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Digital transformation in health systems

Digital transformation and the telehealth scenario in Brazil: reflections on the COVID-19 pandemic

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Introduction

The leap in the use and knowledge of information and communication technologies (ICT) that occurred during the period of the COVID-19 pandemic in various dimensions of the health sector, such as in infrastructure, information recording and monitoring, and telehealth, is undeniable. If on the one hand many challenges have arisen, on the other, the growth in the use of these technologies and what we learned accelerated, and it is difficult to measure or estimate how long it would take to reach the current level of knowledge and use of ICT in any other scenario.

The objective of this article is to identify the main transformations in the way telehealth services were used by healthcare providers in the period before the COVID-19 pandemic (2019) and during its occurrence (2021). We do this using data from the ICT in Health survey[4] conducted by the Regional Center for Studies on the Development of the Information Society (Cetic.br), a department of the Brazilian Network Information Center (NIC.br). Before presenting the data, we will summarize some of the telehealth concepts and discuss the main changes to the regulations in the Brazilian context due to the COVID-19 pandemic.

Telehealth: some concepts

The term telehealth has been used in several ways over the years, and involves more or less specific concepts, such as telemedicine, e-health, and others. In order to present part of the spectrum of existing and used terms, we will discuss some of the concepts and definitions found in the literature and used in the media in general, but with no pretension

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[4] Find out more at: https://cetic.br/pt/pesquisa/saude/

The term telehealth refers to the entire spectrum of activities that are used to provide healthcare at a distance, without any direct physical contact with the patient.

of this being an exhaustive examination of the subject. It is worth noting that just as technology develops rapidly, these terms also undergo changes over time and according to the context.

The term telehealth refers to the entire spectrum of activities that are used to provide healthcare at a distance, without any direct physical contact with the patient. With the advance in ICT, the technological tool used to establish this mode of communication has been adjusted according to the need. Telehealth covers communications from healthcare provider to patient, and provider to provider, and can happen synchronously (telephone and video, for example) or asynchronously (message exchanges via a web portal or other channels), by virtual agents, wearable devices (wearables), the Internet of Things, Artificial Intelligence (AI) and virtual and augmented reality, among others (Wosik et al., 2020).

Modern society first called these events telemedicine, which is the oldest term in the literature referring to the use of telecommunications for the purpose of providing clinical care at a distance, which challenged the assumption that care requires physical presence and contact between professionals and patients. Although telehealth derives from telemedicine, it focuses more broadly on health promotion and education, and includes professional areas of essential care like nursing, pharmacy and rehabilitation. The two terms, however, are often used interchangeably (Silva et al., 2020).

Historically, telemedicine focused on the application of traditional physician-to-patient, and physician-to-physician interactions, which were enhanced by two-way video and audio resources. The use of ICT was later extended to include support services, training, and health information activities for multidisciplinary care providers and for patients, and this configured a broader field called telehealth (Caetano et al., 2020). The main telehealth modalities are outlined below (Table 1).

Table 1 – MAIN TELEHEALTH MODALITIES

TELECONSULTING SERVICES	Recorded consultations between health workers, professionals and managers to clarify doubts about clinical procedures, health activities and issues related to work processes.
TELEDIAGNOSIS SERVICES	The use of ICT in diagnostic support services over geographical and/or time distances, including teleradiology, tele-ECG, tele-spirometry, telepathology, etc.
REMOTE PATIENT MONITORING	Remote monitoring of a patient's health and/or disease parameters, including clinical data collection, transmission, processing, and management by health professionals.
TELEREGULATION	Measures taken in regulatory, evaluation, and action planning systems, in order to provide management with operational regulatory intelligence. It enables waiting times in specialized care to be reduced.

DISTANCE LEARNING IN HEALTH CARE	Classes, courses, or the provision of interactive learning materials on health-related themes.
FORMATIVE SECOND OPINION	A systematized response, which is based on a bibliographic review of the best scientific evidence to questions that originated from teleconsulting services.
TELECONSULTATION SERVICES	Distance consultation with a physician or other health professional using ICT. Until the pandemic, the Federal Council of Medicine permitted this service only in emergency situations in Brazil.

Source: Caetano et al. (2020).

Changes brought about by COVID-19 and the rapid deployment of telehealth services

The COVID-19 pandemic accelerated the rapid adoption of telehealth and very quickly transformed service delivery. At the onset of this health emergency, the use of telehealth increased as patients and healthcare providers sought ways to safely access and deliver healthcare. Spurred on by social distancing recommendations for containing the pandemic, this change was made possible by factors that included: (i) a greater willingness on the part of providers and consumers to use telehealth; and (ii) regulatory changes, allowing greater access and reimbursement for consultations and procedures (Wosik et al., 2020).

According to the Brazilian Association of Telemedicine and Digital Health Companies (Associação Brasileira de Empresas de Telemedicina e Saúde Digital), 7.5 million remote consultations were performed in Brazil between 2020 and 2021 by about 52,200 physicians.[5] Several cases have been reported in the literature of the use of telehealth in different states in Brazil as a tool for controlling COVID-19, mainly by phone, instant messaging services, and smartphone apps, for both patient care (São Paulo[6], Paraná[7] and Minas Gerais[8]), and for exchanges between health professionals (Rio Grande do Sul[9], Bahia[10] and Mato Grosso do Sul[11]).

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[5] Available at: https://saudedigitalbrasil.com.br/noticias/saude-digital-sem-antes-e-depois/

[6] Find out more: http://revista.cofen.gov.br/index.php/enfermagem/article/view/3899

[7] Find out more: https://revistas.unicentro.br/index.php/aproximacao/article/view/6578/0

[8] Find out more: https://www.scielo.br/j/rbepid/a/nDVQynCwtNzwDwYDZbBcXbc/?lang=pt

[9] Find out more: https://www.scielo.br/j/csc/a/GZ4MV5Ffzn9m96Bj7zxc7Nh/?lang=pt

[10] Find out more: http://revista.redeunida.org.br/ojs/index.php/rede-unida/article/view/3343

[11] Find out more: https://brazilianjournals.com/index.php/BJHR/article/view/33480

An innovation in the uses of telehealth arising from the COVID-19 pandemic was the approval and encouragement of the use of teleconsultation services during this health crisis period.

To illustrate the role played by the pandemic in terms of the adoption of telehealth, many hospitals were able to benefit from teleconsultation platforms and services to care for patients in Intensive Care Units (ICU) remotely, and to train multidisciplinary teams, and thus combat COVID-19; the Heart Institute of the Faculty of Medicine, University of São Paulo (InCor/FMUSP) was one of the leaders of this movement in Brazil, having implemented a tele-ICU service in record time. It was used to support several hospitals in the State of São Paulo that were on the frontline in caring for COVID-19 patients. The results so far have shown the great benefit of this technological platform (Rabello, Pêgo-Fernandes, & Jatene, 2022).

Regulatory changes in Brazil

There was already a demand for medical teleconsultation services, which are considered a new and promising segment of the health services market in Brazil (Silva et al., 2020). Nevertheless, remote medical and other health professional consultations via ICT were only allowed after the spread of the disease caused by the new coronavirus (Law no. 13989, April 2020[12]).

Telemedicine began to be used in health teaching and research establishments in the country in the 1990s. *Disque Saúde* (a health helpline) was a pioneering initiative in São Paulo, which was established in 1989 as an information service; it later expanded into a service for customers and for booking appointments and was extended to include other states as well. The Telemedicine University Network (Rede Universitária de Telemedicina – RUTE), which was created to roll out a communication infrastructure in public universities, university hospitals, health institutions, and certified teaching and research hospitals, and the Brazil Telehealth Network Program (Programa Telessaúde Brasil Redes), are two initiatives in public administration that linked telehealth activities in the Unified Health System (Sistema Único de Saúde – SUS) (Caetano et al., 2020).

