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ESSAY

An analysis of the development of digital health technologies to fight COVID-19 in Brazil and the world

Uma análise sobre o desenvolvimento de tecnologias digitais em saúde para o enfrentamento da COVID-19 no Brasil e no mundo

Un análisis sobre el desarrollo de tecnologías digitales en salud para el combate a la COVID-19 en Brasil y en el mundo

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Abstract

The coronavirus pandemic that struck the world in late 2019 continues to break records of new cases and deaths from the disease. Guidelines for clinical management of infected patients and prevention of new cases focus on measures to control symptoms, hygiene habits, social distancing, and decrease in human crowding. This forced a change in the way health services provide care, generating the incorporation of new health technologies. The Essay *thus aims to compile and analyze experiences in the use of digital health technologies to minimize the impacts of COVID-19. The authors identified the development of technological solutions for clinical management of patients, imaging diagnosis, use of artificial intelligence for risk analysis, geolocation apps, data analysis and reports, self-diagnosis, and even orientation for decision-making. The great majority of the initiatives listed here prove effective in minimizing the impacts of COVID-19 on health systems and aim to decrease human crowding and thus facilitate access to services, besides contributing to the incorporation of new health practices and modes of care.*

Information Technology; Coronavirus Infections; Pandemics; Telemedicine; eHealth Policies

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Introduction

The COVID-19 pandemic is a public health emergency of international concern which has received the highest level of alert by the World Health Organization (WHO) according to the International Health Regulation. The number of confirmed cases exceeds 44 million in the world, with more than one million deaths [1,2,3]. In Brazil, there have been more than five million confirmed cases and more than 150,000 deaths from the disease [2,4].

To control the spread of the novel coronavirus, the Pan American Health Organization (PAHO) [2] recommends the adoption of protective measures such as hand hygiene, avoiding coughing or sneezing, encouraging social distancing, and avoiding crowding, as well as only visiting health services in case of aggravated clinical conditions such as fever (above 37.8ºC) and dyspnea. In this context, clinically monitored isolation via apps, software, cellphones, or videoconferences can help contain the exponential growth of SARS-CoV-2 transmission [5,6].

The pandemic has forced a change in the traditional model of care. Healthcare organizations had to forego in-person routine care and invest in technological solutions to provide remote clinical follow-up of patients. Healthcare workers are facing a dual challenge, to advance their knowledge of a new disease and to adapt to a new way of providing care [5,6]. Progress in interactive health technologies can be an effective and safe option to facilitate virtual contact between healthcare workers and patients.

There are many doubts concerning the development and implementation of new digital health technologies. The pandemic marks a turning point in the health sector's technological revolution, requiring new strategies and the adjustment of services to social distancing. The current study's overall objective is thus to compile and analyze the use of digital health technologies to fight the impacts of COVID-19. The following specific objectives were defined for this purpose: (a) list digital technologies developed to fight the novel coronavirus in Brazil and the world; and (b) discuss the contribution of these technologies to clinical management of patients during the pandemic.

Methodologically, this study is designed as an essay, with a presentation of the topic and the hypotheses raised and conclusions reached after analyzing the phenomena [7].

To review international experiences on this topic, we conducted a search in the PubMed database (https://pubmed.ncbi.nlm.nih.gov/) with the keywords "digital health technology" and "COVID-19" in the month of July 2020, yielding 93 manuscripts. The following inclusion criteria were defined for the studies: (1) expound on digital health technologies from the perspective of the fight against COVID-19; (2) available as full text and free of charge; and (3) publication in Portuguese, English, or Spanish. The study adopted a 10-year time frame. After an initial reading of the titles, abstracts, and full texts and application of the inclusion criteria, 27 articles were selected for the sample. Besides the articles selected in PubMed, we also conducted a convenience search in the official website of the Brazilian Ministry of Health (https://coronavirus.saude.gov.br/) to find more information on use of such technologies in Brazil.

The results were compiled and divided into Brazilian and international initiatives. Thus, the article is divided in four sections: (i) *Use of Digital Health Technologies to Fight COVID-19 in Brazil*; (ii) *Use of Digital Health Technologies to Fight COVID-19 Elsewhere in the World*; (iii) *Discussion*; e (iv) *Final Remarks*.

