Making the COVID-19 pandemic a driver for digital health: the Brazilian strategies

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Abstract

The COVID-19 outbreak exposed a number of problems faced by health systems around the world, especially with regard to generation and sharing health data, in a quickly and safely manner. However, this pandemic scenario also facilitates the rapid implementation and monitoring of technologies in the health field. In view of the occurrence of the public calamity state caused by the virus SARS-CoV-2 in Brazil, the Department of Informatics from Brazilian Unified Health System created a contingency plan. This paper aims to report the Brazilian digital health strategies and the first results obtained during the fight against COVID-19. ConecteSUS, a platform created to store all the health data of an individual throughout their life is the center point of the Brazilian digital strategy. Access can be made through an application by the patient and the health professionals involved in the case. The health data sharing became possible due to the creation of the National Health Data Network (RNDS). A mobile application was developed to guide citizens about the need or not to go to a health facility and to assist in the dissemination of official news about the virus. The app is also able to alert the user if he had contact with someone infected. The official numbers of cases and beds available in hospitals are being updated and published daily, on a website containing interactive graphics. These data are obtained due to the creation of an online notification system that uses RNDS to share information about the cases. Pre-clinical care through telemedicine has become essential to prevent the overload in health facilities. The exchange of experiences between medical teams from great centers and small hospitals was possible by the use of telehealth. Brazil took a giant step towards digital health, creating and implementing important initiatives, which do not yet cover the entire health system. It is expected that, in the near future, the sharing of health data kept up and authorized by the patient becomes a reality. The intention is to obtain a better clinical outcome, cost reduction, and faster and better services in the public health network.

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Viewpoint

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Abstract

The COVID-19 outbreak exposed several problems faced by health systems worldwide, especially concerning generation and sharing health data quickly and safely. However, this pandemic scenario also facilitates the rapid implementation and monitoring of technologies in the health field. In view of the occurrence of the public calamity state caused by the SARS-CoV-2 virus in Brazil, the Department of Informatics from the Brazilian Unified Health System created a contingency plan. This paper aims to report the Brazilian digital health strategies and the first results obtained during the fight against COVID-19. Conecte SUS, a platform created to store all the health data of an individual throughout their life, is the center point of the Brazilian digital strategy. Access can be made through an application by the patient and the health professionals involved in the case. Health data sharing became possible due to the creation of the National Health Data Network (RNDS). A mobile application was developed to guide citizens about the need or not to go to a health facility and assist in disseminating official news about the virus. The mobile application is also able to alert the user if they had contact with someone infected. The official numbers of cases and beds available in hospitals are updated and published daily on a website containing interactive graphs. These data are obtained due to creating an online notification system that uses RNDS to share information about the cases. Pre-clinical care through telemedicine has become essential to prevent the overload in health facilities. The exchange of experiences between medical teams from great centers and small hospitals was possible using telehealth. Brazil took a giant step towards digital health, creating and implementing important initiatives, which do not yet cover the entire health system. It is expected that, in the near future, the sharing of health data kept up and authorized by the patient will become a reality. The intention is to obtain a better clinical outcome, cost reduction, and faster and better services in the public health network.

Keywords: COVID-19; Digital technology; Brazil; Public Health; Medical Informatics.

Introduction

The year 2020 was marked by the coronavirus disease 2019 (COVID-19) outbreak, caused by the highly contagious SARS-CoV-2 virus (severe acute respiratory syndrome coronavirus 2), bringing up many challenges to the scientific community and health services worldwide. COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, forcing the public health of all countries to adopt measures focusing on surveillance, rapid case identification, interruption of community transmission, and strong public communication to contain virus spread, mitigate the impact on human health, and also try to prevent the collapse of health systems [1]. In this context, effective, integrated, and safe recording, management, and follow-up of patients' clinical data at the different levels of a health system are fundamental to address better the situation imposed by COVID-19 [2,3]. However, healthcare systems are composed of multiple agents and services, which cannot always share clinical data of patients adequately and at the necessary speed to face the pandemic scenario.

