, communication roadblocks and lack of access to information or data. Furthermore, insufficient utilization of data and information was also an issue. Based on this result, it could be inferred that timely, quality information is vital during public health emergencies.

TABLE 1

Number of publications according to WHO Health system challenges

<i>WHO Health System Challenges</i>	<i>Number of Publications (multiple selection is allowed)</i>
1.0 Information	22
2.0 Availability	7
3.0 Quality	3
4.0 Acceptability	0
5.0 Utilization	3
6.0 Efficiency	5
7.0 Cost	0
8.0 Accountability	1

As seen in Table 2, using the digital intervention system categories of WHO, the most common types of systems studied included: emergency response systems (12 times), client communication systems (12 times), public health and disease surveillance systems (11 times), geographic information systems (7 times), community-based information systems (5 times), learning and training systems (3 times), laboratory and diagnostics information system (1 time) and client applications (1 time). In addition, in Table 2, there are two system categories that were not included in the WHO's system categories: mHealth, and crowd-sourced information system. As mHealth could be used in many functionalities, the uses of mHealth were categorized into different systems categories of WHO depending on the purposes and functions of mHealth applications. However, we also included mHealth as a separate systems category in table 2 to show the frequent use of mHealth (11 times) in our study. Crowd-sourced information gathering system was mentioned by 6 articles. The result implies that an effective measure to share information and communicate with the public are the key in responses to public health emergencies, and mHealth is a promising tool for emergencies.

Findings from the last two types of system categories provide an important insight. Mobile Health or mHealth, the use of mobile phone information technology in the health sector was a type of ICT application and information systems that was widely used to overcome difficulties in management and communication in times of public health emergencies. Client communication system (7 times), Emergency response system (6 times), and Public health and disease surveillance system (6 times) were the most frequently adopted types, and Community-

based information system, Geographic information system, and Learning and training systems were used 3 times. mHealth application was also used as crowd-sourced information system (1 time). Another category, the Crowd-sourced information gathering system emerged rather recently, but it has been a popular method to gather real-time information and map the outbreak. Instead of using traditional data gathering resources, this system uses data gathered from social media like Twitter, Facebook, blog posts, or other image sharing website. This type of information gathering offers more sensitive and timely gathering of data, which has an advantage over traditional data gathering methods. Furthermore, these systems are independent from healthcare-seeking behavior biases and less costly (Wójcik et al. 2015).

It should be noted that it was common to have multiple challenges and multiple interventions per publication. For instance, in order to improve information challenges during Nigeria's Ebola outbreak, the Open Data Kit and Form Hub Technology was used in combination with a dashboard and ArcGIS mapping for follow up for contact, identification of cases, case investigation and management and also for strategic planning during the response (Tom Aba et al. 2015). Furthermore, mHealth was a versatile application used to perform many different functionalities, such as mapping, surveillance, and communication.

Similar to WHO's digital health intervention, WHO's 8 pillars from COVID-19 Strategic Preparedness and Response Plan (WHO 2020) also notes the importance of communication, surveillance, rapid response teams, and case investigation in times of public health crisis. Surveillance, rapid response teams, and case investigation were the most frequently used categories,

TABLE 2

Number of publications according to WHO System categories findings

<i>WHO Health System Categories</i>	<i>Number of Publications (multiple selection is allowed)</i>
C. Client Applications	1
D. Client Communication System	12
F. Community-based information system	5
I. Emergency response system	12
L. Geographic information system (GIS)	7
R. Laboratory and diagnostics information system	1
S. Learning and training system	3
V. Public health and disease surveillance system	11
Crowd-sourced information system ²	6
Mobile health (mHealth) ³	11

with 14 publications, and following was risk communication and community engagement. The following examples show how communication, surveillance, and other pillars were applied during the past outbreak.