Use of digital health technologies to fight COVID-19 in Brazil

The Brazilian scenario features a tool that contributes to practice in primary healthcare (PHC): the e-SUS APS (https://aps.saude.gov.br/ape/esus), a strategy by the Department of Family Health to organize healthcare information in PHC in the country [8] and to allow access to information and use of the citizen's electronic file [9]. The e-SUS APS features an online scheduling functionality by which patients can remotely schedule appointments at health units. The online agenda is linked to the Conecte SUS Cidadão (https://conectesus-paciente.saude.gov.br/), the purpose of which is to allow the population to access available personal and clinical data in the databases, permitting access to ample health data, including COVID-19 test results.

The Brazilian Ministry of Health developed preclinical services with four types of care for the population through the Corona Virus App, which aims to orient the population on COVID-19 prevention, collect data from individuals on their health status, and based on the answer, indicate the patient's clinical referral. The Brazilian Ministry of Health also provides an online chat (https://coronavirus.saude.gov.br/), a hotline number (136), and a WhatsApp channel to facilitate communication between patients and health services, minimizing risks of exposure and contagion [10].

Since the COVID-19 pandemic struck Brazil, various initiatives in telehealth/telemedicine have been identified, as part of contingency plans for the epidemic drafted by state governments, acting in patient care, communications, and training of healthcare workers [11,12,13,14,15]. The development of self-evaluation technological tools has also been identified, functioning in integrated mode to identify patients infected with the novel coronavirus. These technologies aim to reduce exposure to (and contact with) infected patients, thereby decreasing spread of the virus [16].

Some local initiatives have also been identified, such as by the municipal government of Curitiba in the State of Paraná, which implemented telemedicine consultations in primary care. The service is structured as a telephone call center operated by physicians who perform triage and evaluation of symptoms. Information from the consultation is later transferred to the patient's electronic file, and the respective health unit continue the patient's clinical follow-up via daily calls to assess the symptoms and orient the patient [17]. Another example is the program called "Hello Health" (*AlôSaúde Floripa* – https://alosaudefloripa.com.br/), in the city of Florianópolis, Santa Catarina State, which is also a preclinical service that provides health orientation to citizens and communication via free calls, videocalls, or WhatsApp. The municipal government of Recife, Pernambuco State, together with the State Government, launched an internet app that provides virtual orientation on COVID-19, allows classifying the patient's risk, and, if necessary, conducts videocalls with nurses or physicians. The tool can be accessed by cellphone or computer (http://www.atendeemcasa.pe.gov.br) [18].

Initiatives were also identified that stimulated technological development in the governments of São Paulo and Minas Gerais, which issued calls for projects to finance e-Health startups, aimed at strengthening technological tools in the fight against the COVID-19 pandemic [19,20].

Use of digital health technologies to fight COVID-19 elsewhere in the world

China developed a tool linked to the WeChat app that analyzes users' data and traces close contacts of all patients, which allows tracing and early isolation of possible sources of infection. The data from this analysis can also be mixed with other data to predict trends in the epidemic and calculate individual and collective risks [21]. China also made strides in the development of imaging diagnosis and telemedicine strategies. Researchers in e-Health and clinical information technology in China developed computer-assisted diagnostic solutions for COVID-19 treatment. The Chinese experience shows that digital health technologies play a fundamental role in the response to the COVID-19 pandemic [22]. Artificial intelligence and database resources collaborated with case tracing and logistics in the country, related to distribution of medical supplies [23].

In the United Kingdom, the National Health Service (NHS) provided telephone services for information and answers to the population's questions and doubts. The NHS also provides an online symptom check and other virtual resources, through NHS 111 online (https://111.nhs.uk/). Patients with mild symptoms and without complications can undergo consultations at home, and more serious cases are referred to the appropriate health service. Medical certificates can also be obtained directly from NHS 111 online [5]. With social isolation caused by the pandemic, researchers in the United Kingdom developed an app based on streamlined requirements, using voice-based artificial intelligence, which aims to connect persons, especially the elderly and their family and friends, thereby decreasing the social, physical, and mental harms from isolation [24].

In the United States, telehealth played a significant role in the provision of services during the three phases of the COVID-19 pandemic: (1) outpatient care with home hospitalization; (2) initial hospital outbreak of COVID-19; and (3) recovery and treatment of cases [25,26].

In addition, at the global level, a technology was developed that uses twitter posts to allow tracing individuals who had some experience with the virus or symptoms caused by it. This analysis is done

via a search for keywords, and 4,492,954 tweets were found with terms related to COVID-19, 63% of which in the United States [27].

