Implementing an Electronic Health Record System in the State of Bahia—Partial Results

DIGITAL HEALTH CASE STUDIES

EDITION 01

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ABBREVIATIONS & ACRONYMS

AGH	Hospital Management Application
AGHU	University Hospital Management Application
AGHUse	University Hospital Management Application
CICAN	State Cancer Treatment Center
CADSUS	National Health Card Registry
CREASI	State Geriatric Referral Hospital
DMA	Administrative Modernization Division
EBSERH	Brazilian Hospital Services Enterprise
EHR	Electronic Health Records
FAB	Brazilian Air Force
GAL	Laboratory Environment Administrator
HCPA	Porto Alegre Clinics Hospital
HEOM	Octávio Mangabeira Specialized Hospital
HGC	Camaçari General Hospital
HGE	State General Hospital
HGESF	Ernesto Simões Filho General Hospital
HGRS	Roberto Santos General Hospital
IADB	Inter-American Development Bank
LAC	Latin America and the Caribbean
MAS	Albert Sabin Maternity Hospital
MEC	Ministry of Education
MS	Ministry of Health
MTB	Tsyla Balbino Maternity Hospital
PRODEB	Bahia State Data Processing Enterprise
PROSUS	Universal Health System Strengthening Program
SAEB	Bahia State Administration Secretariat
SESAB	Bahia State Health Secretariat
SIGES	Integrated Health Management System
SUS	Universal Health System
WHO	World Health Organization

EXECUTIVE SUMMARY

More than 62% of the 1.8 million people who live in Salvador, Brazil have no access to medical appointments, testing, vaccinations, rehabilitation, and many other services that the Universal Health System (Portuguese acronym: SUS) is required to provide citizens. It ranks last among Brazil's capitals for coverage of basic care (37.61%).[1] Addressing the administrative and care-related bottlenecks in essential areas of public health has become a top priority for the State of Bahia. The Universal Health System Strengthening Program (Portuguese acronym: PROSUS) has allowed the government to funnel spending into implementing an electronic health record system with online data management capabilities in the region. The scope of this project, implemented by the Bahia State Health Secretariat (Portuguese acronym: SESAB) with investments by the Inter-American Development Bank (IADB), is not merely digital; it impacts how people participate, interact, and do tasks in the work environment and how hospitals are managed.

The technology and data intelligence sector was restructured in 2016, starting with a mapping and acquisition of IT equipment. In August 2018, this step was followed by the implementation of the AGHUse (Aplicativos para Gestão dos Hospitais Universitários) hospital management system, which can record administrative, care, and health sector support processes in an integrated and centralized way. AGHUse is a free and open-source software with a collaborative format developed by the Porto Alegre Clinics Hospital (Portuguese acronym: HCPA). It is already being used by more than 100 health facilities throughout the country, including university, Army, and Navy hospitals.

The purpose of this case study is to examine: (i) how digital tools can redesign social protection and health services; (ii) how the AGHUse system impacts the daily routine of health professionals; (iii) how the digital transformation should align with technological best practice (collaboratively developed software, systems developed in platform format and with a modular structure, digital scalability) to create innovative and integrated information systems, and (iv) what the direct and indirect benefits of EHR systems are—in terms of care, diagnosis, and administrative practices—for the state and, ultimately, for the country's health system.

Because of the plethora of practical difficulties that health establishment managers had to overcome to implement a software as complete as AGHUse in a network as diverse as the one administered by the State of Bahia, this study also identifies the main points of resistance to implementing the project and the solutions the SESAB has found. In particular, it analyzes the needs arising from use of an open-source software that is managed in community format, which requires partners to have a solid structure of implementers, programmers, and technical support staff to take on the training, capacity-building, and adjustments to the system, and to address the difficulties health professionals have in adjusting their work culture to AGHUse's requirements.

As of the end of this case study, the SESAB still did not have enough data for a general and conclusive assessment of the effects of EHR systems in the state. However, it could already be seen that when AGHUse is implemented at facilities, it promotes changes in care standards, revealing weaknesses and proposing hospital management solutions. Under the system, patients have a solid medical history, and physicians have access to their complete medical records, leaving less margin for diagnostic errors. The state, meanwhile, is able to avoid unnecessary expense and can identify essential issues to prioritize for subsequent spending, thus contributing to the quality of public health. Ultimately, implementing EHR saves lives.

[1] Data from the Ministry of Health, November 2018.

This document analyzes the process, still currently underway, of implementing the AGHUse online hospital management system and electronic health record system in Salvador (Brazil) and its metropolitan area as part of the Universal Health System Strengthening Program (PROSUS) implemented by the Bahía State Health Secretariat's (SESAB) in the region. This software developed by the Porto Alegre Clinics Hospital (HCPA) is a crucial tool for redesigning Bahia's health sector.

>> **Main theme:** We analyze the importance of digital transformation in the field of health based on a case study of the ongoing process of implementing the AGHUse software at health centers in Salvador and other municipalities; we cover aspects such as procuring structural equipment and tools and selecting and implementing this free and open-source software with a collaborative format to redesign the State's health sector; we analyze the difficulties of implementing an electronic database of this magnitude; and we review how the SESAB has surmounted these obstacles thus far.

>> **Cross-cutting themes:** We show how digital tools can redesign social protection and health services when they are high quality and used securely and efficiently; how digital transformation should follow technological best practice—collaboratively developed software, systems developed in platform and modular structure format, with digital scalability and following the privacy and security rules established by the state—to build comprehensive, innovative, and integrated information systems. We also highlight the direct and indirect benefits of digital transformation for care, diagnosis, and administrative practices; for the State; and, ultimately, for the country's health system.

>> **Keywords:** Electronic medical file; electronic health record; hospital management; open-source software; e-health; digital health; SUS; PROSUS.

CASE STUDY INTERVIEWEES

Name	Institution	Function
Government of the State of Bahia		
Bahia Health Secretariat (SESAB)		
Maria Tereza de Carvalho Braga	SESAB/PROSUS	Director of PROSUS
Diego Cavalcante Teixeira Daltro *	SESAB/DMA	Director of Administrative Modernization
Manuela Dayse Fadigas Santos*	SESAB/DMA	General Coordinator of Technology, Information and Communication
Suzane Tourinho Fontes da Silva*	SESAB/DMA	Systems Coordinator
Daniele da Silva Homem*	SESAB/DMA	Systems Analyst
Cristiana França Brito	SESAB/HGESF	General Director
Roberto Loyola Monte da Silva	SESAB/HGESF	Coordinator of the Information Technology Center
Almira Aparecida Correia	SESAB/HGESF	Emergency Nursing Coordinator
Flávia de Castro Ribeiro Fidelis	SESAB/HGESF	General Medicine Coordinator
Lauro Campos	SESAB/HGESF	On-Call Emergency Response
Rita de Cássia Silva Santos	SESAB/CER	Director of the Patient Management System
Bahía State Data Processing Enterprise (Portuguese acronym: PRODEB)		
Bruno Eduardo Santos	PRODEB	Technical Coordinator
Ministry of Education (MEC)		
Bahía Federal University - UFBA		
Catharina Soares	ISC**	Researcher
Porto Alegre Clinics Hospital - HCPA		
Valter Ferreira da Silva	HCPA	Chief Information Officer (CIO)
Renato Malvezzi	HCPA	Technical Coordinator of the AGHUse Community
Lúcia Caye	HCPA	Business Analyst
Saulo Chaves de Aquino	HCPA	Support and Relations Supervisor
José Ricardo Guimarães	HCPA	Coordinator of the Strategic Committee for the AGHUse Community

* Members of the DMA's AGHUse Management Committee. Different members are included on the Administrative Committee from each health center in the process of implementing the system.
** Collective Health Institute (UFBA).

1. INTRODUCTION

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1.1. Digital transformation applied to health

One challenge that 21st-century governments face is the digital transformation of public services. In an interconnected world, states need tools for digitizing data and leveraging the full potential of information and communication technology (ICT) to improve efficiency and productivity, bring down operating costs, and better services for the population, especially the most essential services like healthcare.

The challenge is sizable in regions like Latin America and the Caribbean (LAC), where public health systems still have not fully matured or have just recently become a broad right of citizens offered without restrictions to the entire population. An IADB study shows that adverse event rates in health remain high in the region, at around 11% in hospitals and 5% in outpatient services. Most countries in LAC still have no digital strategy for the sector, or have just begun discussing the matter (IADB, 2019, p. 12).

A digital health service, with electronic records of patients' medical history, also known as electronic health records (EHR), can be an important tool for expanding and enhancing health systems' coverage and quality. According to the Pan-American Health Organization (PAHO), these electronic records make it possible to oversee medical care with greater precision and provide a unique opportunity to prevent medical errors (PAHO, 2016, p. 43), as well as to analyze data for the purposes of clinical and epidemiological research on the population. However, medical assistants have proven resistant to change: they work with confidential data (the patient's health) and multiple types of information (diagnostic information, prescriptions, medical exams, etc.) that have to be recorded according to rigorous standards to add value to analyses and research in the field (IADB, 2016, p. 11).

Furthermore, the IADB found that many countries in Latin America still use EHR systems that do not identify patients by their name or identification number. Additionally, many of the systems that should help professionals access patients' medical history and allow knowledge to be exchanged between physicians monitoring a patient operate in isolation, which often leads to duplicated data that is of poor quality for the purposes of a solid analysis of health in the region (IADB, 2019, p. 11).

Therefore, creating new online databases is not enough. Data collection needs to be redesigned to make more effective and accurate use of data and achieve better care for specific patients and positively impact public health management as a whole. Data produced by digital systems should be high-quality, operating whenever possible based on governance of the information generated with business intelligence tools in order to interpret large volumes of data stored by computer systems (see IADB 2020 for a more complete discussion of evidence on, and the benefits of, EHR systems).

In 2018, the World Health Organization (WHO) passed a resolution in defense of the digital transformation, inviting countries to develop technologies to promote universal health coverage and sustainable development. In 2019, the IADB adopted the Principles for Digital Development, in support of technological modernization as applied to health and social protection. These principles are designed to help developers and government agencies use integrated digital best practices for the medical sector. These principles (IADB, 2019, p. 7-9) include incentives for projects that are digitally scalable, with products that can be adjusted and allow new features to be continually added; with security and privacy clauses that can protect users' data and access to information; that use open-source code and follow the highest international standards for interoperability, in order to facilitate data exchanges when necessary.

In 2018, the federal government of Brazil published the "Brazilian Strategy for Digital Transformation," a set of assessments, goals, and actions for implementing digital technologies over the

medium- and long-term for a more efficient and productive state, more competitive and productive businesses, and broader inclusion of citizens.

The electronic health record, or EHR, is one of the cross-cutting actions that can enable data integration and enhance health management, an increasingly essential step in challenging times. According to the WHO, more than 5 billion people worldwide are at risk of having no access to basic health services by 2030, and the sector needs investments of over US$200 billion per year, which would save up to 60 million lives (WHO, 2019). Using resources more efficiently and optimizing health management are crucial actions for expanding the reach of the services offered to the population.

1.2. Public health in Brazil

Brazil is the only country of over 100 million inhabitants in the world that has a universal, public, and free healthcare system (PAIM et al., 2015, p. 49). Created in 1988 with the passage of the Federal Constitution, the Universal Health System (SUS) made health a social right guaranteed by law for all citizens of the country, irrespective of their ability to pay into the system. Furthermore, this step made health a public policy, directly linked to economic and social issues that enhance citizens' quality of life and well-being.

The Constitution establishes that the SUS must ensure the health services' **universality** (service accessible to all citizens, without discriminating by race, class, ethnicity, or gender) **comprehensiveness** (all of citizens' health needs should be addressed), and **fairness** (resources should be prioritized so actions meet the population's most urgent needs) of the health services, and society continually holds the government **accountable** for its spending (DATASUS, 2020). Along with outpatient care, medical consultations, prenatal care, and inpatient care, the SUS is also tasked with carrying out preventive health campaigns like immunizations; organizing awareness campaigns like anti-smoking initiatives; inspecting foods; and registering medications.

The SUS works based on cooperation between the three levels of government (municipal, state, and federal), which do not function hierarchically and each have pre-established responsibilities for managing public health. Decentralized decision-making allows region-specific needs to be addressed in a country with continent-sized differences and dimensions. It also lets municipalities manage and analyze their different political, economic, and health-related realities, with technical cooperation from the states.

Through the SUS, all citizens have a right to consultations, exams, inpatient care, and treatment at the health facilities, whether public or private, engaged by the municipal-, state-, and federal-level public health manager. According to data from the Fundación Oswaldo Cruz, the SUS benefits 190 million Brazilians each year, of whom 145 million depend exclusively on the public health system for health care. The system has more than 2 million healthcare professionals who provide care at approximately 64,000 health facilities throughout the country, completing more than 3.2 million outpatient visits and 453.7 million medical consultations every year (PAIM et al., 2015, p.49).

In such a large system, one of the biggest challenges is exchanging citizens' data between the different facilities that make up the SUS. The data is often centralized at a family's health center, but when someone is referred to a different facility or needs a different service, like a medical test, or needs care at an emergency department, the systems are not integrated or in communication with each other.

Therefore, since 2017, the Brazilian government has prioritized applying ICT to the health sector to join the digital transformation. The aim is to enhance the quality of health care and expand access to it in order to build teams' skills, streamline care, and improve the flow of information—including clinical decision-making, monitoring, regulations, and health promotion—for management decisions (MS, 2017, p. 9).

For the government, there are many visible benefits of digital transformation for patients, healthcare professionals, and public administrators: with an EHR system, citizens are able to access information on their health and prescriptions, and they can more quickly set up appointments or tests; healthcare professionals have a medical overview of patients at their disposal, with relevant information on previous consultations; and managers have online access to the information needed for medical, financial, and administrative decisions in a format that is clear, flexible, and compatible with their role (MS, 2017, p. 10).

To bring about this transformation, it is essential to not only create an EHR system, but also to integrate sector data between different systems—a capability called interoperability—while maintaining the information's privacy and integrity.

1.3. Public health in Bahia

Following the trend and recommendation of international bodies and public policies, the Government of Bahia began the process of digitizing health data as one of the actions taken by PROSUS in the Salvador Metropolitan Area, with resources from IADB and implementation by SESAB.

The aim is to integrate and restructure the healthcare network, from the primary to hospital care level, in Salvador and 13 municipalities in the metropolitan area (Camaçari, Candeias, Dias D'Ávila, Itaparica, Lauro de Freitas, Madre de Deus, Mata de São João, Pojuca, Salvador, São Francisco do Conde, São Sebastião do Passé, Simões Filho, and Vera Cruz). This area has an estimated population of 3,573,973 people, of whom 90% depend on the SUS, particularly the medical services offered in the state's capital.

The Salvador Metropolitan Area is the second most populous in northeastern Brazil and the seventh most populous in the entire country (INSPER, 2020, p. 2). Like the rest of the country, its population is aging, with the consequent increase in chronic, non-communicable diseases like hypertension and diabetes. Restructuring the comprehensive healthcare system helps eliminate bottlenecks in care in priority areas and relieve the high load of cases at secondary and tertiary hospitals in the capital that could often be dealt with at the primary level.

According to Ministry of Health data from November 2018, more than 62% of the population of Salvador, around 1.8 million citizens, has no access to consultations, tests, immunizations, rehabilitation, or many other primary care services. Salvador is therefore ranked last among Brazil's capitals for primary care coverage (37.61%) and second-to-last for family health (27.45%). The capital's health services are overburdened because they provide service to the entire metropolitan area. However, some of these services could be provided by primary care centers, which are the municipal governments' responsibility, without the need to go to secondary and tertiary facilities such as emergency departments or hospitals, which are the state government's responsibility (CO-NASS, 2019).