Surveillance, rapid response teams, and case investigation: The earliest form of digital intervention found in our search for public health emergencies indicate the importance of public surveillance in controlling outbreaks. The Influenza A (H1N1) pandemic in 2009 showcased “non-traditional surveillance sources, such as internet news, and social media posts, complemented traditional surveillance systems’ limitations such as delays in reporting, inconsistency in

population coverage and poor sensitivity to detect emerging diseases” (Brownstein et al. 2010).

In Haiti, mobile health and geospatial mapping technologies were found to reduce the need for paper registries and manual data entry, which would have been costly, time consuming, and are known to increase errors. “Using GPS coordinates, the researchers mapped vaccine posts,

² Not on WHO’s list

³ Mobile health is not on WHO’s list, and the usage of mhealth in the literatures were categorized into WHO’s systems categories depending on its usage. However, we included this here to show how frequently mHealth was used during our research.

population size, and vaccine coverage to understand gaps and increase efficiency of the reactive oral cholera vaccination (OCV) campaign in rural areas” (Teng et al. 2014).

Risk communication and community engagement: A case study on the Zika outbreak shows how better and timely public communication and engagement strategies are crucial to controlling outbreak effectively. “Applications of digital tools to share data and information on Zika outbreaks through social media- Twitter, Facebook, blog posts and other image sharing websites- were very useful to governments, and other stakeholders. These direct information channels shared transmission routes, new case reports, and helped mapping and early warning alert for the communities, which helped in logistics, setting priorities, timely intervention for support system and contingency measures” (Tambo et al. 2017).

Case management: In Nigeria, front line workers who used a mobile health tool for learning and training during the Ebola Virus Disease improved their knowledge of the disease, with statistically significant improvements ($p < .05$) on questions about human transmission of the virus, common symptoms, and whether Ebola fever is preventable. The study noted that the use of mHealth learning courses provided reinforcement against risky behaviors, such as contact with Ebola patients, eating bush meat, and risky burial practices (Otu et al. 2016).

Country-level coordination, planning, and monitoring: These two examples demonstrate how these two countries have strengthened their country-level coordination, planning and monitoring after a past outbreak. After the MERS outbreak of 2015 in South Korea, the government introduced several reforms to the country’s

infectious disease preparedness. Among those reforms were utilizing ICT applications and information systems to enhance the country’s capability in preventing, detecting, and rapidly responding to an outbreak (Jeong 2017). Similarly, Taiwan has strengthened its emergency preparedness after the SARS pandemic, applying enhanced country level communication, and surveillance systems to the current COVID-19 pandemic (Wang et al. 2020).

As mentioned above, mHealth is a versatile application during an outbreak, serving different functionalities from client communication to surveillance. Looking at different types of diseases, during Ebola outbreak in West Africa, mHealth was used as a learning and training system (Otu et al. 2016), a community-based information system (Sacks et al. 2015), and a public health and disease surveillance system (Sacks et al. 2015). When Influenza A pandemic occurred in 2009, mHealth tools were used to input data into the Geographic information system (GIS), and to collect data for a crowd-sourced information system (Freifeld et al. 2010). Most recently, mHealth tools were implemented as an emergency response tool and a client communication tool during Taiwan’s response to COVID-19 (Wang et al. 2020).

Though use of digital tools is promising in the times of public health emergencies, some of the articles raised issues related to use of these tools. An article on impact of technology and mobile applications during Ebola and Zika pointed out ethical, legal and medical issues when digital tools were used during these outbreaks. The paper also stated that the issues of informed consent, lack of trust, and security could be caused by the use of digital tools (Tambo et al. 2017). In addition, crowd-sourced information systems could also

TABLE 3

Number of publications according to WHO Pillars findings

<i>WHO Pillars</i>	<i>Number of Publications (multiple selection is allowed)</i>
1. Country-level coordination, planning, and monitoring	5
2. Risk communication and community engagement	11
3. Surveillance, rapid response teams, and case investigation	14
4. Points of entry	0
5. National laboratories	0
6. Infection prevention and control	0
7. Case management	6
8. Operational support and logistics	2

have challenges related to information verification and accuracy (Freifeld et al. 2010), and lack of consistency in data as ensuring consistent participation is difficult for this type of information gathering (Wojcik et al. 2015). Lastly, lack of universal design and accessibility when designing for ICT tools and platforms for emergency management (Chen et al. 2018) is another issue that needs an improvement.