An innovation in the uses of telehealth arising from the COVID-19 pandemic was the approval and encouragement of the use of teleconsultation services during this health crisis period. To understand its scope and the regulations related to this new use, it is important to take a brief look back. Until 2019, the practice of telemedicine was regulated by the Federal Council of Medicine (Conselho Federal de Medicina – CFM) based on Resolution no. 1643[13] of 2002, which defined it as the "exercise of medicine through the use of interactive methodologies of audio-visual and data communication, with the objective of providing assistance, education and research in health" (Art. 1). On February 6, 2019, the CFM established Resolution no. 2227,[14] which allowed physicians to perform online consultations, telesurgery, and telediagnosis, among other forms of remote medical

[12] Available at: http://www.planalto.gov.br/ccivil_03/_ato2019-2022/2020/lei/L13989.htm

[13] Available at: https://sistemas.cfm.org.br/normas/visualizar/resolucoes/BR/2002/1643

[14] Available at: https://portal.cfm.org.br/images/PDF/resolucao222718.pdf

care. On February 22 of that year, this resolution was revoked by Resolution no. 2228,[15] and the practice of telemedicine was again subordinated to the previous resolution (Caetano et al., 2020).

With the COVID-19 pandemic, the regulations on telehealth services were promptly modified. On March 23, 2020, Ordinance no. 467[16] was published providing for telemedicine initiatives in the operationalization of measures to combat the pandemic, and authorizing their practice in the public and private spheres. The ordinance authorizes the use of telemedicine – on an exceptional basis – in actions that include pre-clinical care, care support, consultations, monitoring, and diagnosis in the context of SUS, and in supplementary and private healthcare (Caetano et al., 2020).

On March 25 of the same year, the Chamber of Deputies approved Bill no. 696/2020,[17] authorizing the use of telemedicine in any healthcare activities in Brazil, including in teleconsultation services, while the COVID-19 crisis lasts. Approved in the Federal Senate six days later, the bill was sanctioned by President Jair Bolsonaro through Law no. 13989, of April 15, 2020 (Caetano et al., 2020).

Scenario of telehealth services in Brazil

The data presented below highlight some of the changes that were driven by the COVID-19 pandemic and that affected the dynamics of the supply of telehealth services by Brazilian healthcare facilities. The indicators of the 2019 and 2021 editions of the ICT in Health survey, conducted annually by Cetic.br|NIC.br were used for these analyses.

Given the challenges faced by health institutions in this pandemic period, the data from this survey indicate an increase in Internet use in health facilities, jumping from 92% in 2019 to 98% in 2021. It is worth noting, however, that the growth in this period was greater in the North (from 82% to 96%) and Northeast (from 83% to 96%) regions, with the rate of Internet use remaining stable in the other regions in the country. It is also worth noting that the Northeast and North regions have been historically deficient in terms of ICT infrastructure (Catapan et al., 2021), and basic local health infrastructure (Kashiwakura, Gonçalves, Nunes, Azevedo, & Silva, 2021).

Healthcare facilities in Brazil offer a variety of telehealth services (Chart 1). The data from the ICT in Health survey indicate the relevance and importance of these services, whose supply was boosted during the pandemic period in order to facilitate both the care and monitoring of patients, and the exchange of information and diagnoses between health professionals.

(...) the data from this survey [ICT in Health] indicate an increase in Internet use in health facilities, jumping from 92% in 2019 to 98% in 2021.

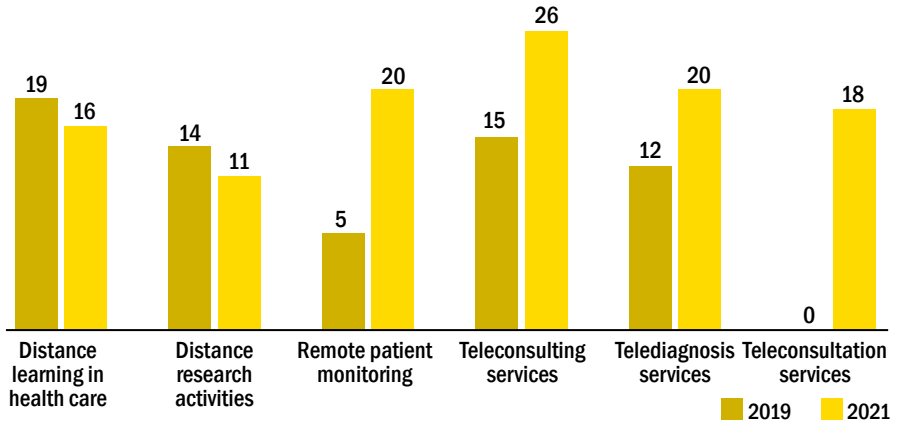
[15] Available at: https://sistemas.cfm.org.br/normas/visualizar/resolucoes/BR/2019/2228

[16] Available at: https://www.in.gov.br/en/web/dou/-/portaria-n-467-de-20-de-marco-de-2020-249312996

[17] Available at: https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=2239462

The results [of the ICT in Health] also point to an increase in the supply of teleconsulting and telediagnosis services of 11 and 8 percentage points (p.p.), respectively, compared to 2019.

Chart 1 – TELEHEALTH SERVICES OFFERED BY HEALTHCARE FACILITIES THAT USED THE INTERNET (%)

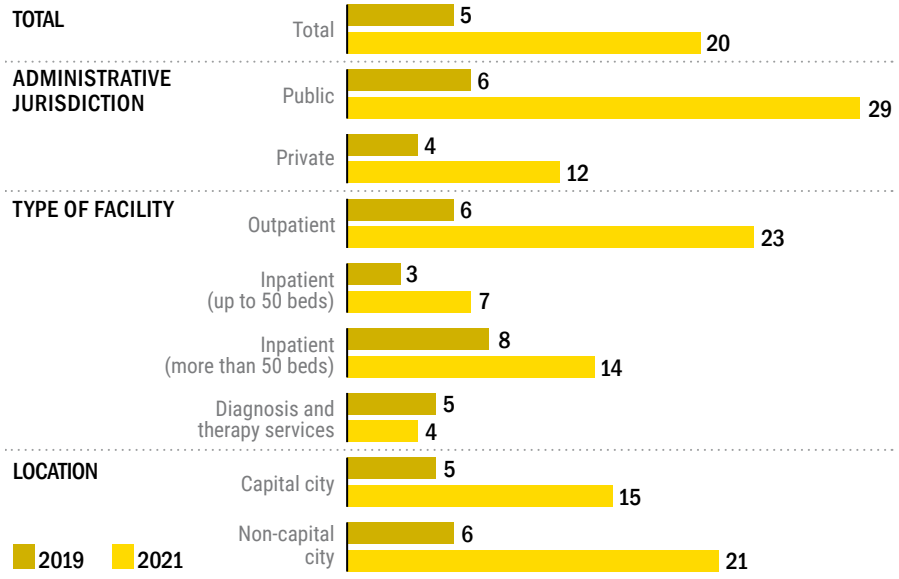


Source: NIC.br (2020, 2021).

Among these services, the growth in the supply of remote patient monitoring stands out: available in only 5% of facilities that used the Internet in 2019, it jumped to 20% in 2021. The results also point to an increase in the supply of teleconsulting and telediagnosis services of 11 and 8 percentage points (p.p.), respectively, compared to 2019. In line with the changes in the law and the authorization of the Ministry of Health for the use of teleconsultation services, the data indicate that 18% of the healthcare facilities that used the Internet began to make this type of service available in 2021 (Chart 1).

To better understand the dynamic of the telehealth services being offered, Charts 2 to 5 show how the availability of this type of service differs in relation to: (i) the administrative jurisdiction (public or private); (ii) the type of facility (outpatient, inpatient, diagnosis and therapy services – DTS); and (iii) the location of the healthcare facilities (whether a capital city, or a non-capital city).

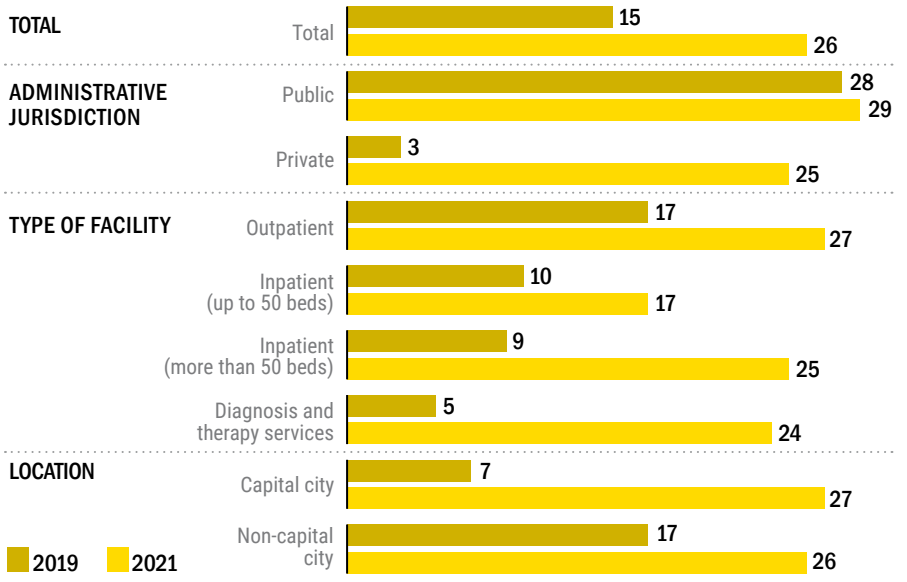
Chart 2 – REMOTE PATIENT MONITORING SERVICES OFFERED BY HEALTHCARE FACILITIES THAT USED THE INTERNET (%)



Source: NIC.br (2020, 2021).