From this perspective, some governments such as Alberta Province in Canada, Australia, France, Germany, and United States have implemented or expressed interest in digital contact tracing. The majority of these COVID-19 contact screening apps use the strength of the Bluetooth signal to calculate the distance between smartphones and to define exposure status based on distance and duration of proximity to an individual later identified as infected. Bluetooth-based apps were launched in Alberta, Australia, and Singapore, using a structure developed by the Singapore government's Technology Agency [28].

Some countries like Singapore, United States, Indonesia, Poland, and Israel also invested in mobile apps to trace cases and notify authorities, using Bluetooth technology [26]. To screen travelers that present COVID-19 symptoms, Taiwan integrated its national health insurance database with immigration and customs data, aimed at creating a big data resource for analysis. The information has been used to classify travelers at risk and generate warnings in real time during clinical visits [29].

India also developed an app that can detect other smartphones to measure risk of infection based on other novel coronavirus test-positive cases. The basis for this calculation was Bluetooth, algorithms, and artificial intelligence. The Indian government also developed a chatbot to help users obtain answers on COVID-19 and analyze risk of infection in relation to their symptoms [26].

Digital technologies have also been developed for psychiatry/mental health in the United States and Croatia. American researchers concluded that mental health apps are more effective when they can be personalized according to each patient's needs for care. The Croatian experience points to strides in the development of tools and methods for measuring emotions, the inoculation of stress, and the prevention of stress-related disorders [30,31].

The Autonomous Community of Catalonia, considered a hub for development and reference in e-Health in Spain, developed various digital initiatives to fight COVID-19. The first was the creation of a call center to facilitate registering the population in health services. This was followed by improvement of the virtual appointments system, known as eConsult, allowing healthcare personnel to schedule videoconferences with patients, both in primary care and in specialized services. An app was also developed for self-evaluation of symptoms, called Stop COVID Cat https://www.intelligentcitieschallenge.eu/stop-covid19-cat), which helps users understand their health status and includes a geolocation function [32].

The Spanish government also implemented a web portal (https://www.mscbs.gob.es/sanidad/portada/home.htm) for the population's emotional management and established daily reports to monitor health status of patients in rest homes (public and private). Data analysis techniques were also developed to predict the necessary number of ICU beds, as well as methods for the automatic analysis of emergency and hospitalization reports, aimed at exploring predisposing factors and uncoded positive cases [32].

The Catalonia also reduced bureaucratic barriers in healthcare processes, allowing patients to access their data, facilitating access by pharmacies to patients' medical plans via an electronic prescription system in order to reduce the burden on citizens and primary care centers and allowed automatic extension of treatment plans for chronic diseases [32].

Another example of a technological solution to fight COVID-19 was developed in Israel, called TeleICU (https://www.soctelemed.com/resources/telemedicine-glossary/what-is-teleicu/), a tool that uses predictive analyses based on artificial intelligence to exponentially expand the capacity and resources in intensive care units. Its algorithms are trained to identify respiratory deterioration in advance, allowing early interventions that can alter the clinical result, mainly in patients with COVID-19. This allows healthcare personnel to identify the severity of the disease from a remote command center. Health units use telemedicine technologies to furnish remote patient monitoring based on centralized command and control installations [26].

Some Latin American countries like Ecuador, Argentina, Peru, Uruguay, Colombia, and Mexico also invested in technological solutions to fight the pandemic, including apps for communication and orientation for users' decision-making, self-diagnosis apps, patient care guidelines, service guides that be used in case of aggravation of the patient's clinical status, geolocation of active cases, and structur-

ing of the telehealth network to supply free real-time medical orientation (AlôSaúde Floripa – https://alosaudefloripa.com.br/).

Box 1 summarizes the tools created to fight COVID-19 in Brazil and the world.

Box 2 also displays a summary of the types of tools implemented and their functionalities for the fight against COVID-19.

Box 1

Types of technology implemented in Brazil and the world in the fight against COVID-19.