5.

What does this mean for current and future outbreaks?



Importance of reliable and accurate information in times of outbreaks:

Information was the most frequently encountered challenge among WHO's Healthy System Challenges of Digital Health Interventions (WHO 2018). Specifically, the lack of quality and reliable data, communication roadblocks, lack of access to information or data, and insufficient utilization of data and information were the main challenges within information category.

Reliable information and efficient communication channels are critical, especially during the times of outbreaks, because information system allows not only detecting and reporting the current trend, but also helps identifying and containing the outbreak. However, too much information can also be problematic; according WHO, "the 2019-nCoV outbreak and response has been accompanied by a massive 'infodemic' - an over-abundance of information - some accurate and some not - that makes it hard for people to find trustworthy sources and reliable guidance when they need it." (WHO 2020). This requires public health organizations to work harder on finding, detecting, and correcting rumors, myths, false prevention measures, and statistics that do more harm than good (D'Agostino et al. 2017).

Literature also emphasizes the importance of stronger information systems in times of public health emergencies, especially in

community-based information system. It is also important to note that the best way to be prepared for an emergency is to plan and develop communication strategies, infrastructure, and other measures to enhance information related emergency preparedness before the emergency, in order to respond in a timely way.

Surveillance and communication related tools as key digital intervention system categories:

Using the [WHO Digital Intervention System Categories](#) (WHO 2018), there were four key systems categories that were most commonly found in literature: Emergency response systems, Client communication systems, Public health and disease surveillance systems, and Geographic Information systems (GIS). We cannot simply conclude that these systems categories were the most effective ICT tools and information systems. However, we can infer that these tools were used to strengthen communication with the public and enhance surveillance and monitoring in times of public health emergencies, and they were effective in some cases.

For instance, improvement in GIS allowed it to link disease information with environmental and spatial data, which makes it an asset in the progression of worldwide healthcare. Health organizations can now visualize, analyze, interpret and display multifaceted geo-location data using GIS tools, mapping applications and Big Data (Musa et al. 2013). These new tools

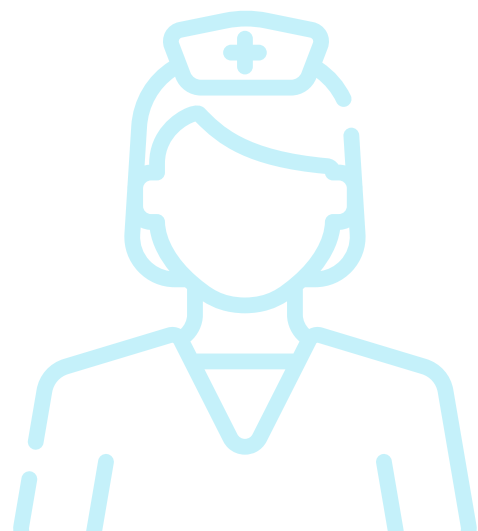
have unleashed new modeling techniques previously thought impossible (Chunara et al. 2012). While we learned that digital tools may strengthen emergency preparedness, the use of digital technology also raises concerns related to ethical, privacy, and so on, which needs to be further analyzed as technology advances.

Crowd-source information system as new form of surveillance and communication tools: A newly emerging surveillance and communication tool, Crowd-sourced information systems, have been gaining importance as they introduce new forms of surveillance and communication tools. Though their history is shorter than other digital tools, they have been a popular way to gather real-time information on outbreaks. Using social media- such as Twitter, Blog Post, Facebook, or other image sharing websites- citizens report and share data on the situation near them, allowing real-time information gathering. Nonetheless, we need to expand our efforts in using newly developed technology to improve surveillance and communication tools for countermeasures of current and future outbreaks.