The results of the ICT in Health survey (Chart 2) indicate an increase in the offer of remote patient monitoring services in the different categories of healthcare facility (except for diagnosis and therapy services). This increase, however, was greater in public facilities (from 6% to 29% in the period), in outpatient facilities (from 6% to 23%) and in non-capital cities (from 6% to 21%).

Chart 3 – TELECONSULTING SERVICES OFFERED BY HEALTHCARE FACILITIES THAT USED THE INTERNET (%)



Source: NIC.br (2020, 2021).

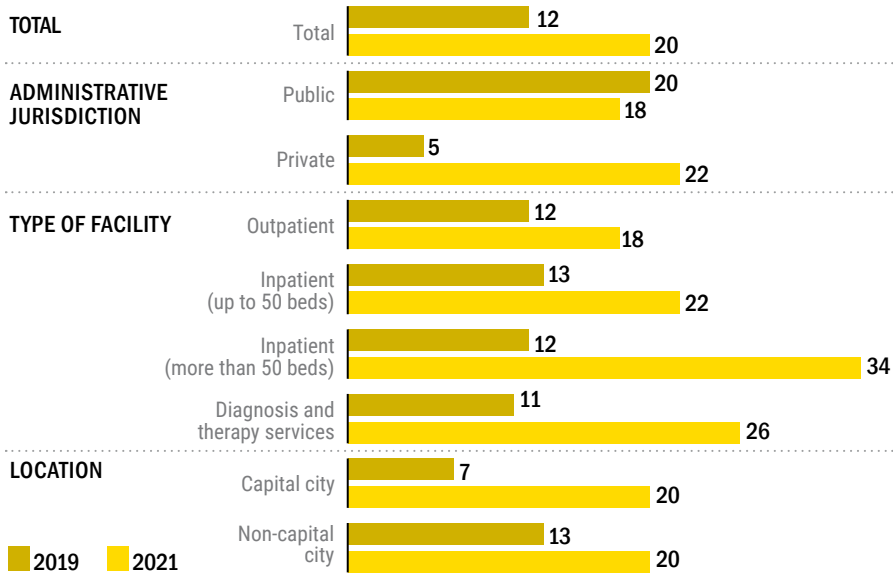
The results show a large increase in the supply of teleconsulting services (Chart 3) among private institutions: while in 2019 only 3% of these facilities that used the Internet had teleconsulting between health professionals, this percentage reached 25% in 2021 (a 22 p.p. increase). This scenario differs from that of public facilities, in which teleconsulting services were present in 28% of these health facilities that used the Interent in 2019, and reached 29% in 2021. Considering the type of healthcare facility, there was growth in the availability of teleconsulting services in all types of facilities, although this increase was greater in DTS facilities (from 5% in 2019, to 24% in 2021) and inpatient facilities with more than 50 beds (from 9% to 25%). The 2021 results still indicate similar levels of availability of teleconsulting services between facilities located in capital cities and in non-capital cities, but it was in state capitals that the supply of these services increased the most (from 7% to 27%).

With regard to the availability of telediagnosis services (Chart 4), the results indicate that between 2019 and 2021, there was a greater increase in the supply of this type of service in private facilities (from 5% to 22%), in inpatient facilities with more than 50 beds (from 12% to 34%), in diagnosis and therapy services (from 11% to 26%) and in those located in capital cities (from 7% to 26%).

The results of the ICT in Health survey indicate an increase in the offer of remote patient monitoring services in the different categories of healthcare facility (except for diagnosis and therapy services).

(...) before the COVID-19 pandemic, teleconsultation and telediagnosis services had been offered in the context of the SUS since 2007 (through the Brazil Telehealth Network Program), with the aim of improving the quality of care and primary care.

Chart 4 – TELEDIAGNOSIS SERVICES OFFERED BY HEALTHCARE FACILITIES THAT USED THE INTERNET (%)

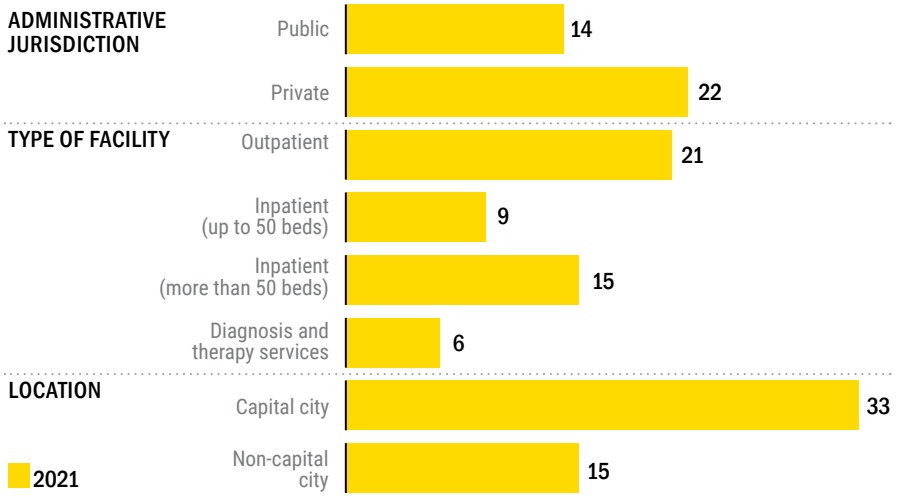


Source: NIC.br (2020, 2021).

It should be noted that before the COVID-19 pandemic, teleconsultation and telediagnosis services had been offered in the context of the SUS since 2007 (through the Brazil Telehealth Network Program), with the aim of improving the quality of care and primary care. The literature reports the use of these services in small and medium-sized cities in the countryside, as well as in rural, indigenous and more isolated areas, since in such regions there is a shortage of health professionals and qualification opportunities (Marcolino, Alkmim, Assis, Sousa, & Ribeiro, 2014; Marcolino et al., 2017). For this reason, it is noted that the public sphere and regions in the countryside of Brazil already had higher levels of supply of these services in 2019. With the COVID-19 pandemic, however, they began to be used by different types of facilities, especially those in the private administrative jurisdiction and those located in capital cities.

As previously explained, teleconsultation services were not regulated by the Ministry of Health, being exclusively implemented in 2020 for the exceptional period of the pandemic. Only data referring to the 2021 edition of the ICT in Health survey, therefore, are shown: this is when such services were first included in the survey as a result of being regulated. The results in Chart 5 indicate that these services are mainly available in private facilities (22%), in those located in capital cities (33%) and in outpatient facilities (21%).

Chart 5 – TELECONSULTING SERVICES OFFERED BY HEALTHCARE FACILITIES THAT USED THE INTERNET (%)



Source: NIC.br (2021).

In the public sector, some initiatives were implemented through the Brazilian Unified Health System (SUS) to provide telecare for patients to minimize the risks of infection, such as TeleSUS (for pre-clinical care) and the Family Healthcare Virtual Office (for teleconsultation services[18]). In the context of Supplementary Healthcare, 2.6 million distance consultations were carried out between February 2020 and January 2021.[19]

The adequacy of the laws in Brazil (...) enabled teleconsultation services and online screening tools, which contributed to social distancing and the maintenance of patient care by offering (public and private) telehealth services.

Final Considerations

The increase in knowledge and the evolution in the use of ICT are critical in the health area, be it on the side of health professionals, patients or public managers. The adequacy of the laws that allow the use of ICT in this area is important for increasing its use, so that the benefits of better and faster healthcare can reach more distant and/or needy places.

