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Not-So-Smart Technology

Tulio Pereira dos Santos Maximo

Abstract

It is certain that smart technologies can benefit healthcare from an individual level to comprehensive healthcare services. This chapter reflects on the use of technologies in public healthcare systems and reveals some barriers encountered in the attempt to integrate the World Health Organisation wheelchair services' good practices into the Brazilian National Health Service information system. Between countries with a population larger than 100 million inhabitants, Brazil is the only to declare healthcare as a duty of the State and a civil right, providing free of charge services to its population. The service is moving from a fragmented to an integrated healthcare service on which the use of technologies plays an important role. This study shows the value of understanding the requirements of the different healthcare service stakeholders and considers the contextual factors to improve service quality. It also shows how technology can become a hurdle rather than assistance to improve healthcare provision.

Keywords: assistive technology, wheelchair service, Sistema Único de Saúde, electronic system, integrated healthcare system, participatory design, World Health Organisation, good practices

1. Introduction

For a long period in Brazil history, the care of the disabled population was neglected by the government and was provided mostly by the charitable institutions [1]. A turning point to this scenario was the creation of the national plan for the rights of the disabled people in year 2011. The Brazilian government plan consolidates a series of policies concerning social inclusion, access to education, accessibility and healthcare, the last of which declares the provision of wheelchairs free of cost for those in need [2].

It is a well-accepted fact in the literature that a wrong wheelchair specification can harm both the user and the caregiver and lead to the discontinuance of device use, resulting in wastage of time and resources committed to the wheelchair provision [3–6]. To confront these issues, the World Health Organisation (WHO) elaborated a series of good practices in the form of wheelchair service training material aiming the right wheelchair fit to the user characteristics [6–8]. Despite so, there was no evidence before the conduction of this study that the service provided in Brazil adheres to these guidelines or other wheelchair service good practices.

This chapter reviews the results of a study conducted in the wheelchair service provision in Belo Horizonte city, Brazil, with the aim to understand the functionality of these services in order to provide context-specific interventions and recommendations to improve the design of current services. This chapter emphasises how technologies have been used to collect user information and support informed

decisions in the wheelchair service provided at Belo Horizonte city's National Health Service. The study compared the information collected to existing good practices and proposed interventions to promote the WHO's suggested good practices.

2. The complexity of brazilian healthcare services

Between countries with a population larger than 100 million inhabitants, Brazil is the only to declare healthcare as a duty of the State and a civil right, providing free of charge services to its population [9]. Public healthcare provision in Brazil occurs by a complex range of system and subsystems that includes public and private care. The Brazilian National Health service called *Serviço Único de Saúde* (SUS) integrates services between municipalities, states, and the union to the philanthropic and for-profit services. The SUS is the only health service choice for more than three-quarters of the Brazilian population, serving more than 150 million people [9, 10]. With such a large and diverse population using a service that involves many institutions, managing user information represents a vital role for the well-functioning of the service.

The Brazilian healthcare service SUS is organised to operate similarly throughout the country. Despite great centralisation of SUS management under the union responsibility in the past, the focus has shifted to its decentralisation with emphases in its municipality level [11]. Consequently, it became more important to understand the municipality context in order to investigate its current issues and provide context-specific interventions.

This study focused on SUS services provided in Belo Horizonte city. The city is the capital of Minas Gerais state and represents a complex and unequal space that needs to be understood [12].

3. The move towards an integrated healthcare system

In a seminal book from the *Organização Panamericana de Saúde*—a regional WHO organisation—Mendes [13] reviews the existing healthcare systems and calls the attention for the move from fragmented to integrated healthcare systems. He explains that fragmented systems tend to focus on the health conditions and acute events and are heavily dependent on clinicians and nurses. On the other hand, the integrated systems have a balanced focus between acute and chronic conditions and stand on a multidisciplinary team. Mendes reinforces the trend in healthcare systems to move from fragmented to integrated systems, resulting in an increased role of multidisciplinary primary care teams in the coordination of the user care.