Researchers recommend that public health practitioners are involved in design of ICT systems (Reeder et al. 2010). Literature also suggests that future studies explore universal design and accessibility of ICT tools and plans for emergency management (Chen et al. 2018) and an up-to date continuity of operations plan (COOP), an organizational guideline during a crisis that ensures continuous delivery of essential services (Reeder et al 2010). These suggestions are applicable to current interventions and future research from the COVID-19 outbreak.

Limitations

In general, there is a lack of research on specific digital interventions in times of public health emergencies. Also, the contexts and cultures in which these literatures were deployed were highly variable, making generalizations difficult. Furthermore, our analysis is limited, as we did not include *case management and related ICT interventions*, such as telemedicine, public health measures and behavior change, but focused on population-based interventions.



6.

Specific applications for COVID-19 and Global Examples



As mentioned before, interventions during epidemic and pandemic situations vary depending on the disease. The [WHO recommends 10 priority areas of work](#) (WHO 2020) for [Critical preparedness, readiness and response actions for COVID-19](#) including: Emergency response mechanisms; Risk communication and public engagement; Case finding, contact tracing and management (including quarantine and isolation); Surveillance; Public health measures; Laboratory testing; Case management strategy; Case management recommendations by case severity and risk factors (which for COVID-19 includes self-isolation at home for mild cases and Hospitalization (in-patient treatment), with appropriate isolation and cohorting for moderate and severe cases); infection prevention and control; and societal response. Our findings are most applicable to the use of digital technologies in the following categories: Emergency response mechanisms; Risk communication and public engagement; Case finding, contact tracing and management (including quarantine and isolation); and Surveillance.

Non-pharmaceutical interventions (NPI) are central for the management of COVID-19 according to The Lancet's article on COVID-19, especially in the absence of licensed vaccines or antivirals (Heymann et al. 2020). At this point, population wide social distancing, home isolation, and school closures have potentials to suppress transmission of the virus (Ferguson et

al. 2020). Furthermore, the WHO has emphasized the importance of close monitoring, enhancing communication strategies, intensified active surveillance systems, and preparation for resilience of health systems (WHO 2020), all of which are areas where digital interventions are useful, and have been used in countries around the world.

Digital tools are promising surveillance, communication, and countermeasure tools to COVID-19 that have been widely applied globally. OECD, in its recent policy brief on health systems policy during COVID-19, has emphasized the role of digital data and tools to improve surveillance and care; digital transformation is helping countries around the world to detect, prevent, and respond to the pandemic (OECD 2020).

In Latin America and the Caribbean, informing citizens have been a priority for digital tools. Chatbots, mainly using Whatsapp, have been popular measure like countries in [Uruguay](#), and [Argentina](#). These chatbot answers questions and provide information on COVID-19 to citizens. Another priority is on following up with the countries' situations. [Colombia](#) launched an informative platform to follow up with the evolution of COVID-19 in the country and launched an app to track COVID-19. ([CoronApp](#)). Peru ([AutoEvaluacionCoVID-19](#)) and Costa Rica ([Dashboard](#), [EDUS App](#)) operate similar platforms, featuring confirmed cases in each countries and

dashboards. Furthermore, [Argentina](#) recently launched an [app that tracks contacts with COVID-19](#), and [another app for self-diagnosis](#). [Uruguay](#) also launched an app to determine if a COVID-19 test is needed. You can access more solutions being used in Latin American at IDB's [+Digital](#).

There has been active development of digital tools in North America. One example is [Healthmap](#), a digital map that tracks the spread of COVID-19 through media networks, chatrooms, and other online crowdsourcing efforts; [BlueDot](#), a Canadian startup that uses AI to detect an outbreak; and [Safe path](#), that tracks users' movement and to see if they have come in contact with anyone carrying the virus, some of these apps are taking data privacy into consideration. In addition, [Unacast](#) created an interactive scoreboard to understand and assess the efficacy of social distancing activity at local level.