The adequacy of the laws in Brazil, such as the Ordinance of the Ministry of Health no. 467/2020,[20] enabled teleconsultation services and online screening tools, which contributed to social distancing and the maintenance of patient care by offering (public and private) telehealth services. It also helped health professionals and patients to get to know and understand that, by using technology it is possible to perform remote medical consultations and procedures. For public management, health professionals and citizens, this new reality has become practical, feasible and reliable, something that until recently was hard to imagine.

[18] Especially in the context of primary healthcare. This includes outpatient units, such as Basic Health Units (BHU) and Family Health Units (FHU).

[19] Available at: https://telessaude.fenasaude.org.br/

[20] Available at: https://www.in.gov.br/en/web/dou/-/portaria-n-467-de-20-de-marco-de-2020-249312996

Given the contribution of ICT to well-being and health promotion, it is fundamental that we are able to reach more people who need care throughout the country, thus contributing to the effective universalization of the health system.

Innovations, such as the use of AI and the Internet of Things, the definition of interoperability standards, blockchain, access to data, and the evolution of technology itself, are soon expected to enable new achievements, but without forgetting the much-needed humanized attention to the patient.

It is expected that in this new stage, in the post-pandemic period, the use of digital technologies will make access to health an increasingly everyday reality. Given the contribution of ICT to well-being and health promotion, it is fundamental that we are able to reach more people who need care throughout the country, thus contributing to the effective universalization of the health system.

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Article II

Open public health: the way not to leave anyone behind[21]

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Abstract. In the context of globalization, public health requires continuous cooperation among all actors and a flow of data and information that facilitates and leverages that cooperation. However, there are still barriers that limit or prevent access to and use of public health for the benefit of societies. In this context, the adoption of open public health is proposed and its implications and scope are explored. Open public health is understood as data, information and knowledge aimed at improving public health, which are shared and developed through collaborative networks without restrictions on access and use and with continuous protection of privacy, security and confidentiality of sensitive data or data requiring special protection.
Keywords: Access to information; public health; public health practice; health planning.

The advent of the Internet in the 1990s, and the access to various information and communication technologies, most notably the cell phone, have caused an increase in the volume of digital data that is created. The needs of the globalized world have also demanded a constant exchange of data and information (protocols, best practices, scientific publications, databases, among many other options). In the case of public health, however, the creation and traffic of data associated with health in many cases has taken place under

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[33] Pan American Health Organization; Washington DC, United States of America.

Open public health can be defined as the data, information, and knowledge for improving public health that are shared and developed through collaborative networks without any access or use restrictions, and with continued protection of the privacy, security, and confidentiality of any sensitive or specially protected data.

restrictions, such as licenses and the various permissions that are granted by the owners or holders of the data. This is a response to a context in which intellectual property and the privacy and confidentiality of sensitive data are protected and has limited the potential use of these data by countries or organizations that do not have the resources to cover licenses and by individuals who are unable to manage the permissions in order to access them. The concept of "openness" emerges, therefore, which can be summarized as a set of principles, values, and practices that allow and promote access to, and the use or dissemination of "information" from data, journals, epidemiological bulletins, maps, panels, educational materials, and others, via multiple technological platforms. This article explores the concept of open public health, which is built on the concept of open data, that is, data that does not have strong restrictions for its access and/or use.

Development of the open public health concept

Open public health is a disruptive phenomenon that implies a paradigm shift, and involves the development of actions in the information and knowledge society, mainly in five key aspects: 1) open science, 2) open data, 3) unstructured data, 4) renewed competencies, and 5) e-government (PAHO, 2017). Open public health can be defined as the data, information, and knowledge for improving public health that are shared and developed through collaborative networks without any access or use restrictions, and with continued protection of the privacy, security, and confidentiality of any sensitive or specially protected data.

Particularly in contexts such as the current pandemic, the opening of structured and unstructured data (such as hospital CRMs that manage customer relationships and are used as health care models or software, government reports, diagnostic images, medical notes, the digitization of documents with information, audio and video files, etc.) enables medical and scientific communities to better understand the transmission of COVID-19, develop rapid diagnostic tests, implement efficient epidemiological control, and facilitate the development of antiviral therapies and vaccines.

In this article, "information" is broadly understood to include, among other things, scientific articles, books, maps, dashboards, epidemiological bulletins, health data, repositories, open-source software, data related to diagnostic and therapeutic methods, and patent content that can benefit the entire world.

As far as collaborative networks are concerned, to implement this new concept of open public health, the active participation of all players – Brazilian and international, public and private, institutional and individual – that coexist directly or indirectly in health systems is important, particularly in response to the pandemic, for which there was an unprecedented global objective. Likewise, thinking about solid foundations for the post-pandemic future, the authors consider it relevant to initiate a debate about the importance of including the "ac-

cess to health information" concept as a clearly defined "health service", a necessary pillar for achieving universal health access and coverage.

Table 1. ADVANTAGES OF OPEN PUBLIC HEALTH

The better the data, information, and knowledge available, the more intelligent the response will be.
Digital tools are crucial to enable access to all kinds of content and technological applications.
Having access to the right data, information, and evidence at the right time and in the right format is one of the key factors that is critical to a successful response to the pandemic or any public health event.
In times of uncertainty, predictive models are a critical success factor in health systems' planning, but if there is no access to reliable data, these models can have some significant limitations.

Open public health would contribute significantly to accelerating the response to the COVID-19 pandemic and the building of the "new normal" after the most acute phases, allowing different people, teams, and institutions that are working to find a solution to always have at their disposal the "information" they need in the time, place and format that is needed (Table 1).

All individuals generate data, as do all work teams, institutions, and organizations. These data, however, particularly those associated with government organizations, are not always available. The lack of access to this set of data and information restricts the ability of having control over the transparency of actions and limits the possibilities for innovation and improving the services provided. On the other hand, there may be new knowledge within that data that a third party could analyze by evaluating existing patterns in and between the databases.

This situation is greatly intensified in the case of a pandemic, in which many countries and multiple institutions and organizations are involved in generating data. So, the potential benefit from its opening is even greater and proportional to the pandemic itself.

Open public health is necessary because, due to the plethora of data being generated, platforms are needed to connect and analyze such data simultaneously in order to improve the response and allow future epidemics and pandemics to be anticipated.

This article focuses on the intersection of the concepts of "openness" and "public health" as the basis of the paradigm shift that will contribute to a better response to COVID-19 and possible future pandemics, and to strengthening universal access to health and universal health coverage, especially in vulnerable populations and groups.

The proposed new concept of open public health is based on the exploration and analysis in the health sector of concepts such as: "open government," "open data," "open access," "open source," "open standards," "open

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(...) data governance is needed to facilitate open and secure access to official and unofficial data, information, and technological applications that facilitate decision making and interventions, while understanding and respecting their sensitivity and privacy.

education," "open science," "open knowledge" and "open maps," and how they can accelerate and improve actions and decision making based on as much evidence as possible within the urgent timeframe the situation imposes. Likewise, and in order to ensure its assimilation implementation, and sustainability, this article also addresses the relationship between "openness," "infodemic" and "infoxication" and how to achieve a productive, effective and collaborative balance between them.

Opening data and information in the response to the COVID-19 pandemic

"Decision making in healthcare does not follow a linear and absolute course. It is a process as complex and dynamic as each of the situations that are found in the real world" (Ramos Herrera, González Castañeda, & Tetelboin, 2012, n. p.). In the case of the pandemic, this complexity increases when there is no open access to quality data and information at the required time and format, including globally agreed definitions and standards. This contrasts, however, to the volume of data and information that grows exponentially every day, generating an infodemic and restricting one's ability to analyze it. Therefore, a more "open" approach in public health centralizes and standardizes the production and analysis of information, helping to reduce and order the existing chaos.

In this sense, open data standards are key, as they facilitate an adequate interoperability of the data. Many countries, especially those with fragmented health systems, would benefit from having interoperability platforms and repositories with open access data standards.

Managing a pandemic is a matter that concerns the whole world, since an outbreak originating in a remote location can reach any corner of the planet in weeks or even days. To be able to address this situation, therefore, data governance is needed to facilitate open and secure access to official and unofficial data, information, and technological applications that facilitate decision making and interventions, while understanding and respecting their sensitivity and privacy.