Also, to avoid hospital emergency room visits, it is essential to bolster the primary care centers and family health centers that are in charge of monitoring patients with chronic diseases, like high blood pressure and diabetes (CONASS 2019), who need frequent tests and medications. Data from the Indicator Centralization System (SISPACTO) shows that 25% of hospital admissions in Salvador could have been prevented by follow-up at the primary care level. The intermediate impact assessment report seems to corroborate CONASS' impression. It states that the Family Health Program's coverage is very low in the Salvador Metropolitan Area compared to coverage in the State of Bahia and other regions in the country (INSPER, 2020, p. 2-3).

Through PROSUS, the Government of the State of Bahia hopes to improve its population's health conditions by focusing on primary care as the gateway to medical services. To achieve this aim, the program focuses its spending on two major areas: infrastructure, to build a range of health establishments—from basic facilities and psychosocial care centers to the Metropolitan Hospital in Lauro de Freitas—and technology, to upgrade and reorganize the sector's IT network and online data management systems.

Digital transformation in Bahia includes procuring hardware and implementing an EHR system for citizens that can enhance both patient care and hospital management in the region. With digitized data, the Secretariat can use tools like business intelligence to survey the population's characteristics, identify public health risks, integrate preventive medicine policies into work at the primary care level, and manage government spending on the sector in a more decisive and targeted way.

In the transformation currently underway, the SESAB chose an open-source software that can be tweaked autonomously instead of needing frequent updates that are costly for the State; that is scalable, to be able to add features and meet growing data processing demands; that is secure enough to protect people's data; and that has the possibility of being inter-operable and integrating with other systems to improve the flow of information. Because it uses cutting-edge equipment, with a hospital management software that is free of charge and scalable and with a server powerful enough to handle large data loads, Bahia can serve as a model and starting point for a new format for managing public health in the country.

1.4. Study methodology

This study presents the main challenges in digital transformation that the Government of Bahia faces. We interviewed 18 professionals for this case study: 11 linked to SESAB, some of whom are project managers and health professionals at the Administrative Modernization Division (Portuguese acronym: DMA), and some of whom work at the IT division at two hospitals in Salvador (Ernesto Simões Filho General Hospital and Camaçari General Hospital); 1 representative of the Bahia State Data Processing Enterprise (PRODEB); 1 researcher and professor at the Bahía Federal University; and 5 professionals from HCPA directly involved with managing AGHUse, the hospital management software, selected by the Government of Bahia to be implemented in the state health network.

Due to the coronavirus health emergency, there were no field visits to Salvador or Porto Alegre. All interviews were performed remotely, via Skype, in two data collection stages for the study. Most of them took place in the first half of 2020, in March and April, and the rest in September of the same year. Some of the interviewees were consulted more than once, by Skype or by email, during the process.

The analysis and results presented here are partial, since the software is still in the process of being implemented at 23 health facilities in Salvador and its metropolitan area.

1.5 Overview of the AGHUse software

Since 2016, the Government of Bahia has invested in restructuring the technology and IT aspects of the health system. The State Health Secretariat's proposal is to make the department 100% digital and to set a national benchmark from online data monitoring. It began by mapping and procuring IT equipment (computers, printers, servers) and software for structural tools, and it then selected a hospital management software that can record administrative, care, and health sector support processes in an integrated and centralized way.

The DMA managers in charge of overseeing ICT at the Bahía Health Department set out to explore the options for EHR systems and hospital management systems on the market. The products they considered included a software from a well-known private sector firm that has been a benchmark for digital health's management solutions in the country. However, they did not choose this product because it was very costly[2]. Another option SESAB considered was a software developed by a state government agency that included medical records; appointment, test, and procedure follow-ups; and inventory control and drug dispensation. The system would have been delivered free of charge, but the negotiations did not move forward, making the partnership inviable.[3]

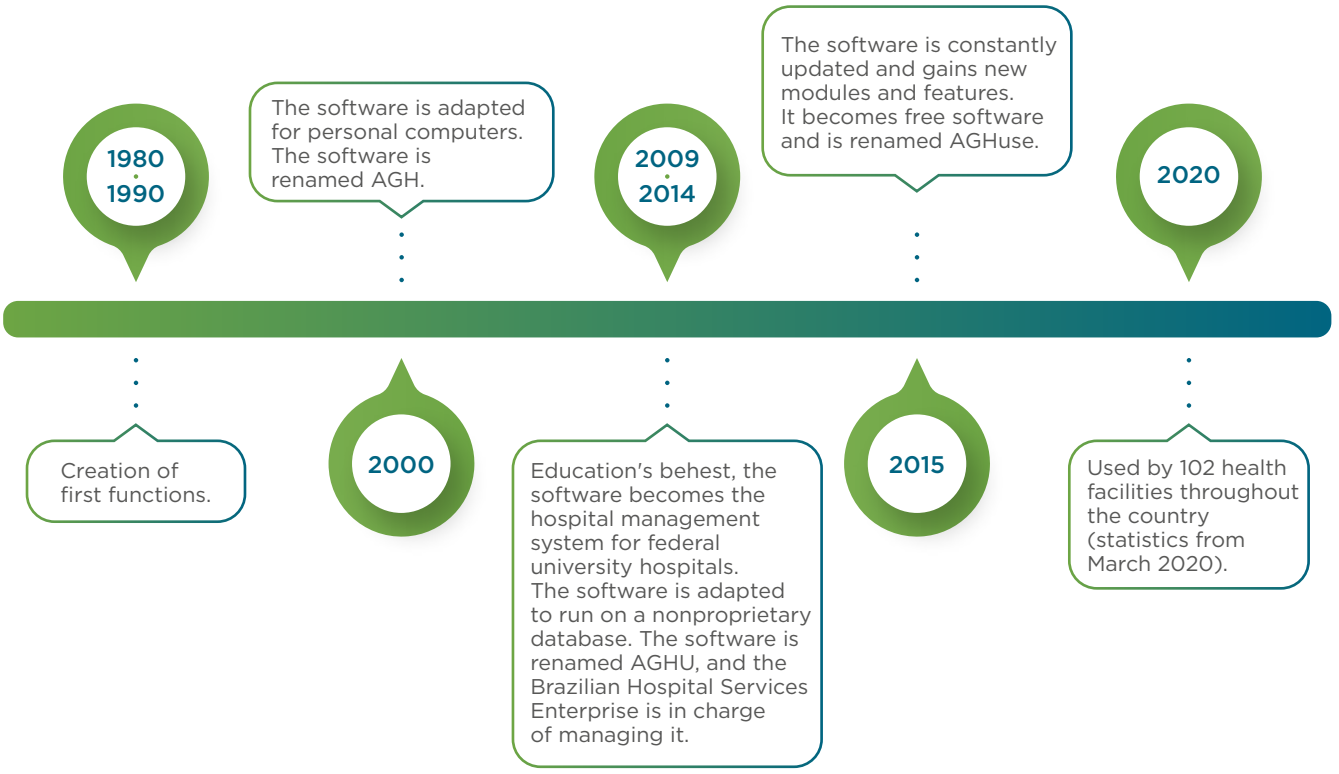
In 2018, the SESAB discovered AGHUse at a talk at an international conference. The software was one of HCPA's initiatives to meet the organization's medical, hospital, and administrative needs, one of countless transformations and upgrades it has put in place over its four-decade history. As a public institution that is a member of the Ministry of Education's network of university hospitals that participate in the SUS, the HCPA is the only hospital in the country that has operated since its inception as a public enterprise subject to private law. It stands out for the quality of its hospital management.

The first features of the system were developed in the 1980s and 1990s for massive computers. At the turn of the millennium, the system underwent its first major technological shift to client format, running on personal computers. Its name changed to AGH (*Aplicativos de Gestão Hospitalar*—Application for Hospital Management). In 2009, HCPA was invited by the Ministry of Education to bring its model for managing technological innovation to other university hospitals in the country. The HCPA then moved the application to a non-proprietary data base, that is, one developed at no cost with the purchase of use licenses. This marked the birth of AGHU (*Aplicativos para Gestão dos Hospitais Universitários*—Application for University Hospital Management), which in 2014 became exclusively administrated by the Brazilian Hospital

[2] Apart from monthly fees for maintaining and upgrading the system, the cost of the license to use the software alone would be around 50 times more than what the SESAB spent to hire consultants and train people to use the AGHUse software.

[3] Political differences may have affected negotiations and made the partnership inviable.

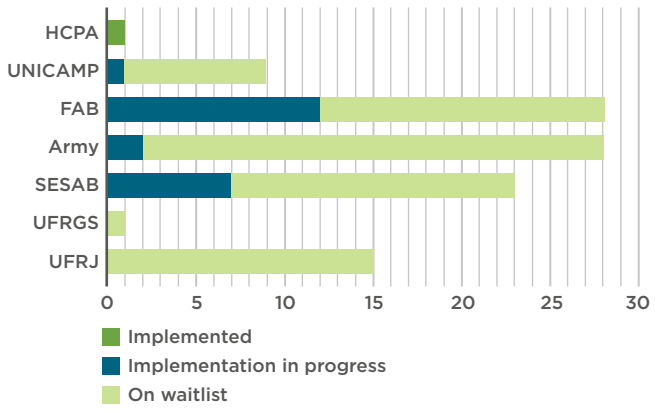
FIGURE 1:
History of AGHUse. Timeline based on interviews with the Board of Directors and online surveys



Services Enterprise (Portuguese acronym: EBSERH) linked to the federal government. At the same time, and with the know-how it acquired in designing for university hospitals, the HCPA continued developing new models and features for the software and added the verb "use" to the name AGHU. This is how AGHUse came to be. This software, which is free and collaboratively developed, is a complete and accessible solution for computerized health management that was developed from the ground up with active participation by health professionals (See Figure 1).

In its 11th iteration, the application has 30 administrative and care modules being used at more than 100 health centers around the country, including university, army, and Brazilian Air Force hospitals (see Figure 2).

FIGURE 2:
Project for Implementing AGHUse at Hospitals (currently 102 hospitals) March 2020



Source: HCPA.

In Bahia, the aim was to implement the system at 23 facilities in the state's direct health network by 2020[4]. After verifying how the system works on-site, decision-makers identified several attributes that were decisive in their decision to choose the system: it is a software with a free use license developed by a team of professionals attuned to the Hospital's priorities and needs and to the requirement to constantly update the system.

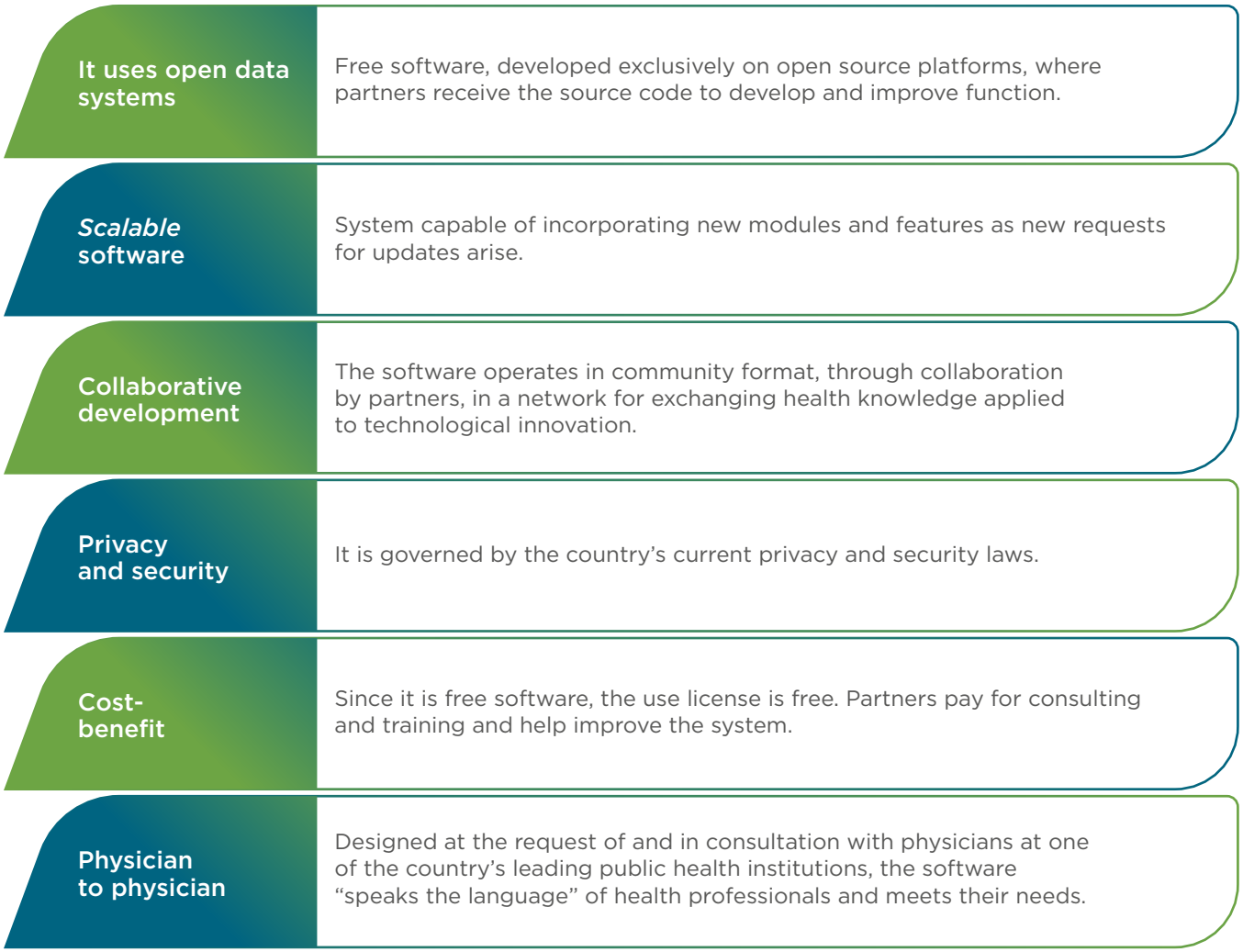
Since the software is exclusively produced on a free, open-source, and scalable software platform, partners that use the system receive the source code for all available modules and work as a community, sharing requests and developing new modules and features to continuously improve a single version of the system. Under this format, partners only pay for the consulting provided by HCPA to explain the software,

identify technical requirements that must be in place to support the system, and help collect data to configure each available module, in addition to relying on professionals from Rio Grande do Sul to train and certify teams that procure the service. There is therefore no product use license free and no monthly maintenance and technical support fees, making the software a financially affordable option.

With AGHUse, all EHR and hospital management information can be centralized in a single software program available to the entire state network, facilitating the exchange of information and strategic planning. Indicators like bed turnover rate, occupancy rate and transfer rate, in addition to procurement, inventory, and invoice control, are all available in a single system, which helps the State Health Secretariat analyze data and do strategic planning. Physicians can also see the transformation: they now have access to better structured information on each patient and to the record of prior prescriptions and medical tests that have already been conducted. For health facility managers, the software breaks down the flow of operations at the hospital, and citizens receive a more decisive service with fewer lines or wait times for scheduling tests and appointments. In short, the software can be a very valuable tool to public health, with benefits for citizens and public finances (see Figure 3 for a summary of what sets AGHUse apart).

[4] The original goal was to finish implementing the software in December 2020. Due to the coronavirus health emergency, the target was revised to 2022.

FIGURE 3:
AGHUse: Differentiating factors



Source: Prepared by the authors based on interviews with the HCPA and supporting materials.