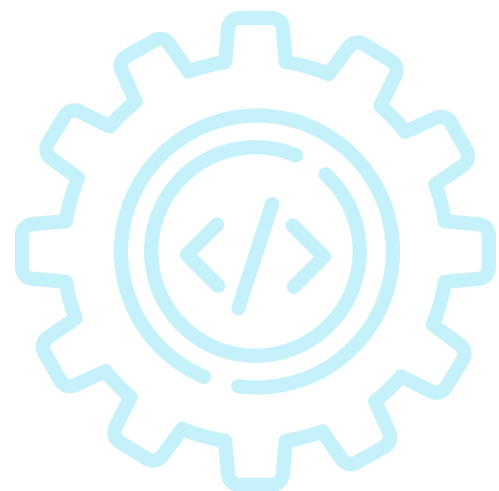
In Asia, ICT tools were quickly deployed as these countries are equipped with high advanced technology. Digital interventions in these countries includes not only surveillance and monitoring, but also communication with the public and inventory control. Some examples include China's [contact detection app](#), which allows citizens to see if they were in contact with someone infected. South Korea has developed many tools for COVID-19, among them is an application to [track mask inventories](#) in pharmacies around the country, which was developed to address shortages of facial masks. [Taiwan](#) is using big data analytics to general real-time alerts during clinical visits based on travel history and clinical symptoms to aid case identification. Singapore uses [a mobile app to trace contacts](#) with confirm patients through short-distance Bluetooth signals.

In Europe, various digital solutions have been introduced by both governments and private sector. From the government, self-assessment apps are operated in countries like Austria ([Home care app](#)), Estonia ([Coronatest](#)), and Spain ([CoronaMadrid](#), [SaludResponde](#), [Stop Covid 19 CAT](#)). Some apps enable people to communicate with doctors, such as Italy's [Lazziodrcovid](#), and UK's [accuRx Fleming](#). Other types of digital solutions by governments in Europe include quarantined citizens tracking apps (Poland: [Home quarantine](#)); chatbots (Spain: [Covid19AragonBot](#)); and information sharing platforms (Spain: [Ser+ Contra Covid](#), [AppValència](#)). From Private sectors, a company from Belgium developed an app that shares information on COVID-19, and self-assessment that could be shared with doctors (Andaman7: [In app Pandemic Module](#)). [Mediktor](#), a Spanish application uses Artificial intelligence-based medical assistance to support clinical decision-making.

In Middle East and Africa, Israel and South Africa have also implemented digital tools for COVID-19. In Israel, health startups have developed various tools using AI, and they have added functions related to COVID-19 response; such as [CLEW](#), a platform using AI based predictive analytics to expand ICU capacity and resources exponentially; and [Sweetch](#); an AI powered mobile platform that enables remote monitoring, management and interventions for COVID-19 patients with chronic diseases. Israel has also developed [Hamagen](#), an [open-source solution](#) for contract tracing. Furthermore, [a robotic process automation solution](#) was adopted to automate reporting of COVID-19 testing results to increase efficiency and minimize human made errors. In South Africa, a WhatsApp based tool, [HealthAlert](#) was introduced to disseminate information to the public. This tool was

recently adopted by the [WHO](#) to increase global awareness of COVID-19.

It will be important to document the update of these tools in different contexts and lessons learned rapidly to share knowledge. Additionally, it is important to note contextual differences may limit the applicability of certain digital interventions across regions, and each digital intervention should be carefully analyzed prior to replication. The OECD notes that some of the technologies implemented for COVID-19, especially related to the use of smartphones and mobile data for detection and control, raise privacy and ethical concerns, noting that “while these approaches help with efforts to contain the spread of the virus, they can raise issues about the right to privacy and personal freedoms. In all of these countries,⁴ the tracking of movements is a privacy intrusion and it is crucial to ensure that such intrusions are both necessary and time limited so that the fundamental rights of people in democratic societies are not eroded” (OECD 2020).



⁴ Page 16 of the OECD document refers to specific examples used in Korea and Israel

7.