COUNTRIES	TECHNOLOGICAL TOOLS
Brazil	Online e-SUS APS Scheduling Coronavirus app Chatbot for answering questions and doubts Telephone hotline (136) and WhatsApp channel Telemedicine Self-evaluation software
China	Geolocation software Telemedicine Imaging diagnosis
England	Telephone hotline (111) Telemedicine Online symptom check Geolocation software
United States and India	Geolocation software Chatbot for answering questions and doubts Telemedicine Telepsychiatry
Croatia	*Chatbot for answering questions and doubts* *Telepsychiatry*
Canada, Australia, France, Germany, Singapore, Indonesia, Poland, and Taiwan	Geolocation software
Israel	Geolocation software Software for management of health services resources Telemedicine
Spain	Call center Telemedicine Self-evaluation software Geolocation software Electronic patient file
Ecuador, Argentina, Peru, Uruguay, Colombia, and Mexico	Telemedicine Self-evaluation software Geolocation software

Source: prepared by the authors.

Box 2

Principal functionalities of technologies implemented in Brazil and the world in the fight against COVID-19.

TECHNOLOGICAL TOOL	FUNCTIONALITY IN THE FIGHT AGAINST COVID-19
Self-evaluation of app/site and online symptom check	Assists users in understanding their health status and facilitates management of non-serious cases, which decreases unnecessary visits.
Online service for scheduling appointments	Allows remote scheduling of appointments in primary healthcare services.
Computer-assisted imaging diagnosis	Adds reliability to medical diagnosis.
Telephone service, call center, and WhatsApp	Allows population's access with and without internet to a reliable information channel.
Chatbot for answering doubts	Assists recognition of first symptoms, orients preventive methods, analysis infection risk based on symptoms, and referral to health services.
Management of health services' resources	Assists management of beds and guarantees resources in health services for follow-up of persons infected with coronavirus.
Electronic patient file	Allows virtual access to patient's clinical information.
Telemedicine	Allows remote consultations and patient monitoring via video calls, telephone calls, or use of specific software.
Geolocation	Allows viewing spatial distribution of positive cases and measurement of risk burden in locations.

Source: prepared by the authors.

Discussion

Primary healthcare assumes increased relevance during the novel coronavirus pandemic, requiring recognition of its peculiarities and operational needs. The model for organization of PHC in Brazil allows the management of suspected flu syndrome cases, with compulsory notification and prescription of home isolation [33,34,35]. In this scenario, digital health technologies such as the electronic patient file (e-SUS APS) and its online scheduling functionality have taken a leading role as tools that facilitate the process of care, during reorganization of services to meet the demand created by the pandemic.

The new practices of care that have emerged with the pandemic produced a revolution in the form of "making health", which highlights some challenges. The international experiences feature orientation for the implementation of non-face-to-face technologies of care, with a focus on training and supervision of healthcare personnel, national-level professional licensing, digital security mechanisms, protection of privacy, and continuous assessment of interventions in this new model of care [36].

Until 2019, telemedicine was defined and regulated in Brazil by the Federal Council of Medicine (*Conselho Federal de Medicina*, CFM) as the use of interactive audio and video communication methods, but only with the objective of healthcare, research, and education. The CFM allowed health professionals to conduct teleconsultations, telesurgeries, and telediagnosis. In 2020, the COVID-19 pandemic demanded expanding the possibilities for online care of patients in isolation [37] and thus required a command of technological tools, aimed at adopting more flexible routines and increasing productivity, which is inherent to the services' quality.

Digital tools that promote virtual interaction between healthcare workers and patients allow remote assessment of users' health status. Healthcare workers are thus able to define strategies for questioning and raising clinical hypotheses, aimed at understanding patients' health conditions. A plan of care is defined, or other procedures are performed, remotely [22].

This initiative demonstrates that the inclusion of interactive and diagnostic technologies in the health sector takes an outstanding position and has been an allied source in the fight against the COVID-19 pandemic. Non-face-to-face methods of care also facilitate access to health services, all of which in a chaotic scenario in global public health. The implementation of interactive technologies requires human resources training and logistics for access [6,38,39].

Patients may need services with different levels of complexity. The adequate use of technological tools can contribute to correct referral of citizens to the most adequate services. This prevents contact between a possibly infected patient and various healthcare workers. Telemedicine is a widespread technology in health systems in the world and is currently in the process of regulation in Brazil. On March 23, 2020, the Brazilian Ministry of Health published *Ruling n. 467/2020* [40], on an exceptional and temporary basis, which rules on telemedicine activities in Brazil, in both the SUS and private health plans.