It is important to specify which information is more accessible and which is more restricted. The former includes open scientific publications, research projects, and epidemiological bulletins, while examples of more restricted information include scientific publications from the commercial scientific circuit, the composition and manufacturing methods of health products that are subject to patents, and databases from official health surveillance systems. The commercial interests of the publishing, pharmaceutical, and medical technology industries are usually involved in the first two cases, while in the third it is the right to patient confidentiality. In this sense, it is essential to guarantee the protection of any personal data that allow users or patients to be identified. Many countries have laws on the protection of personal data and access to public information that oblige the state to provide any (public) information requested from them while safeguarding its confidentiality.

Providing open access to standardized information will facilitate: 1) the development of scenarios and prognoses that allow for improved prioritization, planning and decision making related to public health policies; 2) the use of basic indicators with data being as disaggregated as possible for actions that do not increase inequities in terms of access to care and critical inputs; 3) the formulation of hypotheses on the behavior of the pandemic; 4) the ability to distinguish between rumors or false information and quality data; 5) the development of applications based on open standards that allow for the greatest possible interoperability; 6) access to patents of critical products/solutions that can lead to benefits at the global level and model different response scenarios in each population; 7) real-time monitoring of the epidemiological curves of the pandemic; 8) "increasing the transparency, integrity and access to the results of scientific research, as well as promoting knowledge translation policies and projects" (PAHO, 2017); 9) the collective construction of knowledge and organizational intelligence; 10) reliance on knowledge, especially that which is subject to patents, for the supportive development of solutions that will be of global benefit; and 11) proposing new research, including collaborative and multidisciplinary research.

Creating a productive and effective balance with the concept of "openness" in the context of "infodemic" and "infoxication"

The term "infodemic," formed from the combination of the terms "information" and "epidemic," refers to an overabundance of information about a specific subject that varies in quality, format, structure, and veracity and occurs suddenly and exponentially during a pandemic, emergency, or disaster.

The term "infoxication" (Lewis, 1996), in turn, refers to the problems that arise when the information-processing capacity is notably lower than the amount of information available, leading the system (be it a single person, a work group, or even an institution) to "decision fatigue," with a deterioration in the quality of the decisions made, up to the point of total impossibility of execution (Agostino, Mejía, Martí, Novillo-Ortiz, & Hazrum, 2017).

An infodemic produces infoxication by several mechanisms, including an excess in the variety of the information to be analyzed, an excess in variety of the data formats to be analyzed, an excess in the variety of data structures to be analyzed, and a continuous exponential growth in the data to be analyzed.

A recent study (Hernández-García & Giménez-Júlvez, 2020) analyzed the information published on websites about protection measures against COVID-19. This analysis found that in the first 20 websites of the Goog-

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(...) it is important to understand that open access and the real-time dissemination of scientific information are necessary in times of uncertainty generated by a pandemic.

le search engine, there is variable adherence (35% to 81.3%) to sharing the protection measures promoted by the World Health Organization (WHO) against COVID-19. Many countries have adopted strategies and actions to combat the infodemic and disinformation (Alvarez-Risco et al., 2020). This reveals the imperative need to implement communication actions directed at the population that reflect the importance of consuming corroborated information of scientific value in order to promote the consultation of official websites, such as that of the WHO. Therefore, it is important to understand that open access and the real-time dissemination of scientific information are necessary in times of uncertainty generated by a pandemic.

It was previously mentioned that open access to information would improve decision making, and it was also stated that more information increases the likelihood of infoxication. Although there seems to be a contradiction, this is not necessarily so. If there is a balance between proper information management (through protocols, open-source technology platforms, standards that ensure interoperability, and trained personnel), informed decisions can be made based on as much evidence as possible, thus avoiding infoxication. This can become sustainable through standardization that regulates the life cycle of information, from its production to its consumption and disposal.

The open innovation paradigm assumes that a given institution should use external and internal ideas and processes to provide a better solution for the development of its products and services. Although this model comes from the industry world, it is being adopted as an innovation and development (R&D) strategy in government agencies such as the UK's National Health Service. Open innovation is the antithesis of the traditional vertical integration model, in which R&D activities are developed and applied internally within the institution.

When applied in the health field and, in particular, to the response to the pandemic, open innovation represents new forms of collaboration between people, networks and organizations (community, physicians, researchers) and public-private partnerships (Chesbrough, Vanhaverbeke, & West, 2006). In this sphere of action, the boundaries between different roles blur, causing evidence and data to be generated openly and collaboratively; so that ideas come from any stakeholder, and not just practitioners and researchers; so that innovation focuses on the true needs of users or patients and the knowledge of practitioners; and so that international collaboration encourages decision makers to recognize that the world's health systems can benefit by learning from each other (Gabriel, Stanley, & Saunders, 2017). Examples include current efforts such as the COVID-19 genome map (Hadfield et al., 2018); the open-source initiative to build mechanical ventilators at the University of Florida (Hadfield et al., 2018); and the ESRI COVID-19 HUB, which provides access to geographic information systems, mapping software, services and materials that people are using to help monitor, manage, and communicate the impact of the outbreak (Esri, 2020).

The technologies in open public health

Among the many roles they play and that are not the subject of this article, technologies in health services have provided new ways to generate, collect, analyze, and share health-related data and information. Technological and analytical solutions have the ability to support the use of data and information in health decision making and accelerate the distribution of knowledge flows among different organizations and on various levels in decision making, thus “diluting” knowledge silos and producing policies for people's health care that are based on data and evidence. To accelerate the response to the pandemic, an important role of ICT is enabling access to georeferenced data from health centers in all countries, information on Internet access, laboratories, beds, number of tests per type, etc.

The issue of "openness" is not new; it has been used to a greater or lesser extent since the 1990s. For example, the concept of e-Government refers especially to the use of ICT for the delivery of services. The much more recent concept of open government emerged as a mechanism to improve the relationship and communication between the government and its population (Veljković, Bogdanović-Dinić, & Stoimenov, 2014). One of several mechanisms developed to improve this relationship is open access to public sector data and the concept of open data (Curioso & Carrasco-Escobar, 2020).

In another context, that of scientific literature and evidence, the open access movement emerged in the early 1990s and has been consolidated particularly since the mid-2000s, when there was a gradual increase not only in the number of journals that allowed open access to their content, but also in the number of authors who made use of these journals. Similarly, current license and intellectual property management has driven and accelerated the open access process (Lewis, 2012). Movements associated with open source, standards, and maps, among others, have also emerged in this same manner.

We can think of access to information as a human right, which should even be one of the main social determinants of a "new public health," along with access to the Internet. The Special Rapporteur for Freedom of Expression of the Inter-American Commission on Human Rights states that access to information constitutes an essential tool for fighting corruption, making the principle of transparency in public management a reality, and improving the quality of democracies (Special Rapporteur for Freedom of Expression, 2007). The World Health Organization, on the other hand, refers to the importance of promoting and protecting the right to education and the right to seek, receive, and impart information and ideas concerning health issues (WHO, 2002). It should be clear that the right to information should not take precedence over the right to privacy, meaning that personal data related to health should be treated with confidentiality in all situations (Cabrol, Baeza-Yates, González-Alarcón, & Pombo, 2020). The use of surveillance, review, and shared accountability systems that are similar to clinical research ethics committees, for example, would be useful for constant supervision.

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(...) the right to information should not take precedence over the right to privacy, meaning that personal data related to health should be treated with confidentiality in all situations.

Conclusion

Globalization, current public health needs, and cooperation between global, regional, and local players require the opening of data, information, and knowledge through the open public health approach, defined as the data, information, and knowledge for improving public health that are shared and developed through collaborative networks without restrictions as to access and use, and with continued protection of the privacy, security, and confidentiality of sensitive data or data that require special protection.

Analysis of the individual concepts of "openness" allows us to better understand their specificity, their contributions to health and other areas of science, the gaps covered or being progressively covered in the different fields of application, and the opportunities they involve, particularly in response to the COVID-19 pandemic. All these principles and values were built, supported, and reinforced by the community.

It is essential that countries develop, implement, and keep up-to-date open data repositories in order to better manage information for optimal decision making and to produce new knowledge, including collaborative and multidisciplinary knowledge.

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Interview I

Analluza Bolivar Dallari
Lawyer, Ph.D. and M. Sc. in Law, University of São Paulo

Personal data protection and technologies in health

Analluza Bolivar Dallari is a lawyer with a Ph.D. from the University of São Paulo (USP). In this interview, she presents the main issues surrounding the use of personal data in the health sector and the challenges that still need to be addressed in this debate.