AGHUse can only be accessed through the networks of government systems, from health establishments administered by the State, and with access permissions levels set specifically for each department. In outpatient care, for instance, physicians can only access the medical care part of the system, begin care, and complete the medical history if they are in their office. The system blocks them from accessing it from the facility's reception area, for example. A patient's health records are not available to all physicians at the health center. Rather, there are different levels of blocking and specific permissions to ensure the system's security. The software has a firewall system to prevent hacker attacks and adheres to all security, access, and restriction policies required under the Federal General Data Protection Law. It also follows the HL7 communication standard recommended for health systems aiming to be inter-operable.

The HCPA's task is to offer training on each of the modules used and manage the software's development, screening requests received from partners and only adding features or updates that could be needed by the entire community to the system. If a request to modify the system is only useful for one health facility or network, the adjustment will be configured as a parameter that can be toggled on or off to meet that local need.

Under the HCPA's business model, the software is implemented vertically, with all modules brought on gradually, at a single pilot facility, to then be

replicated by the same partner at all other health facilities under its administration. The HCPA also suggests the order in which modules should be implemented and sends a team of professionals to provide training and monitor each stage of the process on site.

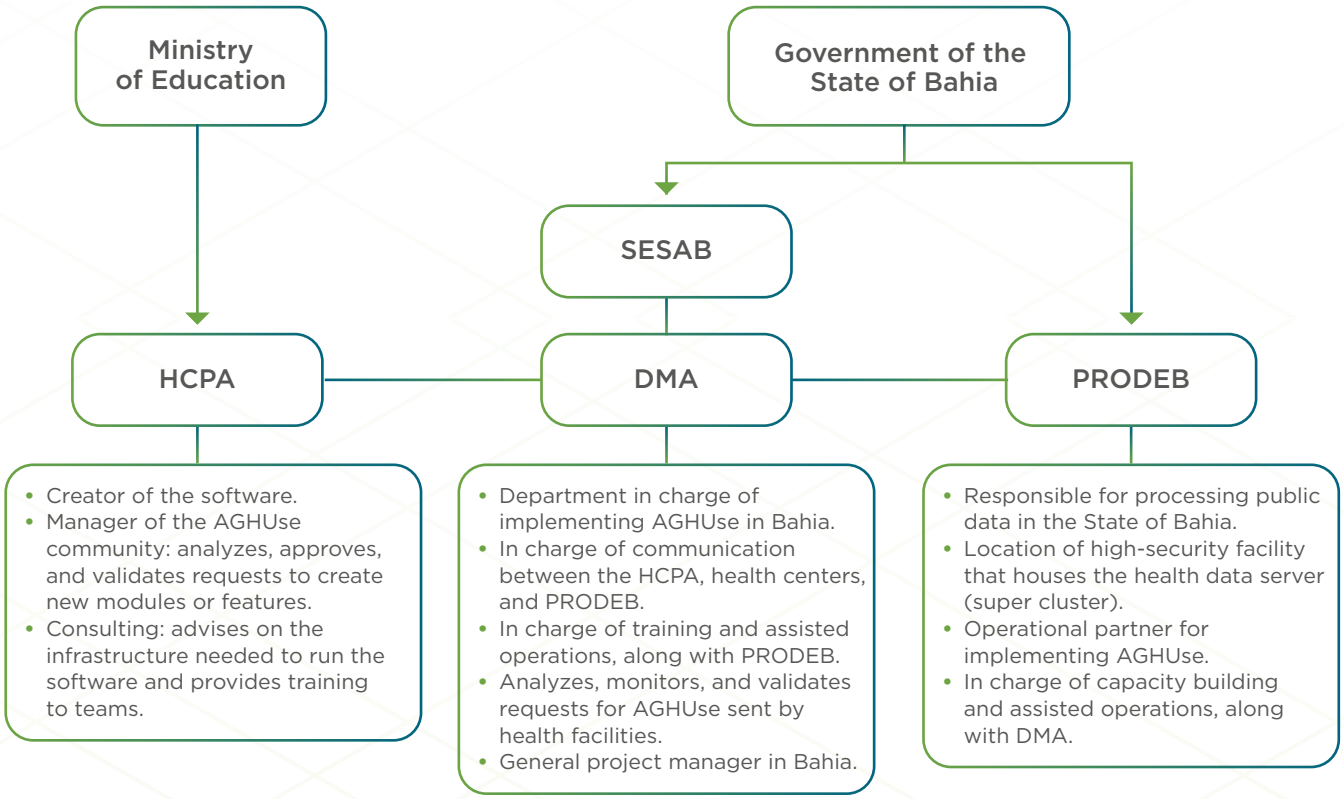
The first meetings to explain the software and train the Bahia team took place in August 2018 in a workspace developed by HCPA in Porto Alegre. A SAEB team, represented by officials from the DMA, and another team from PRODEB, the project's operational partner, went to the state capital to learn about how the system works and begin preparing for the first three modules: Staff, Patient, and Outpatient. They came with the task of configuring and setting the parameters for the registration data for Bahia's reality—staff registered with usernames and passwords; care and consultation rosters, and the first group of patients to receive care, readying the system to be launched in November. Implementation was started with in-person oversight by professionals from the HCPA at the Hospital General Roberto Santos, the facility initially chosen by SESAB for the pilot implementation of AGHUse.

An administrative committee was created to monitor the software's implementation. The DMA, which is the department responsible for ICT management at SESAB, along with the Health Sub-Secretariat and the Director of Administrative Modernization, currently lead the initiative. The General Coordinator of Technology, Information, and Communication, as well as the Systems Coordinator, also participate as project heads, with support from the systems analyst and the product owners, who are responsible for monitoring the project at the facilities. The DMA's technical advisors and IT and network infrastructure analysts also help make the software a reality. Those tasked with carrying out the process at the hospitals form working groups of 5 to 6 professionals per facility. These groups can include IT coordinators, the hospital's general director, physicians, nurses, and technicians from each area involved in the implementation. Figure 4 details the actors and roles involved in managing the system.

From PRODEB, technicians, implementers, and system programmers participate. PRODEB, as official state partner for meeting public data processing needs the region, is in charge of identifying possible errors and suggesting improvements, uploading data, and setting up the system's initial configuration for each module and facility. It also develops new features and holds trainings and performs assisted operations in partnership with the DMA team. Its high-security facility, the largest in the North/North Eastern region and the third-largest in the country among state ICT enterprises, houses the super cluster, a server acquired to store the high load of data generated by AGHUse.

Rather than seeing it as an operating system, AGHUse should be considered a model for hospital management and routine medical care for the health facilities that use it. Since it was designed by and for the HCPA, the system drives structural changes in the performance of medical teams, establishes a new flow in hospital routines, and holds patient care to information and quality standards. The challenge is thus not limited to technology departments and requires the participation of the entire health facility. *

FIGURE 4:
Actor profiles and assignments



2. PRINCIPAL CHALLENGES

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It take many steps to use an EHR and hospital management system in a public health network. In addition to the difficulties inherent to implementing the software, it is necessary to identify the technological upgrades needed for the system to function, have a clear understanding of the best method for bringing it to all health facilities, and prepare for resistance to using the program from the team.

Physical and technological infrastructure: At the SESAB, the challenges began before choosing and implementing the software. In 2016, there were 8000 fewer computers than needed to support the professionals of the Bahia State Health Secretariat. Fewer than 30 IT professionals had to meet the needs of health facilities located throughout the state of Bahia. These professionals were still seen as simply support for day-to-day technological problems rather than a strategic and core area for managing the sector's data.

As the entity in charge of meeting the Bahia State Health Secretariat's technological needs, the DMA had to start restructuring itself from within, setting up a new organizational framework with tasks and teams grouped by segmented areas, such as support, infrastructure, systems development, and planning. AGHUse hired a dedicated project owner (PO) and a support team of four employees to assist her.

However, even two years after launching the project, there was still a shortage of personnel to continue with the implementations. The DMA has already requested that new professionals be hired (systems analysts, programmers, and implementers) to bolster the AGHUse support team. Some of these professionals would work at the division's main office, and others would work at health facilities as IT support, working in shifts, to better meet hospitals' needs around the clock[5].

At the health centers, the lack of technological infrastructure and an integrated hospital management solution meant different provisional measures had to be taken to systematize data. At some hospitals, data was still calculated by hand, in paper files, or, at best, on Excel sheets and in Word formulas formatted by health professionals themselves. At other hospitals, different systems that were sometimes developed by hospital employees with more technological skills did not account for the complexity of the data needed to manage hospitals and were used in a limited way by the team.

At the recommendation of the IADB, the project's sponsor and consultant, an investment was made in cutting-edge equipment able to withstand high-volume data flows over long periods of time. The department's technological structure was completely redesigned. This involved overhauling hardware — computers and printers –; installing fiber-optic cables and establishing network nodes at health centers or engaging web providers with digital signal that all professionals could access; and procuring a latest generation server that is better than the average one used on the market—a super cluster capable of storing information from different programs and health centers simultaneously. These steps give the SESAB the tools it needs to survey health data in the state and, subsequently and if necessary, integrate it with the municipal and federal levels, making it a model for the rest of the country to follow.

The SESAB also lacked the physical infrastructure to support this technological revolution. To house the new format for health data planning and management, the Integrated Health Command and Control Center for the State of Bahia was built. This three-story, 25,000 square foot building holds the State Patient Management System, an enterprise funded by PROSUS with IADB resources.

This building, constructed next to the State Health Secretariat building, also houses the Intelligence Center, known as the Situation Room, which was built to the highest international quality standards. This facility allows people to monitor the health situation in the state of Bahia in real time, uniting

[5] As of the completion of this report, the DMA was waiting to clear the final bureaucratic hurdles for hiring new professionals. Without reinforcements for the team, the timeline for implementing AGHUse in the region could be compromised.

data from surveillance, specialized care, and primary care in a single space. Launched on the eve of the COVID-19 pandemic lockdown, the room has become a pillar of efforts to track the disease. Business intelligence data provides a daily snapshot of the disease in the state, which is available on electronic panels that can be consulted and analyzed by the state's health team.

Patient Management System and Situation Room.
Source: ASCOM (Asesoría de Comunicación) / Sesab.

Human resources and change management: In addition to structural and technological considerations, the human dimension is key. In front of every computer used is a professional who commits to systematizing data, sharing information, and contributing to a system that, to function in a comprehensive way, needs data on care for customers, tests, prescriptions, pharmacy, etc. Health professionals' commitment to the project of implementing the software is thus crucial to its success. However, high staff turnover on health teams, which are organized by shifts and with outsourced contracts that mean many professionals work just once a week at the facility, as well as excessive workloads on the front lines in hospitals that are frequently overwhelmed with patients, often result in dysfunction. The challenge is immense and requires training very diverse teams with different backgrounds at multiple facilities—all at the same time.

To further exacerbate matters, many physicians have very full schedules and no time for training on how to use the software. Meanwhile, nurses are often overwhelmed and overworked at the hospital, and they are then asked to add yet another task into their routine. Another difficulty is the hierarchical work model where physicians act autonomously in their appointments and are not used to sharing information on their patients over a network. All of these factors heighten the challenge, and they are compounded by the resistance of many to working online after years of prescribing treatments on paper and their reluctance to be subject to colleagues' verification, creating a flow of information where incorrect details could compromise a team's performance. How can teams with these characteristics be convinced to migrate to working in a fully digital way?

According to DMA professionals, getting teams to commit to the project and the shift in work culture were the greatest challenges in the process of implementing the software in Bahia. It took many meetings to understand the demands of each sector and separate out individual desires or resistance to technological changes in order to achieve a list of requests that would effectively benefit the entire community and that were worth incorporating into the software. Ultimately, AGHUse is a collaborative software that serves the medical community in different parts of the country, and changes are only added to the system if they meet the needs of the group, with final approval from HCPA as the entity in charge of the software and of managing the AGHUse community.

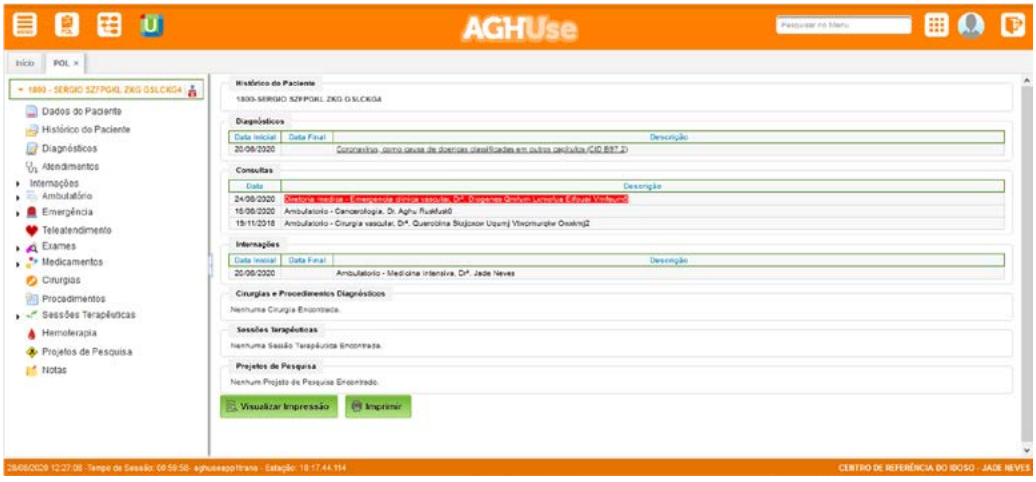
According to the DMA, most requests are mingled with resistance to a workflow alien to the way health professionals normally go about their daily work. To persuade them to use a digital system more open to checks from directors or other department colleagues, SESAB had to seek legal counsel and hold additional conversations with the HCPA team to assure Bahia's health professionals of the security of a key software for managing daily tasks at the hospital. To strengthen the commitment to security for physicians and patients, SESAB requested that an extra field be created within AGHUse: in addition to the initial password, health professionals will also have a digital

certificate to protect them. While the SESAB approves a provider to produce tokens for physicians in the state, the AGHUse community is working to develop a new field for the software.

Meanwhile, and in line with the SUS's decentralized business model, the health facilities in the State of Bahia do not have a systematized or planned workflow to share with the technological team. Most tasks are done autonomously, with no continuity between shifts and no equivalence between hospitals. The software compels a change in work routines, standardizing how tasks are done from one professional to another, and even from one health center to another. It drives systematization of work flows in a continual process of improving the facility and public health in general. SESAB's experience shows that the senior management's participation at each health facility is key to the implementation's progress. The team can only be brought on board with a cultural shift of this magnitude if the hospital's management understands and supports it.

Four screenshots of AGHUse's work environment:
11) Workspace; 2) electronic health record; 3) emergency; 4) inpatient.