The COVID-19 pandemic has several peculiar characteristics that differ from other pandemics already faced by the world, like the number of infected individuals, the high transmissibility levels, the broad spectrum of symptoms, and the rapid evolution of patients to severe conditions [4]. In addition, the COVID-19 pandemic is occurring in an era of massive technological advancement, when digital health solutions have been extensively discussed but are not yet widely deployed and accepted [5]. Considering this adverse scenario, at the same time that the COVID-19 pandemic exposed the deficiency of healthcare systems worldwide, it provides an opportunity to develop and test innovative solutions extremely quickly to strengthen public health measures [6]. In this context, this paper aims to share the Brazilian digital health initiatives to mitigate damage caused by COVID-19. These initiatives were created by a special Committee linked to the IT department of the Brazilian Unified Health System, considered one of the most extensive public health systems in the world.

The Brazilian health system

On February 3, 2020, Brazil declared a public health emergency of national importance. The first case of COVID-19 in Brazil was confirmed in São Paulo on February 26 [7], two months after China notified the World Health Organization (WHO) about the emergence of series of cases of pneumonia of unknown cause [8]. Until May 22, 2021, Brazil had an accumulated record of 14,462,432 cases and 448,208 deaths, with the number of cases increasing every day [9].

The dynamic and high-risk scenario for the population caused by the new coronavirus required forceful responses from the entire health system, especially from the Unified Health System (SUS). SUS is the Brazilian public health system created in 1988 inspired by the United Kingdom's National Health Service (NHS). Until today, Brazil is considered the only country with a population of more than 200 million people with a universal health care system, and about 75 percent of the population uses SUS exclusively. SUS coordinates national actions and orchestrates the efforts of states, municipalities, and even Supplementary Health and is maintained by the public power, with supplementary participation of private initiatives [10].

Although the use of Information and Communication Technologies (ICT) in the health area was guaranteed in Brazil by Organic Law No. 8,080 in 1990, due to the lack of investments and ethical and bureaucratic issues, the insertion of technology and data sharing is not yet a reality for health services. Based on the National e-Health Strategy Toolkit published by WHO in 2012, the Brazilian digital health strategy was approved in 2017 and defined the digital health strategy as a fundamental SUS dimension. The program that "materializes" the Brazilian e-Health strategy is Conecte SUS, which is based on two structuring projects: the National Health Data Network (RNDS) and the

Program to Support Computerization and Qualification of Primary Health Care data (Informatiza APS). The former aims to promote the exchange of information between the Health Care Network's different services, allowing the transition and continuity of care in the public and private sectors. The latter aims to support the computerization of health units and the qualification of primary health care data across the country [11].

Conecte SUS is a standardized, modern, and interoperable platform of services, information, and connectivity that is, in itself, transformative for health. This platform predicts the integration of citizens' health information in an extensive data network organized by the Ministry of Health (RNDS), which will bring benefits both to citizens – who will have access to their trajectory in SUS,- and to health professionals and managers, who will have a set of information that will improve the continuity of care and decision making [11].Conecte SUS was structured as a pilot project. In November 2019, this project started in one Brazilian state to validate the planning carried out and refine the proposal to expand the program throughout Brazil. However, on March 2020, plans designed within the Brazilian strategy for digital health faced the coronavirus pandemic. On March 13, 2020, the SUS IT department (DATASUS) established the New Coronavirus Crisis Committee, responsible for evaluating new health management technologies and prioritizing the care and prevention guidelines of the Ministry of Health itself. The main strategies and actions adopted by DATASUS to assist the Ministry of Health were published as a contingency plan. The contingency plan proposed a series of strategies for a quick and efficient response to the virus through direct communication with the population and public and private health systems. Thus, through the contingency plan, Brazilian strategies to the digital health transformation, such as Conecte SUS and RNDS, were redirected to face the virus. Moreover, the contingency plan developed some specific strategies for the pandemic moment: the creation of an application related to the virus (Coronavirus SUS application), the restructuring of an online compulsory notification system, an online panel of official disease data, and the use of telemedicine to patients care (Figure 1). All these strategies will be explained in the next section.