From the advancements made in Brazil towards a more integrated system, Mendes mentions the creation of health centres in the 1960s, the programme *Ações Integradas de Saúde* (suggested translation: Integrated Health Action programme) created in the 1980s, and the ongoing *Programa Saúde da Família* (PSF, suggested translation: Family Health Programme).

Another strategy added towards an integrated health system was the *Estratégia de Saúde da Família* (suggested translation: Family Health Strategies); the aim of which is to restructure the primary care in SUS employing the *Equipe de Saúde da Família* (ESF, suggested translation: Family Health Team). ESF is a multidisciplinary team supporting the primary care units formed by a minimum of one general practitioner or specialist in family health, one general nurse, one nurse technician and one community health agent [14]. To consolidate the multidisciplinary of the primary care, the government created in 2008 the *Núcleo de Apoio à Saúde da Família* (NASF, suggested translation: Health Family Support Team)

increasing the service offer and access and providing a bridge between primary and secondary care [15]. Each NASF team is composed of up to 19 professionals from a diverse clinical proficiencies providing support among 8–20 ESF teams. NASF personnel vary from physiotherapist, phonoaudiologist, social worker, acupuncturist, nutritionist, and psychologist, to cite a few examples. The purpose was to provide multidisciplinary care by fostering discussion of clinical cases, assessing users in its home environment, operating in the prevention and health promotion, supporting therapeutic projects and qualifying and increasing health interventions [16].

4. The wheelchair service functioning

The functioning of the SUS requires that user information flow between primary, secondary and other levels of care. It means that information is collected and shared between the ESF team, NASF team and other institutions related to additional levels of care.

The primary care team from ESF and NASF first identifies in the community the user in need of a wheelchair or other assistive technologies provided by the SUS. These users are then referred to the secondary level of care. In Belo Horizonte city, assistive technology services, such as the wheelchair service, are provided at SUS level by the CReabs (short for rehabilitation centres). Hence, information flow related to the wheelchair service occurs mainly between the staff from ESF, NASF, CReab and the wheelchair suppliers (**Figure 1**).

The services vary according to the type of wheelchair offered, classified internally into two different categories: standard wheelchairs and adapted wheelchairs.