The study by Caetano et al. [37] cites challenges for the effective implementation of telehealth/telemedicine in Brazil, especially given the resistance from the Regional Medical Boards (*Conselhos Regionais de Medicina*, CRM), who claim that this practice violates Article 37 of the Code of Medical Ethics: "*to prescribe treatment and other procedures without direct examination of the patient*". Also highlighted are the low degree of integration of telemedicine with the national public health guidelines, lack of regulation and financial incentives, need for the development of clinical guidelines, standardization of questionnaires and algorithms for patient care. and the establishment of health data-sharing mechanisms, aimed at integrating telemedicine databases with epidemiological surveillance.

Despite the challenges cited by Caetano et al. [37], telemedicine has become a bridge for integration of care, making it more accessible, more convenient, with greater confidentiality, and with lower risk of contagion, which are called the "five Cs" [41] and will shape the future of telemedicine. However, it is known that the implementation of telemedicine in a non-pandemic scenario will face numerous challenges. The juridical and legal proposals for standardization of telemedicine practices are essential for further developing the sector, besides feasibility issues according to the various realities across the country. In keeping with the above, India launched its *The Telemedicine Practice Guidelines, 2020*, aimed at advancing the construction of a modern medical system [26].

The development of chatbots helps patients identify initial symptoms, in education on preventive methods, as well as referring patients to health services. In this scenario, the use of artificial intelligence by hospitals in China, which provides a large database on positive COVID-19 cases, useful for structuring algorithms, can be used for screening suspected cases, for example, analyzing the history of travels to China, Iran, or South Korea, or exposure to confirmed cases and subsequently in the isolation of these cases [42]. Thus, the use of screening systems based on artificial intelligence can attenuate the clinical burden of healthcare personnel working on the frontline against COVID-19. Thus, telephone apps that detect and record patients' data such as daily temperature and symptoms can prevent unnecessary consultations [6,42]. An example is Israel, which uses an artificial intelligence tool to adapt and improve the management of ICUs with algorithms trained to speedily identify a possible respiratory decompensation, allowing better intervention by the healthcare team.

The traditional telephone call can be used as a safe tool and displays benefits for holding consultations related to COVID-19, mainly when dealing with orientation and reports of symptoms, among other less serious scenarios. Video calls can be an alternative for more reliable clinical follow-up, providing additional visual information, diagnostic clues, and therapeutic impressions that can be observed by the healthcare professional. Thus, videos can be more appropriate for cases with intense symptoms, association with other comorbidities, and analysis of social circumstances that influence the course of the disease [5].

The path to digital health plays out through the transformation of the traditional form of healthcare, encompassing various resources such as ample access to electronic health records, remote monitoring solutions, creation of portals for access to patients, development of mobile health apps, data analysis methods, and other technologies [6,32].

This emphasizes the importance of consolidating the e-Health sector in the current Brazilian and global scenario, as a strategy to improve quality of care and expand access to health services. Countries are rebuilding their health sectors with the incorporation of new technologies, aimed at simplifying care and improving the flow of health information.

Final remarks

The implementation of the technological solutions presented in this study contributes to reducing people´s crowding in health services and provides speed and ease of access to services. The international experiences feature those in countries that already enjoyed considerable technological progress in e-Health, with the implementation of technological solutions for patients' clinical management, imaging diagnosis, use of artificial intelligence for analyzing risks and proposing interventions, case and contact tracing, development of geolocation apps, tools for data analysis and reports, self-diagnosis tools, and orientation for decision-making, among others.

Compared to the international experiences, the Brazilian initiatives also adopted innovations in healthcare impelled by the pandemic, with the implementation of technologies for non-face-to-face preclinical care, online scheduling, telemedicine, self-assessment of symptoms, chat channels, telephone lines, and recruitment and training of human resources.

Although the COVID-19 pandemic is a critical and unwanted situation, the experiences stemming from this period may provide an opportunity for improving processes and flows in the use of information and telecommunication technologies in health. In current and future health services, digital technologies can facilitate and improve access and quality of care. It is thus crucial to promote reflection and encourage studies on the implementation of new technologies, as well to seek to use them better and assess the impact of their implementation on health systems' practices.

This study corroborates the new technologies' academic, political, and social relevance by presenting and contextualizing some technological initiatives in health in the public and private spheres in Brazil and other countries. The study also presents strategies adapted in scenarios in which the fight against the pandemic has made more progress.