Contingency plan

Facing the pandemic requires information at different levels, from the registration of notifications, deaths, results of tests performed to the provision of services aimed at prevention and care. Among these services are self-assessment, teleconsultation, active search for patients, and advanced applications for identifying trends and vulnerable populations. To encompass all these demands, Conecte SUS systematizes a health care and data ecosystem for COVID-19. This ecosystem comprises specific layers for information security, interoperability between systems, notification processes and health surveillance, mobile apps, and access channels, further detailed following.

RNDS is a federated interoperability layer. Several digital health applications, notably Electronic Health Records (EHR), Hospital and Laboratory Management Systems, portals, and mobile applications (to citizens, health professionals, and managers), exchange information through a Service Bus. The RNDS was recently being tested as a pilot project in one of the Brazilian states when the COVID-19 pandemic arrived in Brazil. As health emergency care priorities were modified, the RNDS had to quickly assume the COVID-19 national data repository position, acting on reception and integration of case notifications and results of laboratory tests and distribution and sharing of data and epidemiological information. The epidemiological data are published in the Coronavirus Brazil Panel, the official communication vehicle, about the epidemiologic situation of COVID-19 in Brazil. The Ministry of Health updates daily the numbers of confirmed cases of COVID-19, the number of deaths, and the lethality rate of the virus based on data provided by the state health departments of the 27 Brazilian federative units. The website presents data related to the country, separate data for each state, and presents cases per epidemiological week and an epidemic curve. This communication platform has georeferenced records of all COVID-19 instances registered

in the country. The platform allows a graphic view of cases in an interactive way [12].

In its first phase, RNDS allowed the sharing of COVID-19 laboratory test results performed anywhere in the country through services developed according to the HL7 Fast Healthcare Interoperability (FHIR) standards and Logical Observation Identifiers Names and Codes (LOINC) terminology. Nowadays, RNDS is also integrated with the online notification system, allowing interoperability between the reported cases and the results of laboratory tests. In this context, the cases registered in the network receive the test result automatically, and tests performed on individuals who have not yet been informed generate the notification. Interoperability allows digital automation of the process, which used to be carried out manually by Epidemiological Surveillance teams and clinical laboratories. By the end of April 2021, more than 14 million results from COVID-19 tests were sent to RNDS by 153 laboratories [13].

Additionally, the Conecte SUS Portal is being made available, where citizens, health professionals, and managers will be able to access the information that is in the RNDS, with the primary purpose of improving health care, allowing continuity of care. On March 2021, the Conecte SUS application brought new features to facilitate the vaccination process in the country: the Digital Vaccination Card and the National Vaccination Certificate for anyone who is immunized against COVID-19. In this context, for all citizens to access their information, states and municipalities must send information from the Administrated Immunobiological Registry to RNDS. Until April 2021, more than 39 million vaccine registrations were sent to RNDS, and more than 11 million downloads of the mobile application Conecte SUS were made [13].

Brazilian COVID-19 case-control started on March 20, 2021, when the Ministry of Health declared the community transmission stage of COVID-19 and determined mandatory immediate notification (within 24 hours) of all suspected cases - cases of Flu syndrome and severe acute respiratory syndrome (SARS) - for public and private services [14]. There are two types of notification systems: one for mild Flu syndromes, mainly used by basic health units, e-SUS Notifica, and another, used to record hospitalized cases and deaths by SARS, called SIVEP-Gripe.

The notification system - e-SUS Notifica - was exclusively improved to update COVID-19 and receive daily data from each basic health unit in the whole country and private healthcare units. The consolidated accounts are made, and the number of individuals with suspected infection, individuals with the confirmed disease, and deaths is automatically obtained. This total number is updated every day at 7 pm on the Ministry of Health website if everything goes as expected. In practice, the system is fed from a consolidated number. Every day, workers assigned to each function update their unit's data and summarize these numbers that form the consolidated report released by the Ministry. This worker, who is often a physician or a nurse, reconciles assistance with notification. This notification process is already part of the work routine in health services and is governed by Ordinance 204/2016, which lists the diseases and conditions of compulsory notification. What changes from the previous daily process to that of COVID-19 is the time of notification. As it is a public health event and has national and international importance, agility in treating the disease has exponential significance.