Conclusion



Digital health interventions, which are commonly used tools to improve the efficiency and quality of healthcare are also proven to be effective during public health emergencies (Allen et al. 2019). In this brief, we examined the importance of digital intervention on public health emergencies from Ebola, cholera, MERS, COVID-19, and others between 2005-2020, categorized them by [WHO's Health System Challenges of Digital Health Interventions](#), and discussed applications to [WHO's 8 pillars from COVID-19 Strategic Preparedness and Response Plan](#) (WHO 2020). We discovered that Information was the most frequently encountered challenges, and 4 interventions related to improving information sharing, communication with public, and surveillance and monitoring were most commonly found in the literature: Emergency response system, Client communication systems, Public health and disease surveillance systems, and Geographic information system (GIS). It should also be noted that mHealth tools were commonly cited in the literature and were part of the solutions included in the majority of these categories (40% of studies mentioned mHealth tools).

The increased use in digital interventions from COVID-19 implies that digital interventions are here to stay and will continue to advance. Digital interventions for emergency preparedness will continue to be more valuable tools in terms of all the aforementioned areas. So far, for the COVID-19 pandemic, ICT tools and

information systems that enables public health and disease surveillance, client communication and geographic information systems were used. We should be open to adopt newly developed technologies into emergency preparedness measures and expand the areas of usage.

Establishing reliable public health surveillance response systems and communication channels for general public is crucial for developing countries, (Tambo et al. 2017) but also in developed countries as demonstrated by the COVID-19 crisis (Carinci 2020). It is also important to note that the best way to be prepared for an emergency is to plan and develop communication strategies, infrastructure, and other measures to enhance information related emergency preparedness before the emergency, in order to respond in a timely way. Moreover, Governments must strengthen primary health care systems, invest in disease surveillance, and share data in order to fully harness the use of digital technologies in public health emergencies (Gates 2020). Future work on ICT tools and platforms for emergency management should also consider universal design and accessibility (Chen et al. 2018). Additionally, a specific taxonomy for digital interventions in public health emergencies could be expanded upon in the WHO Digital Intervention Taxonomy.

Information shared should be trustworthy and reliable, and new concepts should be

taken into consideration to avoid chaos and misinformation. According WHO, “the 2019-nCoV outbreak and response has been accompanied by a massive ‘infodemic’ - an over-abundance of information - some accurate and some not - that makes it hard for people to find trustworthy sources and reliable guidance when they need it.”(WHO 2020). It requires public health organizations to work harder on finding and detecting rumors, myths, false prevention measures, and statistics that do more harm than good (D’Agostino et al. 2017).

However, digital interventions alone are not sufficient. Often non-digital approaches - such as interviews for contact tracing- are either more important or need to be in place before digital approaches become useful. That being said, when digital interventions are incorporated in a coherent public health response, they can be very powerful and leverage substantial benefit. While doing so, we must actively monitor un-intended consequences that comes along with the rapid changes and updates with technology. Issues such as privacy, and security during public health emergencies, public perception, and ethical issues will be important areas of concern while using digital interventions. Thus, frameworks to guide policy makers and citizens navigate decisions during times of crisis should be in place prior to future outbreaks.