(1)



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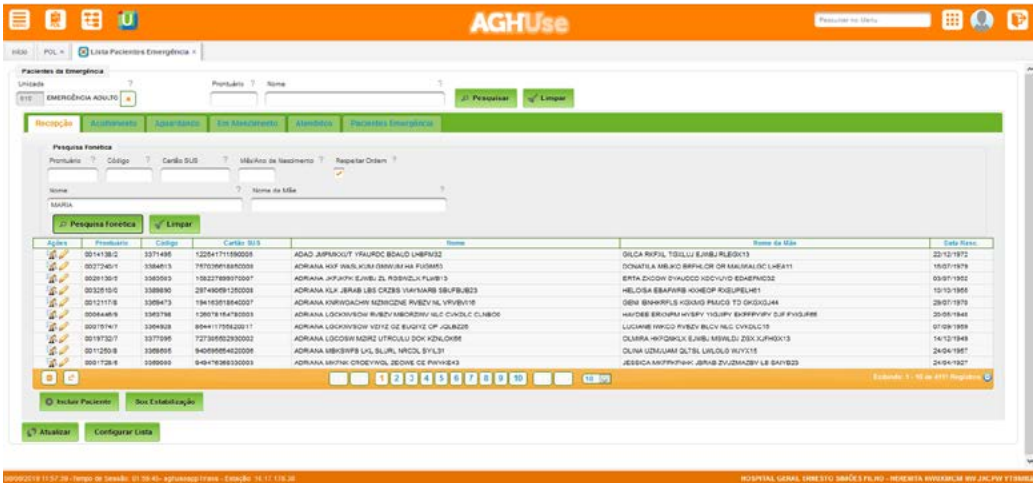

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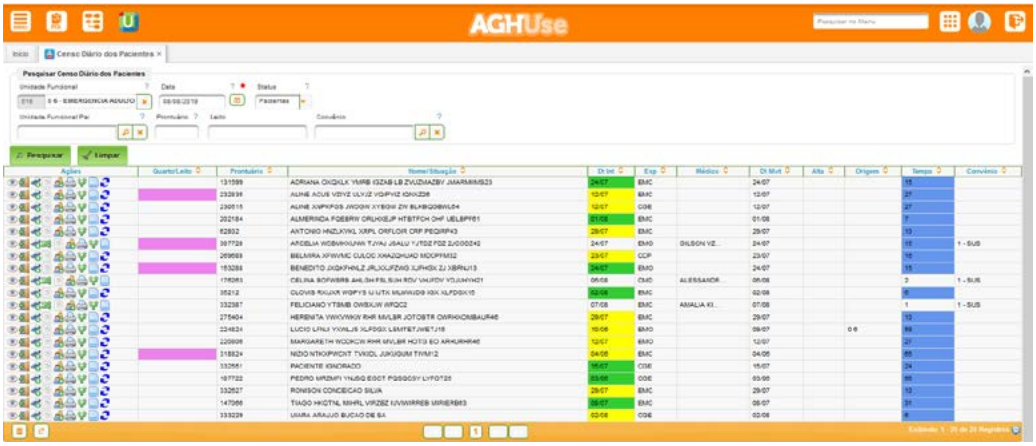
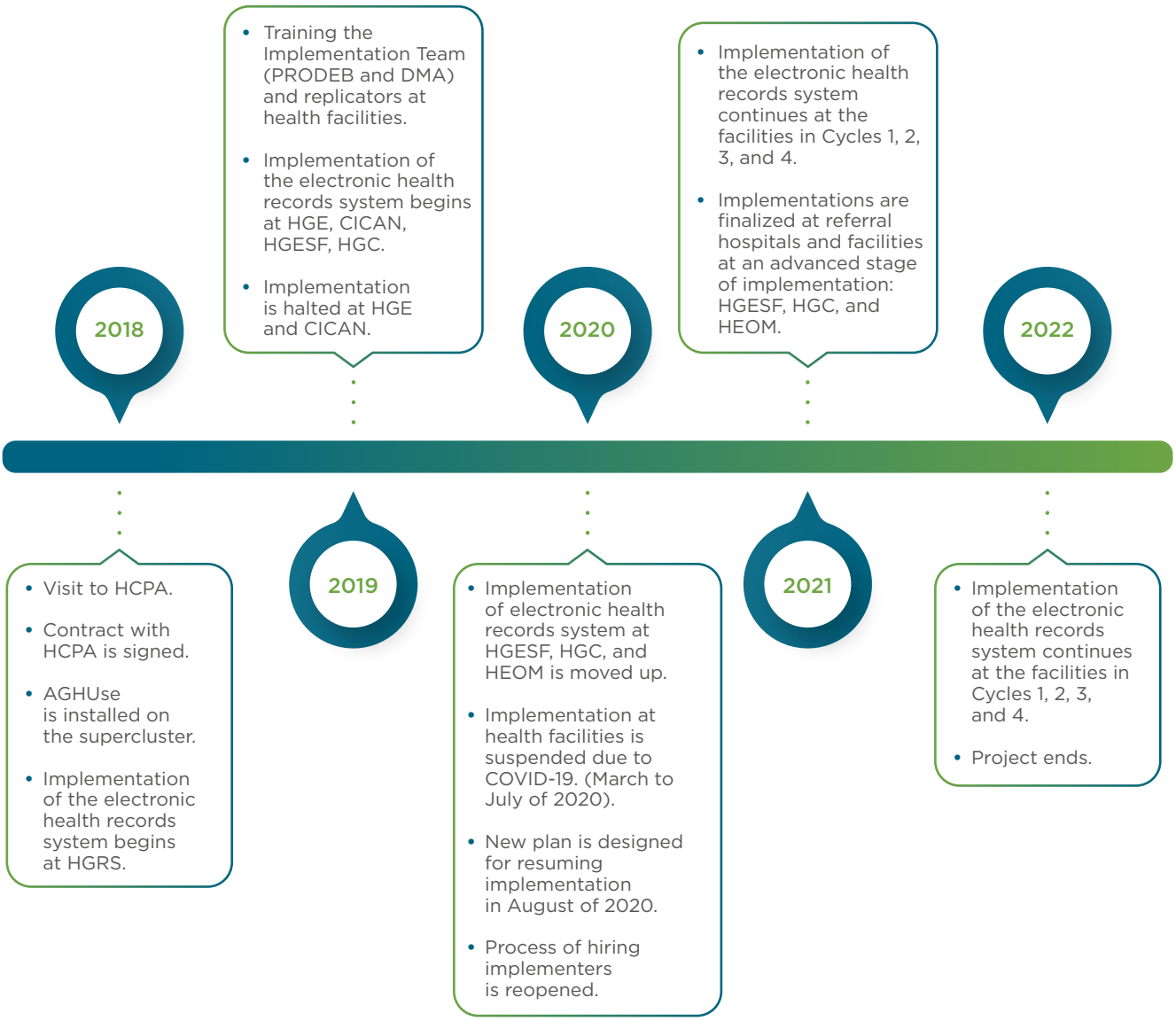


(4)

Original implementation decisions: In Bahia, implementation began in August 2018 at the Hospital General Roberto Santos. This hospital, chosen as the project's pilot facility, is the largest in the region's public network, with 640 beds and services for highly complex cases. However, its size adversely affected the implementation plans and DMA's own goal. With more than 800 professionals providing outpatient services alone, serving a population of more than 67,000 people, the hospital ended up being excessively complex. It took the IT team more than six months of work to finish implementing the first module, the Staff module, which provides a general registry of the facility's employees, and this module is not considered one of the most complex, compared to the Emergency or Inpatient modules, which involve training more professionals and a significant number of critical everyday situations that have to be managed. To put this amount of time into perspective, the Staff module was implemented in a single month at the Camaçari and Hospital Ernesto Simões hospitals.

The complexity and size of the hospital chosen for the pilot implementation of AGHUse led DMA to change its method for implementing the software in the state. Instead of focusing its efforts on a single hospital, as originally planned, from January 2019 onward it has been implementing the software at multiple facilities simultaneously to streamline the project's completion and expansion. Since then, the AGHUse implementation has been taking place in four cycles at eight facilities in the region. Figure 5 shows the actual and planned timeline for implementing the system in Bahia's public health network.

FIGURE 5:
History of the AGHUse project in Bahia's public health network



HCPA: Porto Alegre Clinics Hospital; PRODEB: Bahia State Data Processing Enterprise; DMA: Administrative Modernization Division; HGE: General State Hospital; CICAN: State Cancer Treatment Center; HGESF: Ernesto Simões Filho General Hospital; HGC: Camaçari General Hospital; HEOM: Octávio Mangabeira Specialized Hospital.

Source: DMA/SESAB.

Adapting to the multi-company format: Since the HCPA operates under centralized management and is integrated into a single hospital complex, it did not have to think about developing a multi-enterprise software with modules that can function simultaneously at different health facilities, but with restricted access to certain information in the system. The profile and format of HCPA's work is therefore very different from how the SUS's integrated network operates. In this network, each facility in the system—in the country or in Bahia—is self-managed, has its own pharmacy rules and inventory, and even has different doses for medications, for example. The DMA therefore made it a priority to adapt the EHR system's modules to multi-enterprise format, so all the software's features could be used simultaneously by different health facilities without each hospital modifying the partner's data.

Modules like User Registry, Emergencies, Outpatient, and Inpatient are already set up in this way, with shared information and restricted modification, and they have been implemented or are being implemented, as mentioned above, at eight hospitals in the state. But other equally important modules, like the Supplies module—which includes Procurement, Inventory, and Pharmacy—and all other modules for administrative tasks, need to be adapted to the multi-enterprise format because they can still be operated freely and without restrictions by users at multiple independent facilities, making it inviable to implement them in a network with decentralized management like Bahia's.

Within the AGHUse community, the Brazilian Air Force (Portuguese acronym: FAB) is the partner responsible for adding multi-enterprise functionality to all software modules. The FAB has a technology center and a team of more than 30 software development professionals—a veritable software factory for developing features and systems—that provided support and structure to implement modules as adjustments are made, guaranteeing a quick and high-quality implementation. Additionally, unlike Bahia, the FAB medication inventory and product procurement is centralized under a single management. The Supplies module already works for a single unit, providing service to the entire network, so for them, changing the Supplies module to multi-enterprise format is neither necessary nor a priority.

Given the task's complexity, and since specialized technological support is a bottleneck, the DMA decided to look for a solution to PRODEB's additional needs. For this reason, Extreme Digital Solutions has been tasked with the multi-enterprise adjustment. This company had already been hired by the DMA to carry out other highly complex projects for the Health Secretariat, such as the business intelligence indicators and the IT service bus.

Data interoperability: Perhaps the greatest challenge is integrating the different health databases. With more than 170 software programs in operation at the SESAB alone, including everything from systems to record deaths during Carnival season to systems designed solely to record vaccination campaigns, the DMA currently manages an enormous and valuable data archive that cannot be discarded but that also does not need to be kept in such specific systems that are so incompatible with networked information. There are very small and specific programs that can be discontinued without detriment to health management in the State, and the data from others can be incorporated into AGHUse, making EHR a central repository of information for hospital management in the region. Most health facilities use internal control systems, like supplies and medications. Some still compute their data in Excel or in out-of-date software programs, and these can be absorbed by the administrative management modules offered by AGHUse. Based on SESAB's original assessment, an average of four software programs per facility will be discontinued. At other less technologically equipped facilities, only one or two systems and some Excel sheets will be dropped.

There are also applications that will be integrated with AGHUse via buses, with connectors between systems. These include CADSUS (National Health Card Registry), SUREM (Emergency and Urgent Care Regulation System) and SIGES, an EHR system used at State polyclinics. SIGES was provided by the government of the State of Ceara and is smaller than AGHUse in terms of scope and complexity. It was procured when various polyclinics were opened, before the system developed by the hospital in Rio Grande do Sol was chosen to begin operating in Bahia. SIGES contains a large volume of information on medical tests that are very useful when patients are admitted to secondary or tertiary hospitals.

It is therefore a priority among the electronic corridors the DMA will implement in the state. The matter of data interoperability in the State of Bahia is the responsibility of a private company hired by the state. The data corridor will follow the HL7

standard for exchanging medical and administrative data between hospital management software programs.

Another data corridor that is key to health management extends beyond Bahia's borders and would bring benefits to the entire country. States and municipality use hundreds of interconnection corridors with the Ministry of Health. Each one uses a specific software program and requires buses for communication with the federal level, feeding a centralized health database for the entire country. The SUS's IT department, the DATASUS, currently receives information on the facilities in the state's health network from the SESAB. But it also needs to include data from the health network administered by municipalities in its reports. The data from this exchange is inconsistent. When a patient is admitted to secondary or tertiary hospital, states do not receive enough data from municipalities to trace the patient's pathway from primary care. Furthermore, the data provided often does not match up to the report that the municipality later sends directly to federal bodies.

SESAB wants to create a triangular structure for accessing health data: the municipalities and states would create buses in their many hospital administration programs to feed into the DATASUS, and the states would be able to access municipal data directly from the federal government database, thus avoiding inconsistent information and dependence on municipalities. With cutting-edge equipment, an EHR system that consolidates the state's health information, and a server powerful enough to perform the busing of data with the Ministry of Health, Bahia has set up a technological structure solid enough to allow health data to be integrated within the region, if necessary.

The first steps towards data interoperability have already been taken during the COVID-19 pandemic: the SESAB automatically receives daily municipal data directly from the federal government, without having to manually consolidate numbers in an Excel spreadsheet. The data corridor included connections to some ministry software programs, such as E-SUS, which collects municipal data; GAL, the Laboratory Systems Manager that each state in the country has and that provides COVID-19 test results; and Sivep-gripe, a software program that compiles epidemiological data on cases of Severe Acute Respiratory Syndrome (SARS). SESAB has even created a simple but functional platform where people can consult their own tests results online, without having to go back to the health facility to get them. Additionally, hospitals that have implemented AGHUse, even partially, also capture data from patients who enter the facility with suspected or confirmed cases of COVID, and AGHUse has created a specific form for collecting information on the pandemic.

The Secretariat was thus able to access COVID-19 data shared by Bahia's municipalities through E-SUS and by the laboratory assisting the state, in addition to that collected through AGHUse. Unlike other regions of the country that performed verifications manually, counting up numbers on an Excel spreadsheet, Bahia was able to access the data automatically by integrating systems. The results are published daily on the government website: https://bi.saude.ba.gov.br/transparencia/.

This experience paves the way for potential data interoperability between the three levels of government, the scope of which could be even broader when AGHUse is fully implemented at the health facilities in the State of Bahia.

OBSTACLES TO IMPLEMENTING OPEN-SOURCE SOFTWARE

Paradoxically, AGHUse's chief advantages often contain its greatest challenges: since the software is free and open-source, scalable, and functions in community format, each partner has to contribute to improving the system, developing solutions for the needs that arise as it is implemented. The contract even establishes an annual goal each partner has to meet, which is to contribute 5% of software changes or improvements, whether for their own needs or those of other partners.

To continually improve AGHUse, partners have to invest in a solid team of IT professionals and continually update a living software, contributing to a unique and cutting-edge system. Meanwhile, the HCPA, like the conductor of a large orchestra, ensures the relevance and unity of the project.

Synchronizing changes can jeopardize the implementation schedule: When a partner requests that structural changes be made to the system or that new functions be created, a set of protocols have to be followed, which can jeopardize the system's implementation schedule. Modifications are only applied after consulting with the community and receiving both its approval and, subsequently, that of the HCPA. Even when another partner is already developing a solution to a request, there is no guarantee that the pace or deadline for producing the feature will work for the other partners in the community. Therefore, the community format cannot be exclusively relied on to solve structural problems with the software. It is essential to have an internal team of support professionals to both make sure the project moves forward quickly and meet the annual target of 5% of technical contributions to the system.

Undersized team: The main bottleneck for the Bahia project is the lack of professionals to implement or develop AGHUse in the state. In terms of development, each partner works to address the needs of its own network, as well as those of the AGHUse community. As of August 2020, the average developments contributed by the DMA—including corrective measures and implementing new modules—amounted to 3%, well short of the 5% required by the contract.

As the entity responsible for corrective and software developments in Bahia, PRODEB felt the pressure of running a highly complex system with a meager team of professionals assigned to the project: only nine employees, including developers, programmers, the scrum master, and the project manager. To streamline the process and meet the contractual goals, the DMA contracted out part of the requirements to another partner (in this case, a private company that was responsible for the business intelligence indicators and also developed the service interconnections and converted modules to multi-enterprise format) and requested that additional programmers be hired to work with PRODEB on the AGHUse project.