In addition to the notification, all patients' information must be recorded in citizens' medical records, preferably in the electronic version (EHR), to enable longitudinal and coordination of care, as well as eventual epidemiological investigation and the subsequent formulation of policies and strategies for prevention. The registration must be made directly by the professional who answered the case and not just by surveillance. Nor should only those cases that are confirmed be entered into the system. The judgment to define a suspected case must be clinical-epidemiological and performed by the healthcare professional. Upon laboratory confirmation and interoperability allowed by the RNDS, the laboratory result is automatically inserted in the notification form.

To make the population aware of the disease caused by the new coronavirus and to assist in the dissemination of information for prevention and guidance, the Ministry of Health launched the Coronavirus-SUS Application, which has the following features: list of the symptoms compatible

with COVID-19, how to prevent it, what to do in case of suspected infection, a map indicating nearby health units, and Ministry of Health official news focused on COVID-19. The application allows the user to assess their health status concerning COVID-19, performs automatic notifications based on health data entered by the user, and offers guidelines and recommendations for the patient.

If necessary, the application directs the patient to a teleconsultation or face-to-face clinical care. The latest application update brought the contact tracing functionality, which generates a warning if the user has physically approached someone who tested positive for the new coronavirus in the previous 14 days. The system depends on the voluntary collaboration of those who tested positive. Still, before generating the alert, this information is confirmed by crossing between the person's examination and the integrated records of the surveillance platform (e-SUS Notifica) and the RNDS. The cell phones of the people who had contact (either acquaintances or random people on the street) anonymous exchange keys via Bluetooth through the application. These keys are stored, and if, in the future, the owners of the key test positive, all the others with whom they had contact will be notified. The application's home page has a red button with the question “Are you feeling bad?", which brings up a list of questions that can help in a self-diagnosis of coronavirus infection. The application was made available to 10 countries, including North Korea, Panama, China, and Argentina, and has already been downloaded by more than 10 million users [15].

One of the strategies developed by the Primary Health Care Secretary, in partnership with DATASUS, was the system of Pre-Clinical Health Care - TeleSUS. In the call center/ teleconsultation model, through four service channels (Application Coronavirus SUS, Whatsapp, Dial 136, and Virtual Assistant on the Ministry of Health Portal), citizens can be evaluated, notified, and receive a medical certificate, if necessary. The channels assist the patients by ChatBot Service, Audible Recognition Unit Service, Pre-clinical Service, and remote monitoring. The TeleSUS initiative aims to promote home isolation of the potentially contaminated population or the risk group (those who do not show signs of severity), avoiding overcrowding in primary health care units. One of the structuring solutions of this system is a robot that makes telephone calls to citizens over 60 years of age to offer guidance, provide systematic follow-up, and, if necessary, refer them to a teleconsultation or face-to-face service. With the integration with RNDS and e-SUS Notifica, the Pre-Clinical Care System allows professionals to generate notifications related to the pandemic, access test results from public and private laboratories, and consult the patient's clinical history through the Conecte SUS platform [16].

Another resource developed by the Ministry of Health, in partnership with the Institutional Development Support Program of the Unified Health System (PROADISUS), offers, through the Tele-UTI Project COVID-19 Brazil, a daily routine/horizontal visit service using telemedicine resources, through which the multidisciplinary teams of great centers advise teams of smaller hospitals by teleconference. A "hot-line" is also available for health professionals to assist in handling severe cases and discussing safety protocols every day, from 7 am to 7 pm.

Challenges and Opportunities

The whole context of health data sharing becomes even stronger amid a pandemic, which requires epidemiological data updated daily for control and decision-making by governments and health systems. The COVID-19 pandemic has demonstrated the importance and usefulness of digital health strategies and has allowed the insertion of these solutions into the health care systems in the long term. However, it is essential to understand that digital health is only in the early stages, not only in Brazil but worldwide [17]. Policymakers are first dealing with the considerable challenge of adapting technology to their domestic health frameworks. Furthermore, each country must consider the diversity and necessity of their population to increase the acceptability of digital technologies in health.