References

- Allen, Stephanie, Marc Perlman, Natasha Elsner. 2019. "Digital health technology." *Deloitte insights*, October 31.
- Bennett, DeeDee, Brenda D. Phillips, and Elizabeth Davis. 2017. "The Future of Accessibility in Disaster Conditions: How Wireless Technologies Will Transform the Life Cycle of Emergency Management." *Futures* 87 (March): 122-32.
- Braun, Rebecca, Caricia Catalani, Julian Wimbush, and Dennis Israelski. 2013. "Community Health Workers and Mobile Technology: A Systematic Review of the Literature." Edited by Chris Bullen. *PLoS ONE* 8 (6): e65772.
- Brinkel, Johanna, Alexander Krämer, Ralf Krumkamp, Jürgen May, and Julius Fobil. 2014. "Mobile Phone-Based MHealth Approaches for Public Health Surveillance in Sub-Saharan Africa: A Systematic Review." *International Journal of Environmental Research and Public Health* 11 (11): 11559-82.
- Brownstein, John S., Clark C. Freifeld, Lawrence C. Madoff. 2009. "Digital Disease Detection — Harnessing the Web for Public Health Surveillance." *New England Journal of Medicine* 360 (21): 2153-57.
- Brownstein, John S., Clark C. Freifeld, Emily H. Chan, Mikaela Keller, Amy L. Sonricker, Sumiko R. Mekaru, and David L. Buckeridge. 2010. "Information Technology and Global Surveillance of Cases of 2009 H1N1 Influenza." *The New England Journal of Medicine*.
- Carinci, Fabrizio. 2020. "Covid-19: preparedness, decentralisation, and the hunt for patient zero." *BMJ*.
- Chunara, Rumi, Clark C. Freifeld, and John S. Brownstein. 2012. "New technologies for reporting real-time emergent infections"
- D'Agostino, Marcelo, Felipe Medina Mejía, Ian Brooks, Myrna Martí, David Novillo-Ortiz, and Gerardo de Cosío. 2017. "Fear on the networks: analyzing the 2014 Ebola outbreak"
- D'Agostino, Marcelo, Felipe Medina Mejía, Myrna Martí, David Novillo-Ortiz, Flavio Hazrum, and Federico G. de Cosío. 2017. "Infoxicación en salud. La sobrecarga de información sobre salud en la web y el riesgo de que lo importante se haga invisible"
- Dhillon, Ranu S, Devabhaktuni Srikrishna, and Jeffrey Sachs. 2014. "Controlling Ebola: Next Steps." *The Lancet* 384 (9952): 1409-11.
- Ferguson, Neil, Daniel Laydon, Gemma Nedjati-Gilani, Natsuko Imai, Kylie Ainslie, Marc Baguelin, Sangeeta Bhatia, et al. 2020. "Impact of Non-Pharmaceutical Interventions (NPIs) to Reduce COVID- 19 Mortality and Healthcare Demand."
- Freifeld, Clark C., Rumi Chunara, Sumiko R. Mekaru, Emily H. Chan, Taha Kass-Hout, Anahi Iacucci, John S. Brownstein. 2010. "Participatory Epidemiology: Use of Mobile Phones for."
- Gates, Bill. 2020. "Responding to COVID-19: A once in a century pandemic." *The New England Journal of Medicine*.
- Gjørseter, Terje, Jaziar Radianti, Weiqin Chen. 2018. "Universal Design of ICT for Emergency Management: A Systematic Literature Review and Research Agenda."
- Gomez, Elizabeth, and Murray Turoff. 2007. "Community Crisis Response Teams: Leveraging Local Resources through ICT E-Readiness." *2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07)*.
- GOVTech Singapore. 2020. "Responding to COVID-19 with Tech"
- Heymann, David, Nahoko Shindo, WHO Scientific and Technical Advisory Group for Infectious Hazards. 2020. "COVID-19: What is next for public health?"
- Isere, Elvis, Akinola Fatiregun, and Ikeoluwapo Ajayi. 2015. "An Overview of Disease Surveillance and Notification System in Nigeria and the Roles of Clinicians in Disease Outbreak Prevention and Control." *Nigerian Medical Journal* 56 (3): 161.