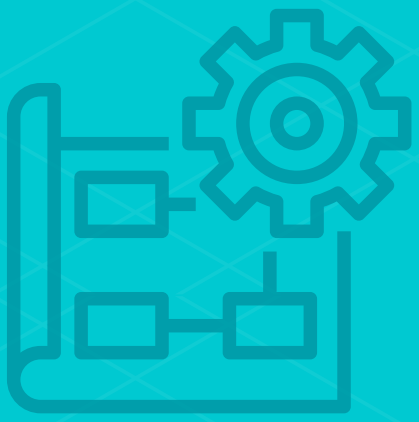
There is also a shortage of implementers, which became exponentially more severe when the implementation expanded from the pilot facility to multiple health centers simultaneously. The DMA currently is awaiting the hiring of an additional team to work at the 23 facilities of the direct network (fully administered and managed by the state) to make sure the AGHUse implementation timeline is met.

The challenge of expansion: In Bahia, the EHR system has to serve an entire health network made up of highly complex hospitals, maternity hospitals, emergency and 24-hour centers, referral hospitals, and facilities ranging from burn clinics to geriatric health establishments. To encompass such diversity, the software needs adjustments, like creating specific fillable fields or even entire modules, as well as changing the order of implementation to prioritize a facility's specialty.

Even though it is a solid software program requiring detailed data in all available modules of the system, AGHUse was not designed to serve an entire medical care network, in all its diversity and complexity. For example, the EHR system is not designed for the highly specific information required for the workflow at the State Geriatric Referral Hospital (Portuguese acronym: CREASI). The module for older people was supposed to be produced by CREASI itself, in partnership with programmers provided by the Bahia Federal University. However, the partnership with the university was suspended due to the coronavirus pandemic, and the request is back with the DMA, which is pushing for authorization to hire programmers and develop the module itself.

There is also no module for maternal health or oncology in the free software developed by HCPA. Although the maternal module has already been developed, it is still being validated by AGHUse committee members, and before being implemented at Bahia health establishments, it has to be migrated to multi-enterprise format. As soon as the HCPA clears it to do so, the DMA will implement it at a maternity hospital in Salvador, to then replicate it at other facilities.

As for cancer treatment, the State Cancer Treatment Center (CICAN) is currently using an EHR system called Smart that already meets its immediate needs. The CICAN annually renews its electronic system's use license out of its own budget, and it resists replacing it with the AGHUse system, which would still require developing and adjusting an oncology module to meet the hospital specific care needs. The DMA is working to overcome this establishment's resistance, since the AGHUse is the EHR system procured to serve the entire state public health network, at no extra cost to hospitals for use licenses.



3. RETRACING THE IMPLEMENTATION STAGES

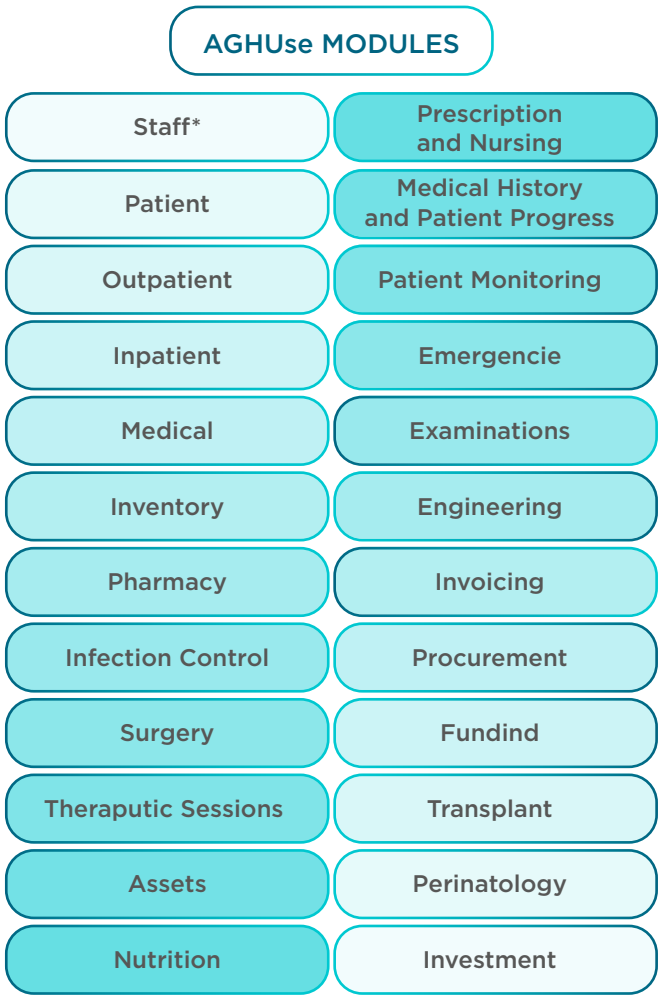
3. RETRACING THE IMPLEMENTATION STAGES

The HCPA leads training and assisted operation for health professionals at the pilot facility chosen by the partner for implementing AGHUse. It sends a team from Rio Grande do Sul to do the work of implementing each module on site. In Bahia, the HGRS provides training, even if the module is initially implemented at another health facility. Professionals from the DMA and PRODEB, the project's implementing partner, monitor these two stages and are then in charge of implementing the module at other state health facilities, reproducing what they learned from the HCPA team. The Rio Grande do Sul hospital provides support for all stages of implementation, even if the support is remote.

Technical visit: AGHUse's implementation begins with a technical visit by the DMA team to map out facilities' structural needs, ranging from space to put an extra computer to a new network connection point to house it. With the Project Owner (PO) heading the visits, the DMA begins assembling the team that will coordinate the software's implementation at the facility. In addition to the IT coordinator and the facility's general director, who are vital to the project's success, physicians and representatives from different areas like nursing and pharmacy also participate in the meetings. The PO acts as a bridge between the facilities' requests, the DMA's project management team, and the technicians who support PRODEB's work.

Order of implementation of modules: After verifying and approving a facility's technical requirements, the DMA and HCPA will evaluate the start date for the implementation based on the availability of the professionals who will travel to Salvador to provide training. SESAB entered into a contract for 24 modules to be used in Bahia (see Figure 6). The order of implementation HCPA uses reflects the operational flow of a highly complex health facility like the HCPA itself, starting with outpatient consultations before then moving on to the emergency and then inpatient modules.

FIGURE 6: Modules procured by SESAB to be implemented in the state



* General registry of the hospital's employees.

As work progressed, SESAB could see that not all health facilities were able to follow the same planned timeline and order of implementation. At specialized care facilities like the CICAN, for example, it is not necessary to wait for the emergency, inpatient, and pharmacy module to be implemented before implementing oncology. The same holds true for maternity hospitals, which do not need to follow the standard flow for implementations before beginning their module. SESAB had to make an informal adjustment to the sequence of modules set out in the contract to better meet the needs of the range of profiles in the region's health network.

Configuring and uploading data: PRODEB development team prepares the software to be implemented at the health facilities, focusing on the system, unraveling its complexity module by module, and compiling the information needed for implementation. It is therefore PRODEB that determines the scale of the software requirements, sets parameters for data, does pre-configurations where necessary, and prepares the system for the basic data logging to be carried out at each health facility. PRODEB is also in charge of adjusting the system when adaptations are needed or script or configuration errors arise.

Between the initial training, conducted at the HCPA's workspace, and the assisted operation, which takes place when the system has already been adapted to the work flow of the facility in Bahia, PRODEB works in partnership with the hospital's IT team to prepare to upload the data needed for each module to work correctly. The hospital's IT team identifies the databases needed to run the module being implemented—from the medical specialties offered to the list of professionals available to provide care, their medical license number, or the database of medications. Meanwhile, PRODEB creates the scripts to upload the data to the system. An incomplete configuration can derail the assisted operation. Since health professionals can't distinguish a structural failure from a configuration issue, they perceive both as system errors, which diminishes the software's credibility for users. Therefore, assisted operation is only offered after the work environment is ready to be used, with all data already uploaded.

The PRODEB and DMA teams learn from their mistakes: when implementing the first two modules (Outpatient and Inpatient) at the Roberto Santos Hospital, the work's initial progress was hindered by inconsistencies in the data that had been entered. Since then, implementation has been carefully planned, with a slightly longer interval between the training and assisted operation stages to give the IT and PRODEB teams enough time to meet all prior data uploading requirements and successfully complete system testing.

Training and assisted operation: Training is scheduled on a module-by-module basis and segmented according to the professional profile of physicians, nurses, and multidisciplinary teams (psychologists, nutritionists, social workers, dentists, pharmacists, and administrative staff). At this first stage, professionals familiarize themselves with the system, do test runs, and get answers to their questions.

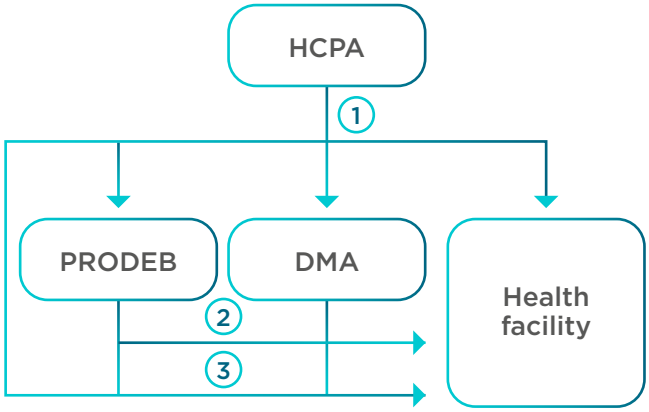
The training lasts an average of a week, but can be slightly longer or shorter depending on the module's complexity and professionals' availability. The DMA works hard to plan training around teams' commitment and availability, scheduling more hours for assisted operation when scheduling difficulties among the professionals cut into initial training.

During the assisted operation, lessons from training are put into practice in a work environment customized for the health facility. A DMA or PRODEB IT specialist monitors the employee's routine and helps him or her use the system. At this stage, it becomes clear whether the system is meeting front-line professionals' needs, whether they resist using the system, whether the navigation interface is well-suited to their use, and even whether there is enough equipment to assist the entire team. Daily meetings allow software or even hardware adjustments that were overlooked during the first visit to be made.

Since the implementation method switched from a pilot facility to multiple facilities at the same time, the DMA also had to find a solution for scheduling training with the Porto Alegre professionals, since, under the contract, the HCPA can only offer training to the HGRS team.

To overcome this bureaucratic hurdle, the DMA included professionals from other health facilities in each training given by the Rio Grande do Sul at the HGRS who in turn help train people at other hospitals, thus creating a ripple effect (Figure 7).

FIGURE 7: AGHUse implementation flow chart: training and assisted operation



1. Training at a pilot facility.
2. Replicating training at health facilities.
3. Assisted operation (HCPA: in-person participation at the pilot facility and remote participation at the others).

Estimated implementation time: In HCPA's experience, it takes approximately two months to implement each module and reach full functionality. However, it took HGRS almost 7 months to actually finish implementing the outpatient module. In the DMA's evaluation, the facility chosen for the pilot implementation ended up being too big and complex, with many professionals in each area, involved in different projects, and with a high daily volume of patients. Roberto Santos' outpatient department alone has more than 600 professionals, with different shifts and employment contracts. At other facilities, a similar department has an average of 30 to 40 professionals, and the module can be fully implemented in slightly over a month, as was the case at the Camaçari and Ernesto Simões hospitals.

Implementation time varies according to the health facility's complexity. In Bahia, the implementation at Roberto Santos took so long that in the project's planning it forced a shift in strategy from a pilot unit implementation to a phased roll-out:

The new method involves implementing the software in phases and at eight facilities simultaneously instead of a single pilot unit. The project's timeline was divided into four cycles or groups. The first began in August 2018 and includes the hospitals Ernesto Simões, Camaçari, and General State, in addition to the HGRS itself and the State Cancer Treatment Center, all of which have been implementing the software since January 2019. Three of the five hospitals in the second cycle began implementation in October, November, and December of 2019: the State Geriatric Referral Hospital, the Octávio Mangabeira Specialized Hospital, and the Albert Sabin Maternal Hospital, respectively. Figure 8 shows how hospitals are grouped by implementation cycle.[6]

[6] Once implementers are hired, the start of the work can be confirmed.

FIGURE 8:
Health facilities grouped by implementation cycle

CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4
Roberto Santos General Hospital	State Geriatric Referral Hospital	Metropolitan Hospital	Curuzu Emergency Center (Mãe Hilda)
General State Hospital	Octávio Mangabeira Specialized Hospital	Mario Leal Specialized Hospital	Cajazeiras VIII Emergency Center (Prof. Hosanah)
Ernesto Simões Filho General Hospital	Albert Sabin Maternity Hospital	Tsyla Balbino Maternity Hospital	Menandro de Faria General Hospital
State Cancer Treatment Center	Pirajá Emergency Center	Anti-Poison Information Center	João Batista Caribé General Hospital
Camaçari General Hospital	Bahia Institute of Perinatology	Disability Prevention and Rehabilitation Center	Juliano Moreira Hospital
		State Center Specialized in Diagnostics, Medical Care, and Research	
		Occupational Health Research Center	
		Bahía Diabetes and Endocrinology Center	

Resolving requests: El equipo de TI de la unidad de salud actúa comoThe health facility's IT team acts as the gateway for questions from software users, which raises the system's credibility. The IT coordinators of both the Ernesto Simões Hospital and the Camaçari General Hospital confirm that most requests have to do with operational questions about how to use the system. Both agree that this initial and immediate support from the hospital's own technical team is key to increasing professionals' acceptance of the software, keeping questions and resistance to the system from proliferating unnecessarily along the way. For that reason, the facility's own IT team studies each software module in depth in a test environment before beginning the assisted operation and making it available to the hospital's professionals.

When technical problems arise—mostly with tickets, scripts, or inputting data—or new fields or features need to be added to the system each health facility's IT team contacts the DMA team using the RedMine management tool, which can be used to continually exchange information between everyone involved in the project and share requests made by each facility so other hospitals in the chain can also support the progress of the process.

Tracking processes: For each new request on RedMine, the DMA team checks whether a similar request from another facility is already being processed. They often find the problem to be a system error--a database parameter that needs to be configured or a script that needs to be run—and these requests are dealt with by the PRODEB team. For broader and more complex issues that involve creating new fields or features in the system, the DMA project managers contact the HCPA and check whether a solution is already in the process of being developed by another partner in the community.

Since HCPA also uses RedMine, DMA managers can use their restricted access to the system to allow the Bahía team to monitor the service's status and know whether the request was prioritized or whether it is on the list of pending tasks. Many of the requests are actually merely questions about matters for which there is already a plan to correct or address them in subsequent software modules that still have not started to be implemented yet. When the system actually needs to be changed, PRODEB mobilizes to begin developing the change.

In addition to using RedMine, the DMA holds frequent meetings with health establishments, especially during the assisted operation period, when questions are frequent and training sessions occur every day. WhatsApp groups run by the project's Product Owner (PO) are also created to help resolve requests more swiftly. The Project Owner provides support and follows up on questions shared in the WhatsApp group, on RedMine, or in person, and refers more complex questions to the project's senior management. The goal of these initiatives is to improve communication between everyone involved in the process and keep questions from fostering resistance to using the software among the team.

External factors: In other cases, there are external factors that interfere with the plan, and the team has to change the timeline to bring it in line with the actual circumstances. In Camaçari, for example, a serious accident at the local petrochemical complex temporarily interrupted implementation of the Emergency module. Staff changes at the facility meant more than one training had to be held for recently hired teams. High staff turnover also complicated AGHUse's implementation at Hospital Octávio Mangabeira. No matter how often PRODEB and DMA teams go back to the hospital to provide more training, staff turnover makes adherence to the project difficult.