Contributors

I. C. Celuppi, G. S. Lima and E. Rossi contributed in the study conception and design, data analysis and interpretation, writing of the article, relevant critical revision of the intellectual content, and final approval of the version for publication; they are responsible for all aspects of the research, guaranteeing the accuracy and integrity of all parts of the work. R. S. Wazlawick contributed in the revision of the content and final approval of the version for publication and is responsible for all aspects of the research, guaranteeing the accuracy and integrity of all parts of the work. E. M. Dalmarco contributed in the study conception and design, data analysis and interpretation, revision of the content, writing of the article, and relevant critical revision of the intellectual content, and approved the final version for publication.

Additional informations

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References

1. Organização Pan-Americana da Saúde. Regulamento Sanitário Internacional (RSI). https://www.paho.org/bra/index.php?option=com_content&view=article&id=5847:regulamento-sanitario-internacional-rsi&Itemid=812#:~:text=O%20Regulamento%20Sanit%C3%A1rio%20Internacional%20(RSI,Mundial%20da%20Sa%C3%BAde%20(OMS) (accessed on 27/May/2020).
2. Organização Pan-Americana da Saúde. Folha informativa – COVID-19 (doença causada pelo novo coronavírus). https://www.paho.org/bra/index.php?option=com_content&view=article&id=6101:covid19&Itemid=875 (accessed on 25/Jul/2020).
3. World Health Organization. WHO Director-General's statement on IHR Emergency Committee on Novel Coronavirus (2019-nCoV). https://www.who.int/dg/speeches/detail/who-director-general-s-statement-on-ihr-emergency-committee-on-novel-coronavirus (accessed on 29/Oct/2020).
4. Ministério da Saúde declara transmissão comunitária nacional. G1 2020; 20 mar. https://g1.globo.com/bemestar/coronavirus/noticia/2020/03/20/ministerio-declara-transmissao-comunitaria-nacional-do-novo-coronavirus.ghtml.
5. Greenhalgh T, Koh GC, Car J. Covid-19: a remote assessment in primary care. BMJ 2020; 368:m1182.
6. Fagherazzi G, Goetzinger C, Rashid MA, Aguayo GA, Huiart L. Digital health strategies to fight COVID-19 worldwide: challenges, recommendations, and a call for papers. J Med Internet Res 2020; 22:e19284.
7. Medeiros JB. A prática de fichamentos, resumos, resenhas. São Paulo: Atlas; 2000.
8. Laboratório Bridge. Pesquisa e inovação em TI: soluções tecnológicas inovadoras para qualificar a gestão pública, visando ao benefício social. https://bridge.ufsc.br/ (accessed on 02/May/2020).
9. Conselho Nacional de Secretários de Saúde. e-SUS atenção básica é lançado pelo Ministério da Saúde. Brasília: Conselho Nacional de Secretários de Saúde; 2013.
10. Ministério da Saúde. Coronavírus: o que você precisa saber e como prevenir o contágio. https://coronavirus.saude.gov.br (accessed on 09/Jul/2020).
11. Secretaria de Saúde do Estado de Minas Gerais. Plano estadual de contingência para Emergência em Saúde Pública: infecção humana pelo SARS-CoV-2 (doença pelo coronavírus - COVID-2019). Belo Horizonte: Secretaria de Estado de Saúde de Minas Gerais; 2020.
12. Secretaria de Estado de Saúde do Distrito Federal. Plano de contingência do Distrito Federal para infecção humana pelo novo coronavírus – Covid-19. Brasília: Secretaria de Estado de Saúde do Distrito Federal; 2020.
13. Centro de Operações de Emergência em Saúde Pública. Plano de contingência do Estado de São Paulo para infecção humana pelo novo coronavírus – 2019-nCoV. São Paulo: Coordenadoria de Controle de Doenças, Secretaria de Estado da Saúde; 2020.
14. Secretaria de Estado de Saúde do Amazonas. Plano de contingência estadual para infecção humana pelo novo coronavírus 2019-nCoV. Manaus: Secretaria de Estado de Saúde do Amazonas; 2020.
15. Secretaria de Estado de Saúde do Ceará. Plano estadual de contingência para resposta às emergências em saúde pública novo coronavírus (2019-nCoV). Fortaleza: Secretaria de Estado de Saúde do Ceará; 2020.
16. Agudelo M, Chomali E, Suniaga J, Núñez G, Jordán V, Rojas F, et al. Las oportunidades de la digitalización en América Latina frente al Covid-19. 2020. Caracas: Banco de Desarrollo de América Latina.
17. Secretaria Municipal de Saúde de Curitiba. Coronavírus: a melhor proteção é a prevenção. https://www.curitiba.pr.gov.br/noticiasespeciais/coronavirus-a-melhor-protecao-e-a-prevencao/11 (accessed on 15/May/2020).
18. Prefeitura do Recife. PCR e Governo lançam aplicativo web para população ser orientada à distância por profissionais de saúde. Notícias 2020; 23 mar. http://www2.recife.pe.gov.br/noticias/26/03/2020/pcr-e-governo-lancam-aplicativo-web-para-populacao-ser-orientada-distancia-por.
19. Prefeitura de São Paulo. Prefeitura de São Paulo busca soluções tecnológicas de startups para combater os efeitos negativos do coronavírus na economia da capital. Notícias 2020; 3 abr. https://www.prefeitura.sp.gov.br/cidade/secretarias/desenvolvimento/noticias/?p=295937.
20. Sistema Mineiro de Inovação. Covid-19. http://www.simi.org.br/covid19 (accessed on 22/Jun/2020).
21. Wang S, Ding S, Xiong L. A new system for surveillance and digital contact tracing for COVID-19: spatiotemporal reporting over network and GPS. JMIR Mhealth Uhealth 2020; 8:e19457.
22. Ye Q, Zhou J, Wu H. Using information technology to manage the COVID-19 pandemic: development of a technical framework based on practical experience in China. JMIR Med Inform. 2020; 8:e19515.
23. Lin B, Wu S. COVID-19 (coronavirus disease 2019): opportunities and challenges for digital health and the internet of medical things in China. OMICS 2020; 24:231-2.
24. Meinert E, Milne-Ives M, Surodina S, Lam C. Agile requirements engineering and software planning for a digital health platform to engage the effects of isolation caused by social distancing: case study. JMIR Public Health Surveill 2020; 6:e19297.