Internet Sectoral Overview (I.S.O.) _The use of health applications has increased significantly as a result of the COVID-19 pandemic, and now includes digital vaccination cards and programs for tracking contagion. What are the implications of the proliferation of these apps in terms of digital security?

Analluza Bolivar Dallari (A.D.)_ The digital transformation of health, whether it is public or private, is very important. Despite the need for social distancing and adapting to other restrictions during the pandemic, health care and assistance had to continue. Many elective surgeries were canceled, and a lot of treatment was suspended due to the impact of the pandemic on healthcare facilities. But it was important to continue looking after the health of these patients, and the alternative that was found was to invest very quickly in digital platforms, including applications and web solutions. Hence, consultations via the Internet, even via WhatsApp and other means of communication, made it feasible to provide healthcare to patients. Healthcare facilities, however, did not have enough time or sufficient funds to invest properly in their own platforms and products, nor even in information security. Their efforts were aimed at saving lives and not at developing technology tools.

To continue with the care, companies known as health techs made technical solutions possible, such as platforms that issue electronic documents and prescriptions, doctor's certificates, requests for tests/examinations, and medical reports. Although these companies are not healthcare facilities, they access patient health data without necessarily taking due care or establishing who might have access to it, because accessing it is also part of the business.

Because of the great speed with which digital health has developed as a result of the pandemic, many issues got out of control, especially in relation to digital security, with constant cyber-attacks, including in the context of public health. Although this transformation is very positive and necessary, there is still a long way to go for these solutions to be considered adequate regarding information security, traffic, and the secondary use of these data, which can also be positive, like providing solutions that are of benefit to patients. What needs to be better defined in this context is who the operator is and who the controller of these data is, and what is going to be done with this database. Is there a secondary use for it? Do patients give their consent? If they don't, what's the legal basis for waiving this consent in light of Article 11 of the General Personal Data Protection Law (Lei Geral de Proteção de Dados Pessoais – LGPD)? Finally, there needs to be greater transparency about the processes and the information security measures adopted by these solutions.

I.S.O._ How do national and international legal frameworks relating to privacy and personal data protection address the use of data for economic purposes in the healthcare sector? Were these frameworks sufficient in the context of the pandemic?

A.D._ They undoubtedly weren't. It's important to point out that the LGPD came into full force in Brazil on August 1, 2021, in other words, right in the middle of a pandemic. There are still a lot of gaps in the health area that need to be worked on and interpreted by the National Data Protection Authority (Autoridade Nacional de Proteção de Dados – ANPD). One of them is in relation to the economic use of health data (Art. 11, §3 of the LGPD), which can be prohibited or regulated by the ANPD; in other words, this matter is still open.

Since health is not currently on the regulatory agenda of this authority, there's a lot of work to be done. There's a gap with regard to what the economic use of data is, whether in terms of defining and/or interpreting it, its relationship with the monetization of health data, the need for consent, or whether consent is waived, data anonymization, and other issues. But it seems that the ANPD is not about to prioritize this matter.

There has been a directive on data protection in Europe since 1995, which was before the General Data Protection Regulation (GDPR). There's a very strong data protection culture there, which became stronger as a result of the Second World War. We're increasingly noting that Europe is tending to be more conservative regarding the use of health data. It has even questioned, for example, the use of cookies by health applications, because they can track and identify individual use. Although the company does not have access to the medical records of patients, these applications have access to information that can be considered health data, such as the number of teleconsultation appointments relating to a particular medical specialty.

The LGPD in Brazil makes it possible to condition the use of a product or service to data information, under certain conditions (Art. 9, § 3 of the LGPD). This is different from the GDPR, for example, which allows an application to be used without the obligation to provide personal data or authorize the processing of these data. There is also still no exact notion of what health data are, because certain information may be relevant in the context of health, but not necessarily in other areas.

Despite this, it is important to note that health has a very strong regulatory and ethical framework, which is characteristic of the area and based on professional confidentiality. These regulations were in force prior to the LGPD, since confidentiality, trust, and the doctor-patient relationship are centuries-old concepts. It is worth noting that in health, in order for the patient to continue being cared for, to avoid fraud and so they can be seen and attended to quickly, health data need to "travel," and indeed they must. The legal frameworks need to be interpreted in order to support this data traffic.

"(...) the LGPD came into full force in Brazil on August 1, 2021, in other words, right in the middle of a pandemic. There are still a lot of gaps in the health area that need to be worked on and interpreted by the National Data Protection Authority (ANPD)."

"In Brazil, data governance in the health sector is characterized by a lack of norms and regulations."

I.S.O._ In a context in which there is an increase in the presence of digital platforms, innovative technological solutions and, consequently, new players in the ecosystem, how is data governance in the health sector characterized?

A.D._ Despite the importance of digital health, there are very few rules and regulations in Brazil that relate to it. In France, for example, there is a national digital health agency, which treats it as a branch of health, thus providing greater transparency, regulation, and, consequently, better security for the patients to whom the data refer. In Brazil, data governance in the health sector is characterized by a lack of norms and regulations.

Digital platforms and technological solutions are very important in the health ecosystem, as they are the innovations that enable greater agility in health. For example, the digitization of the Unified Health System (Sistema Unificado de Saúde – SUS), in addition to the partnerships made by the Ministry of Health with 5G, state-of-the-art hospitals, makes it possible to reduce waiting times, and clean up the data (excluding from the waiting list, for example, data about patients who no longer need particular treatment). There's still a question about the legal nature of health tech companies, however, since they store medical records and have access to medical certificates and prescriptions, but also have partnerships with pharmacies and pharmaceutical industries to provide other services, such as discounts in pharmacies, health insurance and health plans, which are based on use and the health status of patients. In other words, they access confidential information and make economic use of it. Over and above these services, there is little transparency regarding other implications that might be associated with accessing and using these data in other aspects of patients' lives.

So, because these players deal directly with health data, they are the ones that need to be regulated, and not necessarily the health facilities. Brazil's Federal Medical Council (Conselho Federal de Medicina – CFM) has initiatives that are trying to advance in this direction; it is asking, for example, for platforms that issue medical documents to be registered. Considering the State's supervisory power, digital health will not go unscathed; at some point in the future, these platforms – which are new players – will need to be regulated in order to establish a limit, at least ethically, for what has been done with this mass of data to which they have access. The LGPD needs to be interpreted in the health area in the light of these ethical parameters, so that it is actually correct and effective in practice. The ANPD still has a long way to go, and it can't do this alone; it needs the support of the Ministry of Health, the National Health Council (Conselho Nacional de Saúde – CNS), the National Health Surveillance Agency (Agência Nacional de Vigilância Sanitária - Anvisa), the Federal Medical Council (CFM), and the National Research Ethics Commission (Comissão Nacional de Ética em Pesquisa – Conep).

I.S.O._ What are the key issues in the debate over the secondary use of patients' clinical data? How can this debate be expanded in Brazil?

A.D._ I believe that the key issues in the debate are information security and anonymization, or pseudo-anonymization, in order to be more transparent with

the patient and to better identify the waiver of consent.
Using Big Data for predicting health and reducing contagion, for example, leads to an improvement for patients and avoids waste. This is an example of the secondary use of clinical data for finding new health solutions that are of benefit to both public and private health. Despite the positive aspects, key issues include establishing the ethical limits – a legal basis for waiving consent; the principled limits, such as purpose, proportionality, adequacy, and non-discrimination; and, above all, the benefits and anonymization, or pseudo-anonymization.
In general, public debate, participation in forums, and seminars, whether organized by public or private institutions, generally lead to the discussion becoming broader. It is also important to develop and disseminate materials that discuss these topics, such as the book I am organizing: "LGPD in digital health."
Specifically in relation to patients, we need to consider that, when it comes to health, they are the vulnerable party. When you need medical care, reading the terms of consent and use is not a priority. It's also important to remember that there is still a digital divide in our context, which makes certain groups of the population even more vulnerable. In this context, broadening the debate with patients, education and the use of legible and easy-to-understand terms of consent are among the key issues.

Interview II

Technology and innovation in health

John Halamka, M.D., M.S., is president of Mayo Clinic Platform, a group of digital and remote healthcare initiatives in the United States. In this interview, he comments on examples of how emerging technologies such as Artificial Intelligence and blockchain have been used to innovate in the healthcare sector, and identifies their potential uses and limitations.