The need for urgency in decision-making implied by the COVID-19 outbreak made Brazil take an important step towards digital health. However, there is still a long way to implement digital solutions in the health area fully. One of the significant challenges for e-Health in Brazil is the computerization of primary care units. For RNDS to be able to share health data, health systems must have access to the Internet and use the EHR. For this, one of the pillars of the Conecte SUS program is Informatiza APS. The Informatiza APS objective is to qualify health data and computerize all Family Health teams - eSF and Primary Health Care teams - eAP in the country. Through the Informatiza APS project, between October 2019 and January 2021, the number of computerized units increased from 55 to 67% [13]. Besides, over 44% of computerized units use EHR systems different from that created by the Ministry of Health (Electronic Citizen Medical Record), generating losses in terms of data interoperability and integration between the different levels of the health system [11]. The main challenge raised by the municipal managers for the advancement of computerization is the scarcity of infrastructure and trained teams to implement the EHR and guarantee data submission through RNDS. In addition, other difficulties were mentioned, such as power fluctuation (peaks and lack), Internet connection (speed oscillation and no provider), public insecurity in units (theft of equipment), insufficiency of equipment, and lack of deployment team [11].

Direct digitization at the point of data collection and automated reporting is not a reality worldwide. When we look at the deaths and cases of COVID-19 reported in the US, for example, the numbers drop substantially every Sunday and Monday, with case numbers rebounding later in the week. This occurs because most countries still collect the data through paper reporting and forms [18]. The use of online notification directly at the point of care integrated with the RNDS allowed the Brazilian government to track COVID-19 more effectively. However, we still have a delay in the correct notification due to the health units that are not computerized and do the notification manually.

In this state of emergency, the Brazilian federal government enacted Law No. 13989 of April 15, 2020, authorizing the use of telemedicine during the pandemic and allowing physicians to care for their patients virtually. In less than four months, TeleSUS made 7.4 million calls. Worldwide, telehealth will enable citizens to have access to adequate and qualified information and represents an important alternative to avoid contagion and facilitate social distancing [19,20]. Telemedicine still faces barriers to its expansion due to the gaps and inequalities in access to ICTs by health facilities and citizens but provided care for non-COVID-19 patients [21]. Clinical trials have demonstrated that teleconsultations resulted in high satisfaction among health care providers and patients, independent of disease progression, with lower costs than traditional visits [22].

For the digital transformation to occur, several points must be discussed, among them the guarantee of equity and universality of access (premises of SUS) and the way of engaging the population, health professionals, and managers. This is because individuals who do not have the necessary knowledge to use the technologies cannot benefit them [23]. Especially in a continental country like Brazil, which has very marked social differences, it is necessary to think about public policies for the insertion of technology in health that do not reinforce social inequality and do not cause the most vulnerable population to get worse outcomes. Crawford & Serhal (2021) proposed a Digital Health Equity Framework to consider the health equity factors. They point out that together with the care along with person-centered care, digital health equity should be incorporated into health provider training and should be supported at the individual, institutional, and social levels [24].

The development and use of apps in the healthcare field is a reality, and the number of mobile applications created has been increasing more and more. They have been implemented for training, information sharing, risk assessment, self-management of symptoms, contact tracing, home monitoring, and decision making. They are considered valuable tools for citizens, health professionals, and decision-makers in facing critical challenges imposed by the pandemic. In a general manner, the applications can help reduce the burden on hospitals, provide access to credible

information, track the symptoms and mental health of individuals, and discover new predictors [25]. However, the security and privacy of the shared data still need to be improved. An analysis of 50 mobile applications developed worldwide during the pandemic indicated that only 16 of them guarantee that users' data will be made anonymous, encrypted, and secured, and also transmitted online and reported only in an aggregated format. These apps continuously collect and process sensitive personally identifiable information, such as health information, location, and direct identifiers. The fear of having their data used in the wrong way could decrease users' adherence to this type of application [26]. The project Conecte SUS implies the circulation of patient data between mobile applications and digital platforms. As the digital health applications are executed in a heterogeneous and decentralized environment, Blockchain technology was adopted at RNDS because it presents itself as the most robust solution in security issues, naturally addressing security, performance, access, and scalability issues. Recent studies have shown the advantages of using blockchain technology to register health data [27,28,29]. The technology guarantees information security and allows a distributed location, maintaining the local access of each health provider to their data and sharing through an interconnected blockchain network between participating organizations [28,30].