25. Wosik J, Fudim M, Cameron B, Gellad ZF, Cho A, Phinney D, et al. Telehealth transformation: COVID-19 and the rise of virtual care. J Am Med Inform Assoc 2020; 27:957-62.
26. Sarbadhikari S, Sarbadhikari SN. The global experience of digital health interventions in COVID-19 management. Indian J Public Health 2020; 64:117.
27. Mackey T, Purushothaman V, Li J, Shah N, Nali M, Bardier C, et al. Machine learning to detect self-reporting of symptoms, testing access, and recovery associated with COVID-19 on Twitter: retrospective Big Data Infoveillance Study. JMIR Public Health Surveill 2020; 6:e19509.
28. Kleinman RA, Merkel C. Digital contact tracing for COVID-19. CMAJ 2020; 192:E653-E6.
29. Alwashmi MF. The use of digital health in the detection and management of COVID-19. Int J Environ Res Public Health 2020; 17:2906.
30. Torous J, Myrick KJ, Rauseo-Ricupero N, Firth J. Digital mental health and COVID-19: Using technology today to accelerate the curve on access and quality tomorrow. JMIR Ment Health 2020; 7:e18848.
31. Ćosić K, Popović S, Šarlija M, Kesedžić I. Impact of human disasters and Covid-19 pandemic on mental health: potential of digital psychiatry. Psychiatr Danub 2020; 32:25-31.
32. Pérez Sust P, Solans O, Fajardo JC, Peralta MM, Rodenas P, Gabaldà J, et al. Turning the crisis into an opportunity: digital health strategies deployed during the COVID-19 outbreak. JMIR Public Health Surveill 2020; 6:e19106.
33. Barbosa S, Silva de Pinho AV. A prática da atenção primária à saúde no combate da COVID-19. APS em Revista 2020; 2:17-9.
34. Santos AB, França MV, dos Santos JL. Atendimento remoto na APS no contexto da COVID-19: a experiência do ambulatório da comunidade da Escola Bahiana de Medicina e Saúde Pública em Salvador, Bahia. APS em Revista 2020; 2:169-76.
35. Secretaria de Atenção Primária à Saúde, Ministério da Saúde. Protocolo de manejo clínico do Coronavírus (COVID-19) na atenção primária à saúde. Brasília: Ministério da Saúde; 2020.
36. Taylor CB, Fitzsimmons-Craft EE, Graham AK. Digital technology can revolutionize mental health services delivery: the COVID-19 crisis as a catalyst for change. Int J Eat Disord 2020; 53:1155-7.
37. Caetano R, Silva AB, Guedes ACCM, Paiva CCN, Ribeiro GD, Santos DL, et al. Desafios e oportunidades para telessaúde em tempos da pandemia pela COVID-19: uma reflexão sobre os espaços e iniciativas no contexto brasileiro. Cad Saúde Pública 2020; 36:e00088920.
38. Ye J. The role of health technology and informatics in a global public health emergency: practices and implications from the COVID-19 pandemic. JMIR Med Inform 2020; 8:e19866.
39. Mahmood S, Hasan K, Carras MC, Labrique A. Global preparedness against COVID-19: we must leverage the power of digital health. JMIR Public Health Surveill 2020; 6:e18980.
40. Ministério da Saúde. Portaria nº 467, de 20 de março de 2020. Dispõe, em caráter excepcional e temporário sobre as ações de Telemedicina, com o objetivo de regulamentar e operacionalizar as medidas de enfrentamento da emergência de saúde pública de importância internacional previstas no art. 3º da Lei nº 13.979, de 6 de fevereiro de 2020, decorrente da epidemia de COVID-19. Diário Oficial da União 2020; 23 mar.
41. Dorsey E, Okun MS, Bloem BR. Care, convenience, comfort, confidentiality, and contagion: the 5 c's that will shape the future of telemedicine. J Parkinsons Dis 2020; 10:893-7.
42. Ting DS, Carin L, Dzau V, Wong TY. Digital technology and COVID-19. Nat Med 2020; 26:459-61.