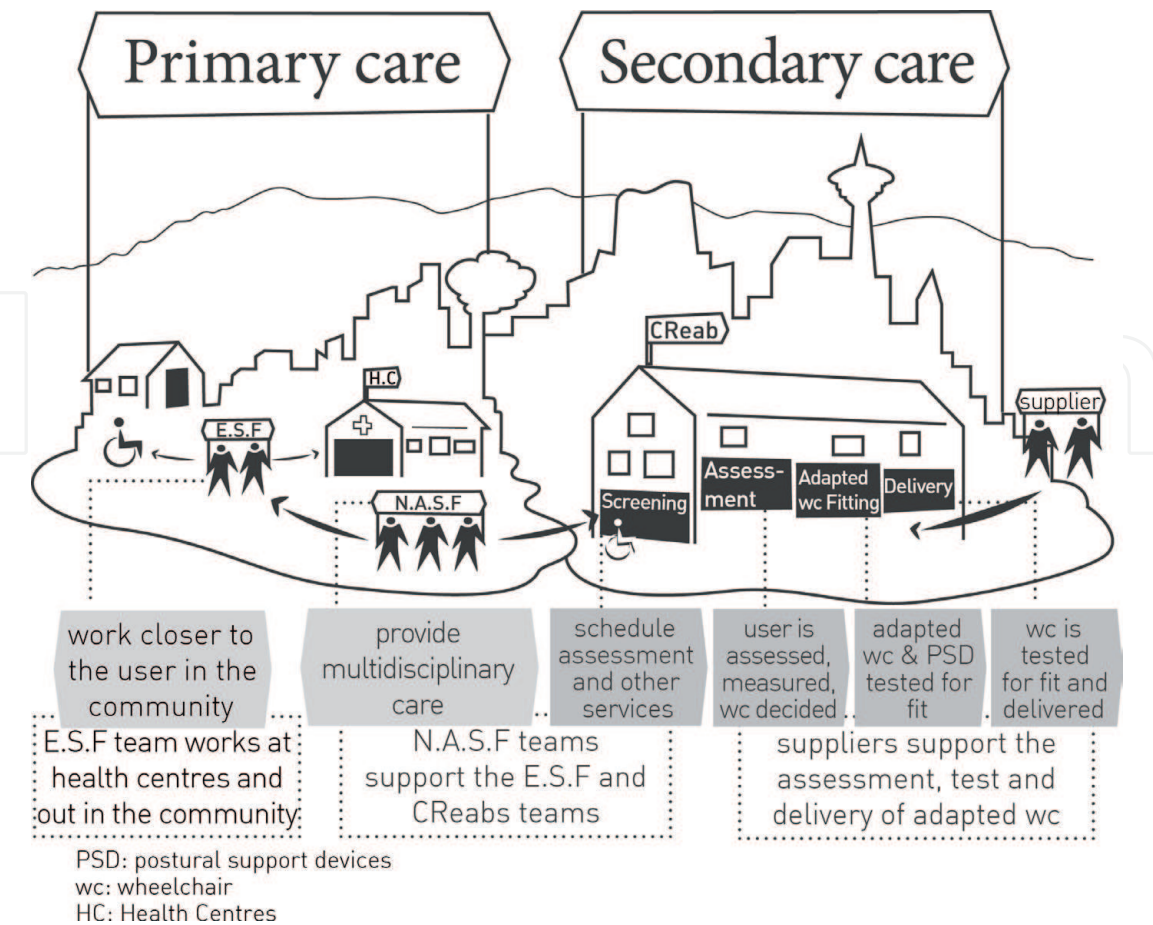


Figure 1.
Healthcare teams and stages involved in Belo Horizonte wheelchair provision.

The first two service stages are common to all wheelchair users, which are the *screening* and the *assessment stage*.

The *screening stage* is the entrance door for all CReab service users (**Figure 1**). In this stage, users provide their referral to the CReab staff who shortly assesses their overall requirements, often beyond the referral area. The outcome is scheduling the users to the available services including services provided by third-party institutions. The users in need of a wheelchair are scheduled for an *assessment stage* at CReabs.

At the *assessment stage*, the CReab staff assess the user, take their measurements and decide if the required wheelchair is standard or adapted. If an option is made for a standard wheelchair, the model and specification are agreed with the user, and

Stage		Activity	How information is recorded
Primary Care		CReab service or assistive technology device is prescribed	Referral form <i>Solicitação de OPMAL</i>
	Screening	User is referred to a rehabilitation service	Referral form <i>Solitação de tratamento fisioterápico</i> AND Electronic System SISREG
User is referred to assessment stage		Assessment waiting list spreadsheet*	
User needs to return to the referring institution		Counter referral form <i>Guia de contra referência</i>	
Secondary Care (at CReab)	Assessment (CReab staff)	Interview with the user	Electronic System SISREDE , or Form <i>Ficha de Evolução Manual</i>
		Measure the user	Form <i>Dimensões Básicas do Cliente</i> *
		Specify the wheelchair characteristics	Form <i>Especificação da Cadeira de Sistema Postural</i> *
		Authorize the wheelchair purchase	Authorization report
	Assessment with supplier	CReab staff interview the user	Electronic System SISREDE , or Form <i>Ficha de Evolução Manual</i>
		Supplier interview the user	Form vary according to supplier
		Supplier staff measure the user	"
		CReab and/or supplier staff specify wc characteristics	"
		CReab Staff authorize the Wheelchair purchase	Authorization report
	Wheelchair fitting	CReab staff accompany the supplier	Electronic System SISREDE or Form <i>Ficha de Evolução Manual</i>
	Delivery	CReab and/or supplier staff test wheelchair fit	Electronic System SISREDE or Form <i>Ficha de Evolução Manual</i>
		User sign the receiving of the wheelchair	Authorization report
	* Name and form vary slightly between CReab		

Table 1.
Electronic systems and printed forms used to collect user information.

the wheelchair purchase is authorised (**Table 1**). If a decision is made for an adapted wheelchair, the user is scheduled for another assessment with the selected supplier staff in conjunction with CReab staff.