Right before the Emergency unit was implemented at the Hospital Roberto Santos, that wing of the hospital was renovated. To keep the time, data logs, and configurations that had already been done to implement the module from going to waste, the DMA moved the work to Hospital Ernesto Simões. There, the Emergency unit was implemented before the Inpatient one, switching the order suggested by the Rio Grande do Sul team, with only remote support from HCPA for training and assisted operation and with full support of the PRODEB and DMA teams, who worked in the community for almost a full month to ensure the project's success. Adaptations have therefore been made continually based on the HCPA's availability and the needs of the Bahia team.

Professionals' availability for training: the greatest training-related difficulty is health professionals' availability. For physicians who have no space in their schedule, who work few shifts at the facility, or who work on teams so small it is hard to split up work, it is often difficult to attend a presentation introducing the software. Even when they are committed to the training, they often cannot leave a shift to participate. In an attempt to address this problem, the IT team at the Ernesto Simões General Hospital began to provide the most relevant sections of the implementation step-by-step via WhatsApp. Having received the description of the software on their cell phone and video tutorials with general information about the module being implemented, professionals can then open the materials at their convenience.

Solutions for optimizing training: Another step taken by HGESF when implementing the Emergency unit was to assign a nursing assistant and physician to be in charge of training in their different spheres of activity. Both professionals have detailed knowledge of how their hospital works and are able to replicate the training for the rest of the team without everyone having to simultaneously halt patient care to attend a training session. They are able to reach the employees that show the greatest resistance or have the least amount of time and are key to answering the team's questions about how to fill out the system. By taking a direct "physician-to-physician" or "nurse-to-nurse" approach, the facility also manages to create a bond of equality between the professional providing the training and the one receiving it, increasing the exchange between parties and, as a result, the team's commitment to AGHUse. Thus, physicians, nurses, or technicians who were more familiar with the technology or more enthusiastic about EHR took ownership of the project and helped the hospital's technical team bring the rest of the team on board, answering questions about the software, giving advice about data entry, and making the system more approachable for everyday use.

To implement the Inpatient module, the hospital went a step further and decided to skip the training stage, going directly to assisted operation. The hospital made this decision to streamline the process after reaching the conclusion that the training is important for introducing the software but is not very efficient in practical terms. Much of the material presented at the sessions is not effectively assimilated by the employees and only works once it is incorporated into medical routines. During assisted operation, service is personalized, and IT professionals help health professionals enter data, answer questions, reinforce the system's step-by-step process, and emphasize the importance of filling out fields with consistent and detailed information. However, Ernesto Simões proves that this decision cannot be applied to all modules, and emphasizes the importance of training, especially for teams' initial awareness and commitment.

4. IMPACTS OF IMPLEMENTATION CHANGE IN HOW WORK IS MANAGED AND RESISTANCE FROM PROFESSIONALS

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For the software to reach medical teams, the constant presence and support of IT teams are essential. But it is not enough to exhaustively test the software, adapt the module to the facility by entering all the logs and databases needed for it to work, and train teams; ultimately, the work does not end at implementation. An EHR system should be incorporated into the medical routine as an element that makes the quality of care stand out, and it should be used effectively by the entire team on a daily basis. For an EHR system to truly take hold, it should be seen as value added to the service, a benefit for everyone involved in the process: physicians, nurses, administrative professionals, patients, and, ultimately, the state.

Understanding the health ecosystem: While EHR is somewhat common in private networks, it is still at its early stages in the public network. The cultural shift the software requires in a work environment that traditionally has fewer management tools creates resistance from teams, especially medical professionals. A common criticism is, "we're not being paid to type"—a reaction to the large quantities of data required by AGHUse. It also often overloads the routines of nurses, who are usually overwhelmed by their tasks and have no hierarchical autonomy to complain or refuse to take on another task.

Modifying the work routine: Otro punto sensible es la dificultad de adecuar Another sensitive subject is the difficulty of adapting the rules for using the software to the habits and particularities of countless professionals not used to following a single and pre-established work flow.

It is therefore crucial for professionals to understand that initial resistance or difficulties cannot be used as a parameter for making structural changes to the system. If a change to the system were requested for each change in routine caused by the software, it would be impossible to implement. And the goal in Bahia is to implement it at 57 facilities in the state's direct and indirect health network.

The team's adaptation to the software's requirements: The SESAB's managers unanimously affirmed that, no matter how complex and challenging it might be, the health facility has to adapt to the software's demands, not the other way around. Standardization, in this case, is key to furthering implementation and achieving concrete, medium- and long-term results for public health management in Bahia or anywhere else undergoing the same process. Without facility directors' unconditional support from the project's outset, making teams aware of the system so they begin using it even before training, AGHUse may come off as merely an IT initiative rather than a public policy project undertaken by the state to ensure the quality of patient care and hospital management.

At the Ernesto Simões General Hospital, for example, the management steadfastly maintained their position that the facility's professionals had to adapt to the system. In addition to training, their actions included posting signs stressing the positive aspects of using EHR systems around the hospital, and, as a more radical step, cutting off access to the server with Word files still being

used by the professionals who were most resistant to the change. They even went so far as to dismiss employees who did not adapt to using the system. Now HGESF is the hospital that has made the most progress on implementing the AGHUse, closely followed by the Camaçari General Hospital, where the management also acted firmly from the project's structural phase onward, supporting the IT team during all stages of the process.

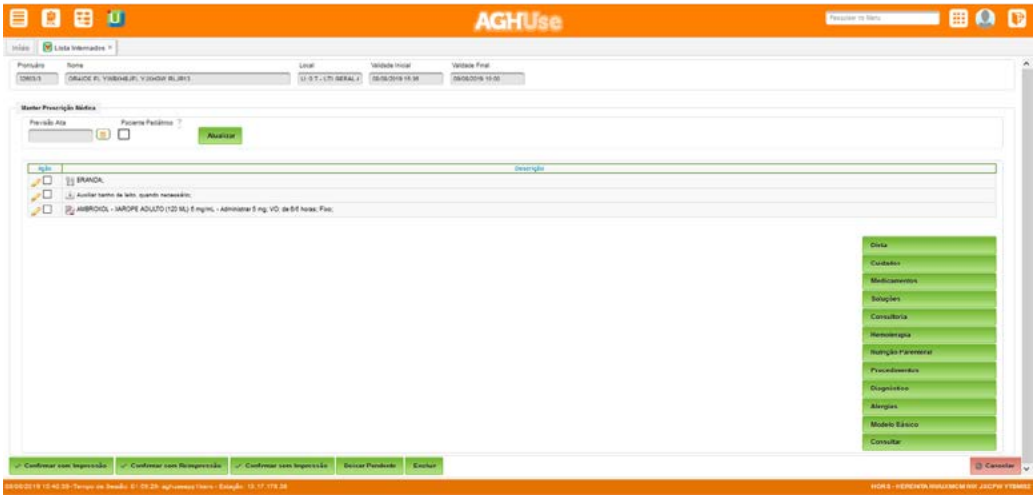
Excessive customization is not an option: In addition to the challenges inherent to all implementation processes, the fact that AGHUse is a free and open-source software managed in community format by HCPA means the Bahia team's requests for modifications are considered and discussed by the members of the AGHUse community. Modifications are only incorporated into the system if the community really does need them and they are approved by HCPA. Even when a small adjustment needs to be made to the system—a change exclusively for a single health facility—the request is analyzed and published for the community.

The DMA does the first screening to separate individual requests from collective needs. Its presence at the facilities is thus essential in this process: the validity and relevance of a facility's request can only be evaluated by an IT professional who is on site, and by discussing it with health professionals and observing the hospital's routine.

This method of constant exchanges between professionals in areas as disparate as technology and health gives rise to analyses of processes that end up improving the EHR system.

From excess data to standardized care: A common criticism among professionals who use AGHUse is that the software is not very user-friendly for first-time users. Most complaints have to do with the medical prescription module. The feature is directly linked to the pharmacy module, where all medications, available doses, and use time instructions (for prescription drugs) have already been entered, with the substance's scientific name rather than its more common trade name.

As shown in the image below, to complete a prescription, a physician has to describe the treatment in detail, filling out all fields in multiple panels (medication, solution, activities, care, etc.). The setup is not intuitive to those new to the system. If the prescription is for a saline solution, for example, the physician has to fill out the field in the "solutions" tab, not in the medications one. Physical therapy goes in the "activities" tab, rather than the "care" one; and if the patient needs to continue taking Novalgine, the physician has to fill out the "medications" tab.



Prescription panel in AGHUse's Inpatient module, with its multiple fields, on the right side of the second screen.

However, after completing a few prescriptions, physicians figure out how to fill it out and master the software, adapting to the system's requirements. The excessive number of fields slows the pace of care, but it ensures that the patient's medical treatment will be prescribed in a detailed and careful way. Therefore, despite initial resistance, the professionals who were interviewed unanimously agreed that the system's benefits outweigh the difficulties of using it.

Overcoming resistance: After implementing various modules at different health facilities, the DMA's IT team was able to make a stronger case for the software to health professionals. If medical professionals complain that it takes them 10 minutes to complete what used to take them few seconds, or that they will have to open many different tabs just to finish a single medical appointment, which further complicates an already difficult work routine, the IT team is equipped with more arguments to assure them that the effort will pay off in the form of optimized tasks, data transparency, and more decisive communication between departments.

At facilities that are further along in the process of implementing the system, initial resistance has gradually given way to admiration as health professionals become familiar with the system and start to glimpse the benefits it entails for their routine. The professionals at Ernesto Simões interviewed for this case study emphasized that the software establishes a method and work routine staff have to follow and obliges physicians or nurses to be organized so they can clearly and consistently enter each patient's data into the EHR. They also say the system creates a valuable record of their activity, providing a detailed picture of the reasoning behind the diagnoses and treatments given by physicians. It is therefore crucial to persevere and continue with the implementation, making the act of using the software daily a common good shared by professionals, citizens, and the hospital management alike.

How the software and hospital management feed into each other

The system is updated based on user suggestions, and the system drives changes in how the health facilities that use it are managed, and even structured. Therefore, the software and hospital management are part of a feedback loop. At the Hospital Ernesto Simões, for example, emergency care patients were first registered in the system through the reception desk. Then, a nurse saw the patient to classify their risk before sending them on to a physician. Finally, the patient waited in a support room before the physician saw them. The physical order of how the patient moved through rooms did not match the system's logic. The patient was moved more, and in an order opposite to the one proposed by the software, until reaching the physician.

Prompted by the EHR system, the hospital made a structural change, moving the location and order of the rooms to improve the service using the software's features. With the AGHUse, the system itself alerts the nurse when a patient has entered the emergency department. They immediately perform triage on the patient—assigning them the status of green for milder cases, yellow for medium risk, or red for the most serious cases. The physician is also alerted by the same system of the severity of the patient's condition and the order of priority for treatment. The software helps with decision-making and speeds up care: a "red status" patient is attended to before everyone else and is immediately sent to a specific area in the hospital.

After the physician sees them, most patients are discharged, but some have to be admitted to the hospital. Contact with the patient is then passed off to the Internal Patient Management System, which manages the hospital beds. But at Ernesto Simões the Internal Patient Management System was far away from the emergency department, often hindering communication between the two areas. Care was delayed by situations as simple as a protocol lost by an in-house courier or a staff member who was not near the telephone. Following the work flow designed by the software, the hospital moved the Internal Patient Management System to a space next to the emergency department, bringing the areas closer to each other and streamlining and improving the quality of services. This simple change brought about surprising results that were confirmed by the hospital management analysis: shorter wait times in the emergency department and better management of the hospital's beds.

5. EVALUATION OF RESULTS

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It may still be premature to evaluate the results of implementing AGHUse in Bahia's public health system. The SESAB's original goal was to implement the software in 23 facilities of the direct network by December 2020, followed by another 27 facilities in the state's indirect network. Implementation began in August 2018, although it had to be halted in March 2020 because of the COVID-19 pandemic, so the goal was revised and extended. The new implementation timeline stretches into 2022, as shown in Figure 9. Under the new plan, the AGHUse modules will only be implemented at facilities in the direct health network, in four different cycles. Facilities in the indirect network were left out of the project until further notice. The timeline was set up based on the team's limitations, and implementation at facilities that still have not received any AGHUse modules will only begin once the request to hire new professionals to work on the project has been approved.

With only three PRODEB implementers and three support professionals offered by the DMA, the SESAB cannot commit to increasing its workload at this time. There still are not enough programmers to be able to handle the backlog of possible new adjustments or create new features for the system. At this time, any data sampling is limited, so it does not reflect AGHUse's potential impact on the region's public health system.

Based on the SESAB's organizational chart, Bahia has entered into a contract for a total of 24 AGHUse modules for creating electronic health record systems and managing hospitals, and so far eight facilities are in the process of implementing them. Some will use 21 modules of the system, others only 10. The number varies according to the health facilities' size and profile. Two establishments have been at the forefront of the implementation so far: the Ernesto Simões Filho General Hospital and Camaçari General Hospital, which have already implemented nine modules (with varying degrees of progress) each. Both are completing the medical history and patient progress module that was begun before the pandemic while waiting for Procurement, Inventory, and Pharmacy, which make up the Supplies module, to be switched over to multi-enterprise format so they can continue to implement it.

FIGURE 9:
Implementing AGHUse in Bahia

IMPLEMENTATION PLAN — DIRECT NETWORK — SESAB					
	Facilities	Modules*	% **	Started	Finished
1st CYCLE	Roberto Santos General Hospital	21	19	Aug. 2018	Feb. 2022
	General State Hospital	19	7	Jan. 2019	Jun. 2022
	Ernesto Simões Filho General Hospital	19	40	Jan. 2019	Jun. 2021
	State Cancer Treatment Center	18	9	Jan. 2019	Mar. 2022
	Camaçari General Hospital	19	38	Jan. 2019	Jun. 2021
2nd CYCLE	State Geriatric Referral Hospital	10	20	Oct. 2019	Jan. 2021
	Octávio Mangabeira Specialized Hospital	19	13	Nov. 2019	Oct. 2021
	Albert Sabin Maternity Hospital	20	10	Dec. 2019	Dec. 2021
	Pirajá Emergency Center	19	0	Nov. 2020	Feb. 2022
	Bahia Institute of Perinatology	19	0	Nov. 2020	Feb. 2022
3rd CYCLE	Metropolitan Hospital	18	0	Nov. 2020	Dec. 2022
	Mario Leal Specialized Hospital	17	0	Nov. 2020	Dec. 2021
	Tsyla Balbino Maternity Hospital	19	0	Nov. 2020	Feb. 2022
	Anti-Poison Information Center	10	0	Nov. 2020	Apr. 2021
	Disability Prevention and Rehabilitation Center	10	0	Nov. 2020	Apr. 2021
	State Center Specialized in Diagnostics, Medical Care, and Research	10	0	Nov. 2020	Apr. 2021
	Occupational Health Research Center	10	0	Nov. 2020	Apr. 2021
	Bahía Diabetes and Endocrinology Center	10	0	Nov. 2020	Apr. 2021
4rth CYCLE	Curuzu Emergency Center (Mãe Hilda)	19	0	Nov. 2020	Feb. 2022
	Cajazeiras VIII Emergency Center (Prof. Hosanah)	19	0	Nov. 2020	Apr.2022.
	Menandro de Faria General Hospital	19	0	Nov. 2020	Apr.2022.
	João Batista Caribé General Hospital	19	0	Nov. 2020	Feb. 2022
	Juliano Moreira Hospital	17	0	Nov. 2020	Nov. 2021