To ensure that data will be collected and used safely and transparently, the Brazilian government sentenced the General Data Protection Law (LGPD) on August 16, 2020. The main objective is to make Digital Health an innovative path capable of promoting the service's improvement to the population and the transition and continuity of care through safe and transparent access to the clinical history of the user. The LGPD defines people as the exclusive owners of their data and determines the health data as sensitive data. The use of personal health data by third parties will not be allowed. However, disclosing certain information for the benefit of the community or public health reasons is permitted, without prejudice to the patient's intimacy and privacy, through anonymity. Individual health data can only be accessed by health professionals involved in the case (through the Conecte SUS portal) and with the data owner's prior consent, who must be informed both about the use and who made that use and its purpose.

After the end of the implementation phase, only with COVID-19 data, RNDS will resume its initial strategy, prioritizing establishments that already use the Electronic Citizen Medical Record system and establishments that use the Management Application for University Hospitals. The Electronic Citizen Medical Record is the service that allows the collection of health records. It is available free of charge to City Halls for the management of Primary Health Care. The new version of this service and the RNDS are at an advanced stage in 10 municipalities chosen for this initial phase [31].

The adoption of EHR has become a consolidated technology for storing patient clinical data [32]. This concept has more recently evolved into the idea of Personal Electronic Health Record (PHR). The main difference between traditional RES and PHR is that the latter allows interaction with patients through access to clinical data [33]. It is expected that Conecte SUS be the central point of access to procedures performed in the future. The tool should work as a PHR and allow citizens to monitor their health situation, health professionals to access their patients' tests and clinical history to continue care, and managers to monitor health indicators.

A long way has been taken to facilitate the exchange of health information between different primary care establishments in the country. Strategies that are part of the digital health revolution in Brazil were redirected to mitigate the virus damage. Still, they must resume their purposes when we are in a stable situation. The ethical use of health data through an information platform with high availability, but at the same time safe and accessible, will undoubtedly allow greater participation by society. The emergence of new services, research, and innovation will benefit the population and Brazil.

Conclusion

Brazil has been working to digitally transform the health sector since the Brazilian digital health strategy launch in 2017. The COVID-19 pandemic accelerated this transformation and has brought enormous challenges for decision-makers. The pandemic is a national test of acceptance and the ability of Brazilian citizens to use and engage with digitizing health and communications services. It is still too early to assess Brazil's experience in implementing digital solutions for the entire population; we have a long way to go before reaching digital health due to technological issues and territorial, financial, and ethical issues. IT and health professionals' approach is also fundamental because the digital health revolution will only occur if clinicians embrace this challenge. More research is needed to explore and analyze the pitfalls and the right decisions and define the challenges of this digital experience for the Unified health system, private institutions, and employees and consumers.

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Abbreviations

LGPD: General Data Protection Law
RNDS: National Health Data Network
COVID-19: Coronavirus disease 2019
SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2
WHO: World Health Organization
SUS: Unified Health System
SARS: Severe acute respiratory syndrome
NHS: United Kingdom's National Health Service
DATASUS: IT department from the Brazilian Unified Health System
FHIR: HL7 Fast Healthcare Interoperability (FHIR)
LOINC: Logical Observation Identifiers Names and Codes
PROADISUS: Institutional development support program of the Unified Health System
EHR: Electronic Health Record
PHR: Personal Electronic Health Record

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Supplementary Files

Figures

The digital health strategies deployed in Brazil in response to COVID-19.