Internet Sectoral Overview (I.S.O.)_ New disruptive digital technologies, such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain, are being increasingly adopted for use in healthcare. How have emerging technologies been used for fostering innovations in the healthcare sector?

John Halamka (J.H.)_ As any new technologies, IoT technologies can certainly be innovative and disruptive in positive and negative ways. Many clinicians and patients find themselves searching for reliable IoT devices for remote monitoring, but find the decision-making process fraught with difficulty and challenges, mainly because solutions available are few and their due to their reliability.
As an example of this, I would mention the case of an IoT device vendor

John Halamka, M.D., M.S.
President of Mayo Clinic Platform

"(...) even though blockchain technology has been available for many years and serves as the backbone of the bitcoin industry, it is still very new to the medical world, which makes it difficult to offer a real-world assessment of its strengths and weaknesses."

that recently received a warning letter from the United States Food and Drug Administration (FDA) for making unsubstantiated claims. The company makes "smart socks" for placing on new-born babies' feet to monitor their oxygen levels, heart rate, and total hours of sleep. According to the FDA, the company's sales team stated: "We look at the best indicators of your baby's overall well-being and will proactively notify you if your baby may need you." The FDA sent a warning letter to the company advising that products that measure blood oxygen saturation and pulse rate "are devices when they are intended to identify (diagnose) desaturation and bradycardia and provide an alarm to notify users that measurements are outside preset values." Since the vendor never submitted the necessary documentation to the agency to demonstrate its product is a safe and effective medical device, it violates United States federal law.

At the other end of the IoT spectrum are several other well-researched and tested products, all of which have FDA clearance or approval, like IDx-DR[34] and AliveCor.[35] In this context, researchers from the Mayo Clinic and AliveCor Inc. have been using AI to develop a mobile device that identifies patients at risk of several heart conditions, including atrial fibrillation, which can lead to a stroke. The research team determined that a smartphone-enabled mobile electrocardiogram (ECG) device can rapidly and accurately determine a patient's corrected QT (QTc) interval, thereby identifying patients at risk.

I.S.O._ How is blockchain currently being used in the healthcare sector? What are the main challenges and opportunities of such uses?

J.H._ Although some technologists believe that blockchains have the potential to revolutionize healthcare, that enthusiasm may be unwarranted. In theory, the technology could enhance security controls around access to health records. However, even though blockchain technology has been available for many years and serves as the backbone of the bitcoin industry, it is still very new to the medical world, which makes it difficult to offer a real-world assessment of its strengths and weaknesses. Estonia is the first country to use blockchain in health care, and in 2016 it launched a blockchain technology to secure the health records of the patients. In the UK, two hospitals were the first to deploy blockchain technology to monitor the storage and supply of temperature-sensitive COVID-19 vaccines. A Reuters report[36] explains that this "tech will bolster record-keeping and data-sharing across supply chains, said Everyware, which monitors vaccines and other treatments for Britain's National Health Service (NHS)." According to the report, "Firms from finance to commodities have invested millions of dollars to develop blockchain, a

[34] AI-based software used to detect and diagnose signs of Diabetic Retinopathy in retinal images.

[35] Medical device and AI company that produces electrocardiogram (ECG) hardware and software for personal mobile devices.

[36] Available at: https://www.reuters.com/article/uk-health-coronavirus-blockchain/british-hospitals-use-blockchain-to-track-covid-19-vaccines-idUSKBN2900RW

digital ledger that enables the secure and real-time recording of data, in the hope of achieving radical cost cuts and efficiency gains. Results have been mixed, though, with few projects achieving the revolutionary impact heralded by proponents."

Such mixed results beg the question: What happened to the revolution once predicted by blockchain enthusiasts? One reason is a lack of scalability. In addition, there are already trusted agencies in the health care ecosystem. Another problem: there is no significant incentive – financial or otherwise – to alter existing patient records. Equally important is the fact that other solutions are available for checking the integrity of data and handling database immutability. One way to address these issues is to use blockchain to double-check the integrity of medical records stored in more traditional databases, which often have different origins and provenance (from patients, from different types of laboratories, for example). Having an integrity check allows the physician and/or patient to understand both where the data came from with certainty and its integrity.

I.S.O._ What challenges are associated with the implementation of AI-based systems and tools in the healthcare sector? In particular, what are the implications of adopting algorithms that were developed, tested, and trained with datasets deriving from different contexts, geographies, and cultures?

J.H._ Implementing accurate, unbiased AI-based algorithms remains one of the biggest challenges in digital health right now. As was recently discussed in a healthcare technology conference, the Health Information Management Systems Society (HIMSS), although several developers have created innovative algorithms, many of the digital tools have been built upon faulty datasets. These sets lack adequate diversity, and are often biased against several demographic groups, including people of color, women, and patients from lower socioeconomic groups; they are also not designed well enough to seamlessly fit into clinical workflows. Algorithms should be tested on both internal and external datasets, which should be sufficiently large and representative of the patient populations they will serve. They should also be tested in prospective studies that include real patients in real time.

Data shift is another challenge faced by AI-enabled algorithms. Dataset shift is what happens when the data collected during the development of an algorithm change over time and are different from the data when the algorithm is eventually implemented. For example, the patient demographics used to create a model may no longer represent that patient population when the algorithm is put into clinical use. This is what happened when COVID-19 changed the demographic characteristics of patients and made a popular sepsis prediction tool ineffective.

Dr. Samuel Finlayson, from Harvard Medical School, and his colleagues described a long list of dataset shift scenarios that may compromise the

"Algorithms should be tested on both internal and external datasets, which should be sufficiently large and representative of the patient populations they will serve."

"(...) AI-based systems need to be better validated and their datasets assessed for potential bias."

accuracy and equity of AI-based algorithms, and this in turn can compromise patient outcomes and patient safety.[37] They list 14 scenarios which fall into three broad categories: changes in technology, changes in population and setting, and changes in behavior. Examples of ways in which dataset shift can create misleading outputs that send clinicians down the wrong road include:

- changes in the X-ray scanner models used;
- changes in the way diagnostic codes are collected (for example, using ICD 9 and then switching to ICD 10);
- changes in patient population resulting from hospital mergers.

I.S.O._ What key recommendations should be followed by healthcare facilities for safeguarding the transparency, explainability, and testability of AI-based systems and tools? How could health professionals and patients be involved in this debate?

J.H._ As mentioned above, AI-based systems need to be better validated and their datasets assessed for potential bias. The underlying rational and mathematical logic and technology should also be more easily understood by clinicians, who sometimes have a limited understanding of data science. Put another way, we must open up the AI black box.
AI's so-called black box refers to the fact that much of the technology behind machine learning-enhanced algorithms is based on probability and statistics with no humanly interpretable explanation. This is often the case because the advanced math or the data science behind the algorithms are too complex for the average user to understand without additional training. Several stakeholders, however, argue that as long as an algorithm generates actionable insights, most clinicians do not really care about what is "under the hood." Is that sound reasoning?
Some thought leaders point to the fact that physicians accept many of the advanced, computer-enhanced diagnostic and therapeutic tools that are currently in use, and although they do not fully understand them, they nonetheless accept them. The CHA2DSA-VASc score, for instance, is used to estimate the likelihood of a patient with non-valvular atrial fibrillation having a stroke, and although few clinicians are familiar with the original research or the detailed reasoning upon which the calculator is based, they still use the tool.
It is important to point out, however, that the stroke risk tool has been heavily endorsed by organizations that physicians respect. The American Heart Association and the American College of Cardiology both recommend the CHA2DSA-VASc score. That makes physicians trust the tool even if they do not grasp the underlying details. To date, there are no major professional associations recommending specific AI-enabled algorithms to supplement the diagnosis or treatment of disease.

[37] Find out more: https://www.himss.org/global-conference/speaker-paul-cerrato

Although it may not be possible to fully explain the advanced mathematics used to create machine learning-based algorithms, there are other ways of describing the logic behind these tools that would satisfy clinicians. There are tutorials available that simplify machine learning-related systems like neural networks, random forest modeling, clustering, and gradient boosting. Our most recent book, *The Digital Reconstruction of Healthcare*,[38] contains an entire chapter on that particular digital toolbox. The *Journal of the American Medical Association (JAMA)* has also created clinician-friendly video tutorials designed to graphically illustrate how deep learning is used in medical image analysis, and how such algorithms can be used to help detect lymph node metastases in breast cancer patients.