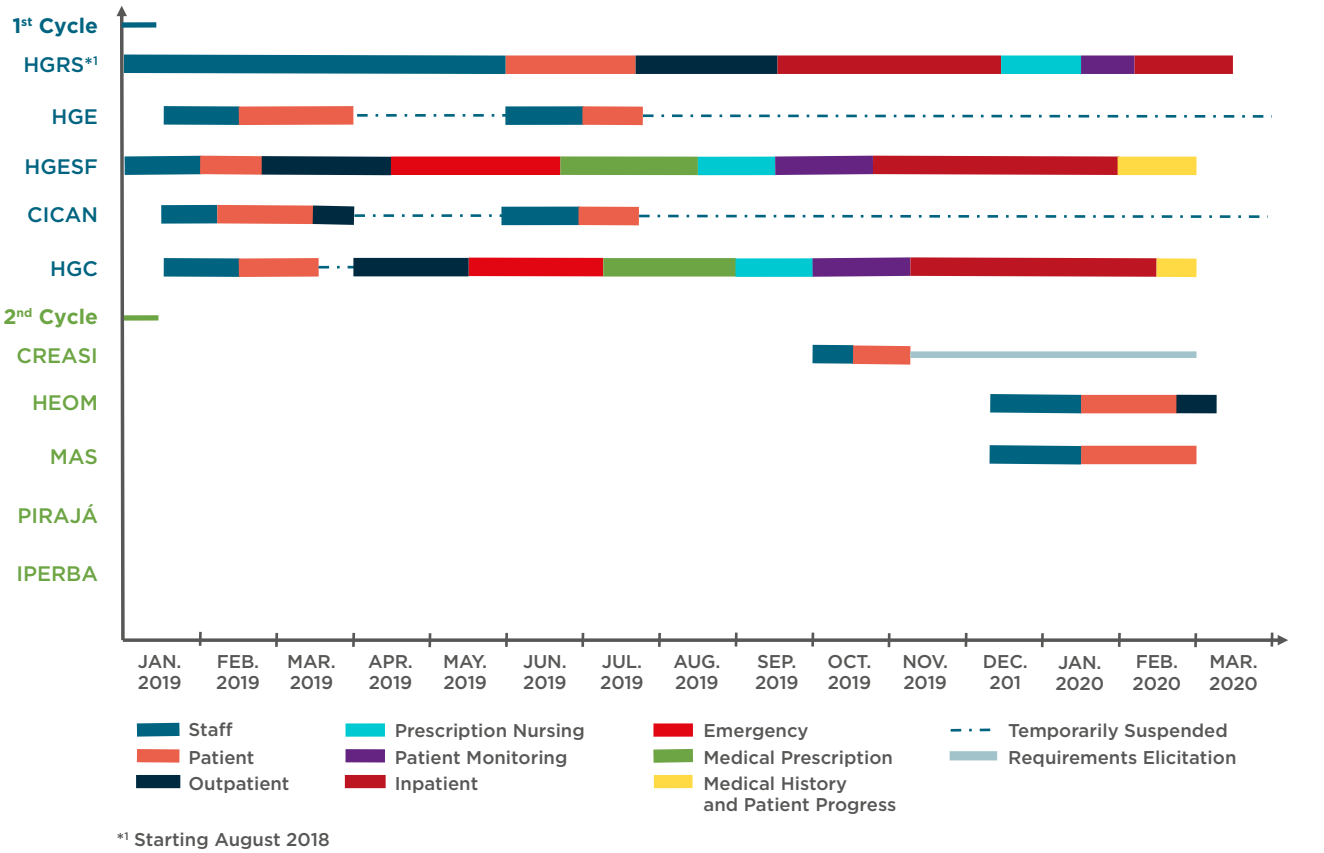
* Total number of modules per facility.
**Only modules that have been 100% implemented and are fully operational in all of its functional units are counted when calculating the implementation percentage.

Source: DMA/SESAB.

Despite being the first to receive AGHUse, Roberto Santos General Hospital has so far only implemented seven modules. The Inpatient Module still has not been completed because of the number of beds and specialties offered at the facility: there are several ICUs—cardiac, pediatric, general, etc.—and nurses' stations. The cardiology department alone has more than 60 professionals per shift to be trained. Implementation was halted when a health state of emergency was declared in Bahia, with seven functional units of the inpatient module already up and running. The next challenges on its list are the Medical History and Patient Progress modules, followed by Emergency. Figure 10 shows the implementation timeline by module.

At the State General Hospital, which is also participating in the first cycle, construction work in the emergency department interrupted implementation before the pandemic began, when only the Staff and Patient modules had been completed. Since the HGE is essentially an orthopedic emergencies and burns hospital, the DMA thought it better to suspend operations to minimize the impact on patient care, which is already suffering due to the renovation work and shortage of professionals. The facility says there are not enough employees to input data into the software. The DMA requested support from the Comprehensive Health Care Superintendence (Portuguese acronym: SAIS), which, together with the State

FIGURE 10:
Timeline for implementing AGHUse – Cycles 1 and 2 – up to the start of the COVID-19 pandemic, when work was halted



*1 Starting August 2018

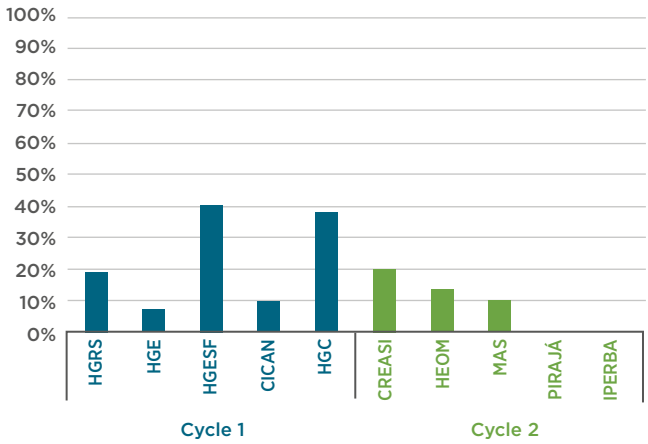
Facility Service Directorate will confirm the need to hire new professionals for the facility. And at CICAM, as mentioned previously in this study, the team is resisting AGHUse because the facility already uses a different electronic health record system that even covers the specific requirements of cancer treatment. The DMA is working to diminish the hospital's resistance to implementing AGHUse while it awaits the development of the oncology module to provide better service to the facility.

Three facilities from the second cycle began their implementation at the end of 2019: the State Geriatric Referral Hospital (CREASI) has only finished implementing two modules (Staff and Patient), while the Octávio Mangabeira Specialized Hospital and Albert Sabin Maternity Hospital have implemented those two modules and are in the process of implementing the Outpatient module. The CREASI's implementation's prospects hinge on the arrival of new programmers capable of creating the module for older people after a failed attempt to develop the feature in partnership with the Universidad Federal de Bahía. The DMA's goal is for facilities from cycles 1 and 2, where implementation has already begun, to have the software in operation by the end of 2021. The exception is the Roberto Santos General Hospital, where the task is more complex due to its size. The goal for this hospital is for AGHUse to be fully operating by the beginning of 2022 (see summary in Figure 11).

The DMA has already commissioned the first studies on AGHUse's impact on health management in Bahia, but it is waiting for the EHR system to be completely implemented at least one health facility—probably the Ernesto Simões Filho General Hospital—to finish the analysis. But in terms of indirect impact, the AGHUse project managers at the DMA estimate that the state's printing costs have plummeted since AGHUse started to be implemented. SESAB estimates that similarly significant results should be achieved through savings on medications that have expired or are wasted due to misuse, for example, as soon as the system begins counting and monitoring this data.

Even without numerical data on the partial implementation of the software at eight state health facilities, the DMA can detect major qualitative changes in care. Physicians and directors at Ernesto Simões General Hospital assert, for example, that the improvement in patient care is evident from the moment they walk into the facility: instead of having to endure countless screening lines, the patient fills out a universal patient form

FIGURE 11: AGHUse implementation percentage at health facilities in cycles 1 and 2



Source: Figure prepared based on data provided by the SESAB.

before being triaged and receiving care. Patients' hospital stays are shorter and the work flow has improved.

Ernesto Simões General Hospital has been adapted to receive exclusively COVID-19 patients since March 2020, and its medical and management teams unanimously stressed the importance of the EHR system for the hospital during the pandemic. Even with the software only partially implemented, its effects on daily medical care can already be seen. According to the hospital's management, teams have been more integrated since AGHUse was implemented, because as they work they can share all the important information on each patient. At a critical time like the coronavirus health emergency, it only takes a few clicks to know who the patient is, when they entered the hospital, and what their medical history is, without having to sort through piles of documents or unnecessarily expose coworkers to the risk of infection. Since they are generated by the system, prescriptions are more complete and there is no confusion due to bad handwriting. Medications are administered more quickly because the entire process, from when the patient enters the hospital to when they receive a prescription, is more streamlined, with clearer information and no waiting lists. In line with Federal Medical Council recommendations, the staff of some medical specialties is forbidden from going to specific areas of the hospital to reduce the spread of infection among

employees. But despite these restrictions, everyone can see the patient's pathway and make prescriptions through the system.

After seeing how the system benefits the hospital routine, several departments have requested that the software be implemented. Even professionals from sectors like pharmacy, who were reluctant to use AGHUse, began using it to avoid contact with frontline staff working with COVID-19 patients and discovered its advantages.

The Patient Management System is perhaps the sector that will benefit the most from AGHUse, even without using it directly yet. The Center is responsible for managing users' access to SUS services and identifying patient needs and the resources available to best to meet them according to a careful risk classification. It therefore needs access to consolidated data to better manage the beds available in the public health network. Since demand for beds is greater than supply, the goal is to progressively reduce wait times for spaces at health facilities. A second major challenge for the Patient Management System is improving the flow of communication and quality of information so it can make decisions based on concrete and complete data on patients' progress.

When the EHR system is fully implemented, physicians will request hospital beds automatically through AGHUse's bed mapping feature. The Patient Management System will be activated and reserve the empty bed, in real time, without having to contact hospitals one by one to check availability. When the two systems are operating in an integrated way, the Patient Management System will have access to the patient's complete health records, from their entry into the health system at the primary care level to transfers to secondary or tertiary hospitals, all integrated by the interoperability of AGHUse and SUREM, the software used by the Patient Management System.

AGHUse drives a shift in work culture that is already proving to be beneficial to hospital management, staff, and patients. An outpatient appointment at Ernesto Simões or Camaçari follows the same work flow, requires filling out the same fields, and generates a similar service report, even if done by staff with different backgrounds and methods. Patients received more detailed and better documented prescriptions. The hospital ends up with a data archive that can be used to manage the hospital more efficiently. Physicians are sure to provide more consistent service because they have access to more complete medical records on each patient.

As of the end of this case study, the DMA still did not have enough numerical data for a general and conclusive assessment of the impact of EHR systems in the state. If we add up the percentages of implementation at the facilities have begun to receive AGHUse so far, we find the software is operating at less than 7% of capacity in the State of Bahia, so a numerical assessment of the system's impact on patient care or health management in the region is still premature.

The DMA renewed its collaboration contract with the HCPA for another year. The six new modules developed by the HCPA are not yet being considered for possible procurement. The Bahia team prefers to conclude the tasks under the current contract and develop specific modules for local needs—like care for older people or cancer treatment—before procuring extra modules for a new round of implementation. The 24 modules procured so far are already solid enough and can provide a coherent vision of how health operates in the State of Bahia, without risk of becoming obsolete.

6. FINAL INSIGHTS AND RECOMMENDATIONS

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The transformation of hospital settings prompted by AGHUse is by no means limited to the digital realm. The change began at the SESAB, with the DMA taking on an unprecedentedly important role: rather than focusing exclusively on tech support as it had to that point, it took charge of producing and collecting comprehensive health data in the state and became a key component of a complex and necessary management apparatus. At health establishments, the software's arrival sparked a revolution in health professionals' work culture, changing patterns of care and administrative flows and bringing to light weaknesses and solutions related to hospital management. For better or worse, the software exposes bottlenecks in the sector, but it also reveals possible solutions for quality health services for the population.

The problems the health sector faces, with so many unresolved structural problems, can lead those most skeptical of the benefits of digital advances to see technological transformation as something superfluous, or even unnecessary. Perhaps the primary challenge in implementing AGHUse was overcoming resistance by highlighting the importance of having software that can bring medical and administrative data together in a single system, recording the patient's pathway from primary care to tertiary care. Hospital management software is quite common in the private sector, but it is still a rarity in the public health network. However, it plays a crucial role in helping to generate indicators, perform hospital monitoring, assess patient profiles, and manage facilities' resources. The software also sheds light on the hospital itself, providing insight into the reality of its operations and the bottlenecks that it needs to fix, or at least minimize. And since it is implemented throughout the entire network, it keeps facilities from operating in a way that is isolated from the needs of the community and instead allows them to coordinate and integrate their operations with the rest of the group.

Moving beyond a focus on just the technological aspects of the process was not the SESAB's only challenge in the digital transformation underway in Bahia. The distance between the reality of a hospital setting and the software's complexity was perhaps underestimated, even by the IT team. The IT teams from the DMA, PRODEB, and Ernesto Simões and Camaçari hospitals report that they found the complexity of implementing AGHUse, in comparison to the state's other management systems, to be a reflection of its quality, precisely because it unites operations that have never been centralized or even brought into closer collaboration with each other. Ultimately, each SUS health facility operates independently, following its own management rules. This arrangement has undeniable benefits, but it also complicates any push for integrated data management.

The first error in the scope of the project perhaps lay in the choice of facility for the pilot implementation of the software, since the Hospital General Roberto Santos is the largest in the Bahia public network and one of the largest in the country, along with the University Hospital of the Bahía Federal University, certified by the Ministries of Health and Education. From the outset, the DMA pushed for starting implementation at a smaller facility, preferably with fewer than 100 beds. Despite this, the Office of the Secretary, together with SAIS, chose to implement the system at a large hospital. Their reasoning was that if the software can be implemented at a more robust and complex facility, it will also work at smaller ones.

The PRODEB's technology team has a long road ahead of it before training, with limited personnel to carry it out and little experience running such a complex system. The timeline provided by the SESAB shows that it took nine months to fully implement the first module (the Staff module) at Roberto Santos General Hospital—from August 2018 to May 2019—while at Ernesto Simões the same module was completed in only two months. The size of the hospital and the complexity of preparing the work environment precluded a fast implementation. However, the lessons learned during the first implementation were valuable and were

quickly applied to subsequent implementations. Now it is necessary to gauge whether the technical experience gained is enough to overcome the implementation problems, since the technical team at the State General Hospital and the CICAN proved to be very nimble when implementing the Staff and Outpatient modules, but it had to repeat the training because of the health team's low uptake of the project.

At Ernesto Simões Filho General Hospital, an analysis of the steps used to implement AGHUse shows that health professionals participated more in the project. The staff engagement translates to numbers: 40% of the system was implemented in slightly over a year. The hospital assigned a nursing assistant and physician to be in charge of training for the Emergencies module. They understood the need to honor health professionals' pace and knew that having to pull them away from emergencies to attend IT trainings would make it impossible to execute the project or significantly delay it. Physicians thus took on the task of sharing how to use AGHUse with colleagues, even producing video tutorials to help new staff at the hospital use the system, especially during the COVID-19 pandemic when there was more staff turnover. The same health facility suggested creating a WhatsApp group to engage staff members at different hospitals in the implementation process and exchange experiences and share solutions between teams.

Along the same lines, the project leaders proposed including a physician on the steering committee from the start of the project. Health professionals can act as EHR system ambassadors, overcoming the initial resistance of physicians and nurses. They can also help programmers understand and design a hospital's work flow when creating a new module, act to integrate a facility's different medical care and administrative sectors, or help IT teams compile the data that needs to be logged at each stage of the system. Better communication between departments and different health facilities is key to the project's success.

Also important is assisted operation in order to incorporate the software into staff work routines. Training prepares the technical team to recognize initial data configuration needs and presents the general challenges of using a specific module to health professionals. However, assisted operation actually prepares a team to use the program in a health center's everyday work. It is a crucial step in getting a health facility's staff to use the software securely and quickly.