Resumo

A pandemia de coronavírus que atingiu o mundo no final de 2019 segue batendo recordes de novos casos e óbitos relacionados à doença. As orientações para o manejo clínico dos pacientes infectados e a prevenção de novos casos estão centradas nas medidas de controle dos sintomas, hábitos de higiene, isolamento social e diminuição da aglomeração de pessoas. Tal fato forçou uma mudança no modo como os serviços de saúde prestam cuidados, protagonizando a incorporação de novas tecnologias em saúde. Assim, este Ensaio objetiva compilar e analisar algumas experiências de uso das tecnologias digitais em saúde, para minimizar os impactos da COVID-19. Identificou-se o desenvolvimento de soluções tecnológicas de manejo clínico do paciente, diagnóstico por imagem, uso de inteligência artificial para análise de riscos, aplicativos de geolocalização, ferramentas para análise de dados e relatórios, autodiagnóstico e, inclusive, de orientação à tomada de decisão. A grande maioria das iniciativas listadas tem sido eficaz na minimização dos impactos da COVID-19 nos sistemas de saúde, de modo que visa à diminuição da aglomeração de pessoas e assim facilita o acesso aos serviços, bem como contribui para a incorporação de novas práticas e modos de cuidar, em saúde.

Tecnologia da Informação; Infecções por Coronavírus; Pandemias; Telemedicina; Políticas de eSaúde

Resumen

La pandemia de coronavirus que afectó al mundo al final de 2019 sigue batiendo récords de nuevos casos y óbitos relacionados con la enfermedad. Las orientaciones para el manejo clínico de los pacientes infectados y la prevención de nuevos casos están centradas en las medidas de control de los síntomas, hábitos de higiene, aislamiento social y disminución de la aglomeración de personas. Tal hecho forzó un cambio en el modo en el que los servicios de salud prestan cuidados, protagonizando la incorporación de nuevas tecnologías en salud. Así, este Ensayo tiene como objetivo compilar y analizar algunas experiencias en el uso de tecnologías digitales en salud, para minimizar los impactos de la COVID-19. Se identificó el desarrollo de soluciones tecnológicas de manejo clínico del paciente, diagnóstico por imagen, uso de inteligencia artificial para análisis de riesgos, aplicaciones de geolocalización, herramientas para el análisis de datos e informes, auto diagnóstico e, inclusive, de orientación para la toma de decisiones. La gran mayoría de las iniciativas listadas se demuestran eficaces en la minimización de los impactos de la COVID-19 en los sistemas de salud, de modo que, tienen como objetivo la disminución de la aglomeración de personas, así facilitan el acceso a los servicios, del mismo modo que contribuyen a la incorporación de nuevas prácticas y modos de cuidar en salud.

Tecnología de la Información; Infecciones por Coronavirus; Pandemias; Telemedicine; Políticas de eSalud

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