- Jeong, Eun Kyeong. 2017. "Public health emergency preparedness and." *Journal Korean Medical Association*.
- Munro, Robert. 2012. "Crowdsourcing and the Crisis-Affected Community." *Information Retrieval* 16 (2): 210-66.
- Musa, George, Po-Huang Chiang, Tyler Sylk, Rachel Bavley, William Keating, Bereketab Lakew, Hui-Chen Tsou, Christina W. Hoven. 2013. "Use of GIS Mapping as a Public Health Tool--From Cholera to Cancer." *Health Services Insights*.
- Nelson, Jennifer, Luis Tejerina, Gianluca Cafagna, and Andrea Ulrich. 2019. "Approach to Digital Transformation: Guidelines and Recommendations." Washington, DC: Inter-American Development Bank.
- OECD. 2020. "ELS policy brief on the policy response to the COVID-19 Crisis: Beyond Containment: Health systems responses to COVID-19 in the OECD", Paris: OECD
- Otu, Akaninyene, Bassey Ebenso, Okey Okuzu, Egbe Osifo-Dawodu. 2016. "Using a mHealth tutorial application to change knowledge and attitude of frontline health workers to Ebola virus disease in Nigeria: a before-and-after study." *Human resources for health*.
- Palen, Leysia, and Sophia B. Liu. 2007. "Citizen Communications in Crisis." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems- CHI '07*.
- Reeder, Blaine, Anne Turner, and George Demiris. 2010. "Use of Technology to Support Information Needs for Continuity of Operations Planning in Public Health: A Systematic Review."
- Sacks, Jilian A, Elizabeth Zehe, Cindil Redick, Alhoussaine Bah, Kai Cowger, Mamady Camara, Aboubacar Diallo, Abdel Nasser Iro Gigo, Ranu S Dhillon and Anne Liu. 2015. "Introduction of Mobile Health Tools to Support Ebola Surveillance and Contact Tracing in Guinea." *Global Health: Science and Practice*.
- Tambo, Ernest, Kazienga A, Talla M, Chengho CF, Fosting C. 2017. "Digital Technology and Mobile Applications Impact on Zika and Ebola Epidemics in Data Sharing and Emergency Response." *Journal of Health and Medical Informatics*.
- Tambo, Ernest, Emmanuel Chidiebere Ugwu, and Jeane Yonkeu Ngogang. 2014. "Need of Surveillance Response Systems to Combat Ebola Outbreaks and Other Emerging Infectious Diseases in African Countries." *Infectious Diseases of Poverty* 3 (1)
- Teng, Jessica, Dana R. Thomson, Jonathan S. Lascher, Max Raymond, Louise C. Ivers. 2014. *Using Mobile Health (mHealth) and Geospatial Mapping Technology in a Mass Campaign for Reactive Oral Cholera Vaccination in Rural Haiti*.
- Tom-Aba, Daniel, Adeniyi Olaleye, Adebola Tolulope Olayinka, Patrick Nguku, Ndadilnasiya Waziri, Peter Adewuyi, Olawunmi Adeoye, et al. 2015. "Innovative Technological Approach to Ebola Virus Disease Outbreak Response in Nigeria Using the Open Data Kit and Form Hub Technology." Edited by Diane Medved Harper. *PLOS ONE* 10 (6): e0131000.
- Tom-Aba, Daniel, Patrick Mboya Nguku, Chinedu Chukwujekwu Arinze, Gerard Krause. 2018. "Assessing the Concepts and Designs of 58 Mobile Apps for the Management of the 2014-2015 West Africa Ebola Outbreak: Systematic Review."
- Wang, C. Jason, Chun Y. Ng, Robert H. Brook. 2020. "Response to COVID-19 in Taiwan: Big data analysis, new technology, and proactive testing." *JAMA Network*.
- World Health Organization. 2018. "Classification of Digital Health Interventions 1.0"
- World Health Organization. 2019. "What are the International Health Regulations and Emergency Committees?"
- World Health Organization. 2019. "WHO Guideline: Recommendations on digital interventions for health system strengthening"

- World Health Organization. 2020. "Critical preparedness, readiness and response actions for COVID-19"
- World Health Organization. 2020. "COVID-19 Strategic Preparedness and Response Plan: Operational planning guidelines to support country preparedness and response."
- World Health Organization. 2020. "Novel Coronavirus (2019-nCoV): Situation Report -13"
- World Health Organization. 2020 "2019 Novel Coronavirus (2019-nCoV): Strategic preparedness and response plan"
- Wójcik, Oktawia P, John S Brownstein, Rumi Chunara, and Michael A Johansson. 2014. "Public Health for the People: Participatory Infectious Disease Surveillance in the Digital Age." *Emerging Themes in Epidemiology* 11 (1)