Also worth discussing is AGHUse's business model, which requires that each partner have a solid structure of implementers, programmers, and technical support to handle trainings, capacity building, and adjustments to the system. According to the contract, each partner is responsible for replicating training and assisted operation at additional facilities that will receive the software. It takes a strong team to replicate the implementation across an entire health network like Bahia's: from DMA implementers to carry out the project to technicians who handle requests and answer questions at health facilities 24 hours a day, seven days a week. Political will and commitment from professionals is not enough to complete the project. There has to be a team capable of replicating the software implementation at 23 facilities, knowing that each one presents unique challenges.

And in Bahía there aren't enough implementers and technical support staff working on the project, both at the DMA and at PRODEB or on the IT teams assigned to the health facilities. The DMA is working hard to fill this gap, requesting new hires to meet the new project implementation goal[7]. The solution HCPA found for the Brazilian Army was decisive—and admittedly more costly—, since an exception was made for that project and external companies were engaged to help with the training and assisted operation of the network so the Army would not have to be in charge of replicating the implementation at each facility.

In addition to the challenge of training, there is also the difficulty of frequently optimizing free software. The community format proposed by HCPA requires partners to contribute complex technological solutions for sensitive parts of the project. While the software is free of charge, it does require a significant investment in a team of programmers or hiring a software factory that can quickly handle complex requests even just to actually meet the annual target in the agreement with the HCPA of developing 5% of new functions.

Despite the size of the software, with its 24 modules that demand rigor and a high level of detail when filling out fields, it still lacks modules to

[7] As of the end of this case study, the request to hire professionals was still awaiting the state's final authorization.

cover the many profiles and needs of an entire health network, with general hospitals and others focused on specialized services. For example, there is no oncology module. It seems the DMA team initially underestimated the need to make the software scalable, and they were surprised by how much the program had to evolve to cover an entire medical care network. Therefore, implementing an EHR system in a network as diverse as Bahia's can be seen as a valuable learning experience for those wishing to participate in the country's digital transformation.

Interoperability between the systems used by the Health Secretariat is another obstacle on the road to digital transformation. To make the electronic health record system a warehouse of health data in the region, AGHUse's relevance has to be inversely proportional to the number of systems used—from smaller software programs created to meet specific needs to the different sets of data stored in Excel spreadsheets or Word documents. By discontinuing less relevant systems with information now completely covered by AGHUse, the state saves time and money. Other systems that are equally solid and relevant to the SESAB's monitoring and management, like SIGES, the EHR system used by state polyclinics, or SUREM, the tool used by the Patient Management System, are awaiting software buses to integrate them with AGHUse so the State of Bahia can identify the region's most relevant health data in a consistent and integrated way.

The advantages of interoperability can go beyond the state's borders and make the state's integrated management of data a national model for public health. As of right now, the federal government still has not been able to achieve an electronic health records system that substantially integrates state, municipal, and federal databases with enough technical support to meet the demands of such a large network. AGHUse constitutes an alternative to E-SUS, a more complete EHR system that is also free of charge and that has the potential to become a catalyst for database interoperability between different levels of government. If the SESAB is able to effectively integrate state and municipal databases with the federal level—an effort that was partially begun as a one-off initiative to compile data on COVID-19 cases during the pandemic—AGHUse could become an option for integrating the SUS network countrywide. Under this scenario, the State of Bahia would play a role in identifying and implementing a digital transformation solution accessible to the entire country, and it would be ahead of the other states because the system is already being implemented in the region.

The road to integrating national health data appears long and is subject to adjustments, shifts in direction, and political decisions that could either accelerate or derail the project. However, Bahia seems to have overcome the most significant hurdles and is now steadily moving towards data integration in the state. The coinciding investments in infrastructure and hospital technology applied to health management yield, as a result, better structured health establishments that provide higher-quality, quicker, and more efficient service. This system give patients a solid medical history, and physicians have access to their complete medical records, leaving less margin for diagnostic errors. Meanwhile, the state avoids wasteful expenditure and identifies the most essential priorities for future spending, thus contributing to the quality of public health. Ultimately, it is an effort that saves lives.

LESSONS	RECOMMENDATIONS
Transform more than just digital aspects	Understand that the electronic health record system is much more than a technological benefit: the system changes the work culture, the standards for care, and administrative work flows.
Move beyond a focus on just the technological aspects of the transformation	Showcase the relevance of digitizing health data, even in situations with other structural deficiencies, and understand that technological solutions lead to better hospital management in the long run.
Overcome user resistance to using the software	Involve health professionals in the project to expand the team's participation and increase software uptake. We suggest including a physician on the steering committee from the start of the project.
Plan for a bigger challenge than expected	Take hospitals' reality into account and plan for situations that are beyond the scope of implementing software. Planning should also address construction work at facilities, change management, or high staff turnover.
Avoid the "you get what you pay for" trap	Realize that the savings from using software with a free license should be used to invest in the team of IT professionals who can implement the project.
Adjust the implementation method	Counteract, if necessary, possible delays in the timeline by adjusting the implementation method (from pilot facility to multiple facilities, for example) to streamline the process and ensure project delivery.
Efficiently configure data	Study the system beforehand and upload all data required by the software before making it available on the network, recognizing that the preparation phase is key to the project's success.
Place value on assisted operation	Recognize that the initial training only serves to give people an idea of how to use the software. Assisted operation is what actually trains employees to use the system.
Guarantee the project's scalability	Understand that no matter how complex the software may be, it is important to plan for the possibility of scaling up the system to satisfy the network's many different profiles and of hiring more programmers to launch the project.
Expand the team of implementers	Adjust the size of the team based on the software implementation method: if switching from pilot facility format to simultaneously implementing at multiple facilities, the IT teams at both the health facilities and the Secretariat have to be expanded.
Identify the path to interoperability	Recognize that electronic health record systems are not standalone, no matter how complete they are. They have to be integrated with other systems to improve overall data management, taking into account the team and specific investment needed to accomplish this.

BIBLIOGRAPHY

Agência para o Desenvolvimento da Indústria no Brasil (ABDI). 2019 .“Economia digital vai movimentar US$ 100 tri nos próximos 10 anos, aponta ABDI”. Bruno de Castro. Available at https://www.abdi.com.br/postagem/economia-digital-vai-movimentar-us-100-tri-nos-proximos-10-anos-aponta-abdi. Consultado el 05.09.2020. Retrieved on 05/25/2019.

Conselho Nacional de Secretários de Saúde (CONASS). Governo da Bahia investe em nova ferramenta de ges- tão para a Saúde. Published January 23, 2019. Available at https://www.conass.org.br/governo-da-bahia-investe-em-nova-ferramenta-de-gestao-para-saude/. Retrieved on 8/25/2020.

Departamento de Informática del SUS (DATASUS). Available at http://datasus1.saude.gov.br/informacoes-de-saude/publicacoes. Retrieved on 9/5/2020.

INSPER. 2020. “Programa de Fortalecimento do Sistema Único de Saúde na Região Metropolitana de Salvador – PROSUS”. Relatório Intermediário de Avaliação de Impacto.

Inter-American Development Bank (IADB). 2019. “Enfoque de la División Social y Salud para la transformación digital: pautas y recomendaciones”. Available at https://publications.iadb.org/es/enfoque-de-la-division-social-y-salud-para-la-transformacion-digital-directrices-y-recomendaciones. Retrieved on 2/27/2020.

Inter-American Development Bank (IADB). 2018. “La priorización en salud paso a paso. Cómo articulan sus procesos México, Brasil y Colombia.” Available at https://publications.iadb.org/publications/spanish/document/La-priorizaci%C3%B3n-en-salud-paso-a-paso-C%C3%B3mo-articulan-sus-procesos-M%C3%A9xico-Brasil-y-Colombia.pdf. Retrieved on 2/26/2020.

Inter-American Development Bank (IADB). 2015. “Programa de Fortalecimiento del Sistema Único de Salud en la región metropolitana de Salvador, PROSUS.” LENDING OPERATION 3262/OC-BR (BR-L1389) OPERATING RULES. Available at http://www.saude.ba.gov.br/wp-content/uploads/2017/07/PROSUS_BID_REGULAMENTO_OPERACIONAL_JUNHO2015.pdf. Retrieved on 2/26/2020.

Inter-American Development Bank (IADB). 2020. “Sistemas de Historias Clínicas Electrónicas Definiciones, evidencia y recomendaciones prácticas para América Latina y el Caribe.” Available at https://publications.iadb.org/publications/spanish/document/Sistemas-de-Historias-Clinicas-Electronicas-Definiciones-evidencia-y-recomendaciones-pr%C3%A1cticas-para-America-Latina-y-el-Caribe.pdf. Retrieved on 2/27/2020.

Ministério da Ciência, Tecnologia e Inovações (MCTIC). “Institui o Sistema Nacional para a Transformação Digital e estabelece a estrutura de governança para a implantação da Estratégia Brasileira para a Transformação Digital.. Decree No. 9319, of March 21, 2018, published in the DOU, Section 1, folios 2, 3, and 4, of March 22, 2018.” Available at http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/D9319.htm. Retrieved on 3/8/2020.

Ministério da Ciência, Tecnologia e Inovações (MCTIC). 2018. “Estratégia Brasileira para a transformação digital – E-Digital.” Federal Government. Brasilia.

Ministério da Saúde (MS). 2018. Estratégia e-saúde para o Brasil, Comitê Gestor da Estratégia e-Saúde, Federal Government. Available at https://saudedigital.saude.gov.br/wp-content/uploads/2020/02/Estrategia-e-saude-para-o-Brasil_CIT_20170604.pdf. Retrieved on 3/8/2020.

Paim, Jairnilson Silva, et al. 2015. *“O que é o SUS.”* Rio de Janeiro: Editora Fiocruz, 93p. Colección Temas em Saúde.

Pan American Health Organization - Brazil (PAHO). “Países devem investir no mínimo 1% a mais do PIB na atenção primária à saúde para eliminar lacunas na cobertura”. September 23, 2019. Available at https://www.paho.org/bra/index.php?option=com_content&view=article&id=6024:paises-devem-investir-no-minimo-1-a-mais-do-pib-na-atencao-primaria-a-saude-para-eliminar-lacunas-na-cobertura&Itemid=843. Retrieved on 10/1/2020.

Pan American Health Organization (PAHO). 2016. "La Salud en la Región de las Américas: derribando las barreras para la implementación. Resultados de la Tercera Encuesta Global de eSalud de la Organización Mundial de la Salud." Washington, DC: Pan American Health Organization.

Pan American Health Organization (PAHO). Annual Report of the Director 2019: Advancing the Sustainable Health Agenda for the Americas 2018-2030. Executive Summary. Washington, D.C.: PAHO; 2019.

Secretaria da Saúde do Estado da Bahia (SESAB). Atendimento ao cidadão: Como funciona o SUS. Available at http://www.saude.ba.gov.br/atencao-a-saude/comofuncionaosus/. Retrieved on 9/5/2020.

OTHER PUBLICATIONS

"Governo da Bahia investe em nova ferramenta de gestão para a Saúde." Available at http://www.conass.org.br/governo-da-bahia-investe-em-nova-ferramenta-de-gestao-para-saude/. Retrieved on 3/1/2020.

"Secretaria da Saúde implanta prontuário eletrônico em cinco unidades." Available at http://www.saude.ba.gov.br/2019/04/18/secretaria-da-saude-da-bahia-implanta-prontuario-eletronico-em-cinco-unidades/. Retrieved on 3/2/2020.

Interview of Fábio Vilas-Boas. Available at https://www.bahianoticias.com.br/entrevista/396-fabio-vilas-boas.html. Retrieved on 2/27/2020.

"Software criado pelo HCPA será implantado em provedores da Bahia." Available at https://saudebusiness.com/voce-informa/software-criado-pelo-hcpa-sera-implantado-em-provedores-da-bahia/. Retrieved on 2/1/2020.

"AGHU – Modelo de Gestão do HCPA Inovando a Assistência à Saúde." Available at https://repositorio.enap.gov.br/bitstream/1/4075/1/AGHU%20%20Modelo%20de%20Gest%C3%A3o%20do%20HCPA%20Inovando%20a%20Assist%C3%AAncia% 20% C3% Y0% 20Sa% C3% BAde.pdf. Retrieved on 3/9/2020.

"Secretaria da Saúde da Bahia implanta prontuário eletrônico em cinco unidades. Available at http://www.saude.ba.gov.br/2019/04/18/secretaria-da-saude-da-bahia-implanta-prontuario-eletronico-em-cinco-unidades/. Retrieved on 3/1/2020.

"Será preciso defendermos o SUS?" Available https://blogs.iadb.org/brasil/pt-br/sera-preciso-ainda-defendermos-o-sus/. Retrieved on 3/2/2020.

"5 resultados da integração de dados na gestão da Saúde Pública." Available http://www.mv.com.br/pt/blog-/5-resultados-da-integracao-de-dados-na-gestao-da-saude-publica. Retrieved on 8/2/2020.

"Falta de dados qualificados dificulta estratégias de gestão da Saúde Pública." Available at http://www.mv.com.br/pt/blog/falta-de-dados-qualificados-dificulta-estrategias-de-gestao-da-saude-publica. Retrieved on 8/2/2020.

"Por que o sistema público de saúde paga por uns medicamentos e por outros não?" Available at https://blogs.iadb.org/brasil/pt-br/por-que-o-sistema-publico-de-saude-paga-por-uns-medicamentos-e-por-outros-nao/. Retrieved on 2/26/2020.

"Serviços públicos: quem manda é o cidadão." Available at: https://blogs.iadb.org/brasil/pt-br/quem-manda-eo-cidadao/. Retrieved on 2/26/2020.

"33 portais para você ficar por dentro da saúde pública e gestão em saúde no Brasil." Disponible en https://blogs.iadb.org/brasil/pt-br/33-portais-para-voce-ficar-por-dentro-da-saude-publica-e-gestao-em-saude-no-brasil/. Retrieved February 26, 2020.

"Consegue matricular seu filho na escola pública pelo celular? Na Bahia é possível." Available at https://blogs.iadb.org/brasil/pt-br/consegue-matricular-seu-filho-na-escola-publica-pelo-celular-na-bahia-e-possivel/?fbclid=IwAR3lqyORB- 8xe-L_NIuMvDAeRlKcRE9BoG7SidbYjFJ-K2gBQFN27udw9Wg. Retrieved on 2/26/2020.

"How Governments can use the Digital Principles to Enable Digital Transformation". Available at https://digitalprinciples.org/cross-post-how-governments-can-use-the-digital-principles-to-enable-digital-transformation/. Retrieved on 3/8/2020.

"Perfil do município de Salvador/BA: análise do acesso e da qualidade da Atenção Integral à Saúde da população LGBT no Sistema Único de Saúde." Available at: https://www.nesp.unb.br/saudelgbt/images/arquivos/Perfil_Salvador.pdf. Retreived on 3/7/2020.

"Plano estadual de saúde 2016-2019." Revista Baiana de Saúde Pública, vol. 40, supl, 3 2016, da Secretaria de Saúde do Estado da Bahia. Available at: http://www.conass.org.br/pdf/planos-estaduais-de-saude/BA_Plano-Estadual-de-Saude_Revista40-Sup3-2016-PES2016-2019.pdf. Retrieved on 3/7/2020.

"Plano Estadual de Saúde 2020-2023 é aprovado por conselheiros estaduais de Saúde." Available at: http://www.saude.ba.gov.br/2019/12/06/plano-estadual-de-saude-2020-2023-e-aprovado-por-conselheiros-estaduais-de-saude/. Retrieved on 3/8/2020.