Domain Report

Domain registration dynamics in Brazil and around the world

The Regional Center for Studies on the Development of the Information Society (Cetic.br), department of the Brazilian Network Information Center (NIC.br), carries out monthly monitoring of the number of country code top-level domains (ccTLD) registered in countries that are part of the Organisation for Economic Co-operation and Development (OECD) and the G20.[39] Considering members from both blocs, the 20 nations with highest activity sum more than 90.14 million registrations. In March 2022, domains registered under .de (Germany) reached 17.23 million, followed by China (.cn), the United Kingdom (.uk) and Netherlands (.nl), with 9.73 million, 9.42 million and 6.24 million registrations, respectively. Brazil had 4.89 million registrations under .br, occupying 6th place on the list, as shown in Table 1.[40]

[38] Co-authored with Paul Cerrato.

[39] Group composed by the 19 largest economies in the world and the European Union. Find out more: https://g20.org/

[40] The table presents the number of ccTLD domains according to the indicated sources. The figures correspond to the record published by each country, considering members from the OECD and G20. For countries that do not provide official statistics supplied by the domain name registration authority, the figures were obtained from: https://research.domaintools.com/statistics/tld-counts. It is important to note that there are variations among the date of reference, although the most up-to-date data for each country is compiled. The comparative analysis for domain name performance should also consider the different management models for ccTLD registration. In addition, when observing rankings, it is important to consider the diversity of existing business models.

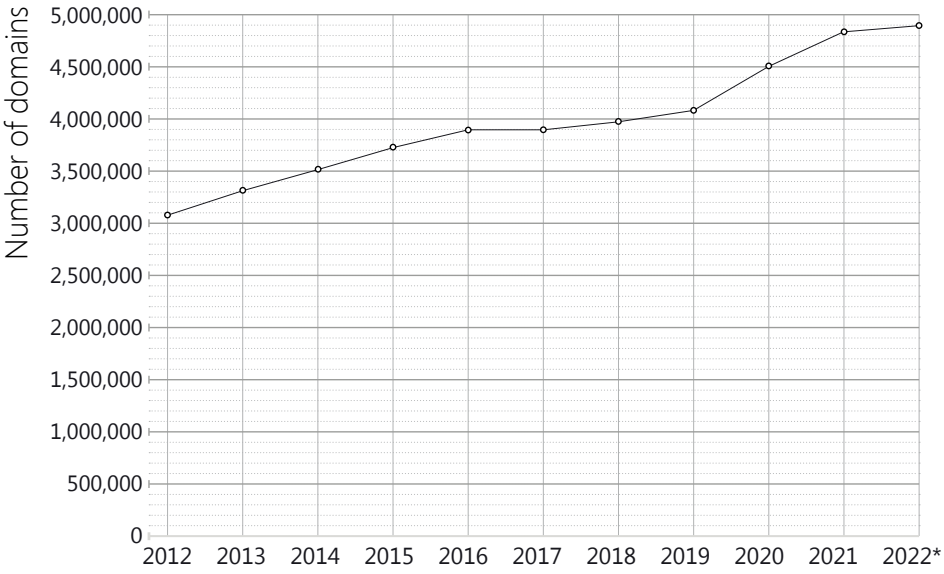
Table 1 – TOTAL REGISTRATION OF DOMAIN NAMES AMONG OECD AND G20 COUNTRIES

Position	Countries	Number of domains	Date of reference	Source (website)
1	Germany (.de)	17,234,880	31/03/2022	https://www.denic.de
2	United Kingdom (.uk)	9,738,031	01/02/2022	https://www.nominet.uk/news/reports-statistics/uk-register-statistics-2022/
3	China (.cn)	9,427,255	31/03/2022	https://research.domaintools.com/statistics/tld-counts/
4	Netherlands (.nl)	6,248,082	31/03/2022	https://api.sidn.nl/rest/counters/domains
5	Russia (.ru)	5,044,497	31/03/2022	https://cctld.ru
6	**Brazil (.br)**	**4,897,535**	**31/03/2022**	**https://registro.br/dominio/estatisticas/**
7	France (.fr)	3,925,726	31/03/2022	https://www.afnic.fr/en/resources/statistics/detailed-data-on-domain-names/
8	European Union (.eu)	3,691,322	31/03/2022	https://research.domaintools.com/statistics/tld-counts/
9	Australia (.au)	3,505,904	31/03/2022	https://www.auda.org.au/
10	Italy (.it)	3,463,816	31/03/2022	http://nic.it
11	Colombia (.co)	3,350,078	31/03/2022	https://research.domaintools.com/statistics/tld-counts/
12	Canada (.ca)	3,274,782	31/03/2022	https://www.cira.ca
13	India (.in)	2,650,846	31/03/2022	https://research.domaintools.com/statistics/tld-counts/
14	Poland (.pl)	2,531,721	31/03/2022	https://www.dns.pl/en/
15	Switzerland (.ch)	2,483,555	15/03/2022	https://www.nic.ch/statistics-data/domains_ch_monthly.csv
16	Spain (.es)	1,985,465	08/02/2022	https://www.dominios.es/dominios/en
17	United States (.us)	1,809,515	31/03/2022	https://research.domaintools.com/statistics/tld-counts/
18	Belgium (.be)	1,741,114	31/03/2022	https://www.dnsbelgium.be/en
19	Japan (.jp)	1,688,481	01/03/2022	https://jprs.co.jp/en/stat/
20	Sweden (.se)	1,454,665	31/03/2022	https://internetstiftelsen.se/en/domain-statistics/growth-se/?chart=active

Collection date: March 31, 2022.

Chart 1 shows the performance of .br since 2012.

Chart 1 – TOTAL NUMBER OF DOMAIN REGISTRATIONS FOR .BR – 2012 to 2022*



*Collection date: March 31, 2022.
Source: Registro.br
Retrieved from: https://registro.br/dominio/estatisticas/

In March 2022, the five generic Top-Level Domains (gTLD) totaled more than 191.20 million registrations. With 159.70 million registrations, .com ranked first, as shown in Table 2.

Table 2 – TOTAL NUMBER OF DOMAINS AMONG MAIN gTLD

Position	gTLD	Number of domains
1	**.com**	159,709,070
2	**.net**	13,231,264
3	**.org**	10,610,280
4	**.info**	3,963,559
5	**.xyz**	3,691,807

Collection date: March 31, 2022.
Source: DomainTools.com
Retrieved from: research.domaintools.com/statistics/tld-counts

INTERNET USERS AND TELEHEALTH IN THE PANDEMIC[41]

Telehealth makes it possible to carry out medical consultations and access different health services at a distance. Hence, it was very important for the continuity of health care during the health emergency.

The following data[42] relate to the use of telehealth in Brazil in 2021 during the COVID-19 pandemic.

ONLINE MEDICAL CONSULTATIONS

26% of Internet users had an appointment with a physician or other healthcare professional online (teleconsultation) in the 12 months prior to the survey.

Among the Internet users who performed teleconsultations, these were carried out using the following applications:

- **59%** Messaging applications, such as WhatsApp and Telegram
- **35%** Applications provided by the public healthcare system
- **34%** Applications provided by private health insurance companies
- **31%** Video calling applications, such as Skype or Zoom
- **36%** Another type of application

Among the Internet users that did not perform teleconsultations, the declared reasons for this were the following:

- **77%** Preference for in-person care
- **60%** No need to consult a physician or other healthcare professional in the period
- **58%** Concern with the security of personal data
- **51%** Find it difficult to to consult a physician or other healthcare professional on the Internet
- **47%** Lack of trust in in consulting a physician or other healthcare professional on the Internet
- **19%** Unable to find this service available on the Internet

[41] Data taken from the fourth edition of the ICT PANEL COVID-19, web survey with Internet users in Brazil carried out by Cetic.br|NIC.br. Find out more: https://cetic.br/en/pesquisa/tic-covid-19/indicadores/

[42] The data refer to Internet users aged 16 or more.

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United Nations Educational, Scientific and Cultural Organization

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Regional Center for Studies on the Development of the Information Society under the auspices of UNESCO

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Brazilian Network information Center

cgi.br

Brazilian Internet Steering Committee

STRIVING FOR A BETTER INTERNET IN BRAZIL

CGI.BR, MODEL OF MULTISTAKEHOLDER GOVERNANCE

https://cgi.br

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