One additional stage may be required for users in need of an adapted wheelchair after the assessment with the supplier. Often bespoke adjustments are expected to accommodate the user deformities or specific requirements such as structure to accommodate ventilator or other devices. During the *adapted wheelchair fitting stage*, the supplier staff in conjunction with CReab staff fit the users in a partially made wheelchair to determine the required postural support devices (PSDs) and other bespoke modifications.

The service cycle is completed after the *delivery stage* (**Figure 1**). At this stage, the user is assessed for the wheelchair fit. If no problems are encountered and the wheelchair fit the user as expected, he or she receives the service guarantee and signs the delivery of the wheelchair, concluding the service cycle. Nonetheless, if the user, the supplier or the CReab staff identify any issue with the wheelchair fit or any other problem with the wheelchair, a decision is required. This can vary from a simple on-spot adjustment to the replacement of the wheelchair model and restart of the entire service cycle.

5. The existing technologies

In order to deal with the multilayer complexity of the wheelchair service in Belo Horizonte SUS, two electronic systems are employed. The *Sistema de Informação de Regulação das Ações de Saúde* (SISREG) is one of them. SISREG was created to be used in the entire country to coordinate the request for hospital and outpatient services. SISREG intends to speed up the population access to health services by exchanging information between regional health units through the Internet. The other system used is the *Sistema Saúde em Rede* (SISREDE). The SISREDE is a local-level intranet system implemented by the Belo Horizonte Municipal Department of Health aiming to integrate and manage user information.

In addition to the electronic systems, a series of digital and printed files such as referral forms and an authorisation report are used to collect user information and record service procedures (**Table 1**). The printed forms specific to the wheelchair service are made available to the practitioners directly involved in the service and kept in a physical folder. This folder also contains information and photos about the wheelchairs supplied.

6. Current issues

The SISREDE system was developed based on the concept of business intelligence (BI), which refers to technologies, applications and practices for the collection, integration, analysis and presentation of business information [17]. The purpose of BI is to support better business decision-making. Though the SISREDE enables recording and reassessing user information as well as producing reports, it does not guarantee the quality of the healthcare information recorded neither promotes service quality on a general scale. For that, information collected should comply with evidence-based practice and existing healthcare and service delivery system good practices. The SISREDE system does enable the incorporation of such good practices as it was designed to permit personalised healthcare assessment. However, the study found that the system was yet adapted to comply with existing good practices in assistive technology services and did not reflect the requirements of many key stakeholders.

Currently, the SISREDE only requires the collection of elementary information about the user, its health condition and its environment. The study revealed there was no consensus between CReabs staff regarding how to conduct the activities involved in the various service stages. There was no use of an evidence-based protocol to ensure that the necessary areas were covered when assessing the users or fitting the wheelchair to them. There was no clear agreement about what kind of information should be passed or who should pass them. Many users ended up not being informed concerning various topics. Therefore, the recurrence of similar information passed to users was considerably low. Also, duplicated information was collected by different staff in different stages whether important information was not being collected thoroughly. The study concluded that the information collected proved not enough to comply with existing good practices in wheelchair services. Many gaps were found regarding the service good practices suggested by the WHO [6–8] and the Association for the Advancement of Assistive Technology in Europe (AAATE) [18]. These are exposed in **Figure 2** by means of a Swiss cheese model for cumulative effects. The model is used to identify cumulative failures in various stages of a process or complex system that can lead to accidents, often applied to identify the causes of accidents on mass transportation systems and to improve healthcare systems. The holes represent current failures and latent conditions. An adverse outcome occurs when the holes in various layers line up to permit a trajectory, allowing an accident to occur [19]. In this case, the accident was interpreted as the risk of the wheelchair not fitting the user profile.

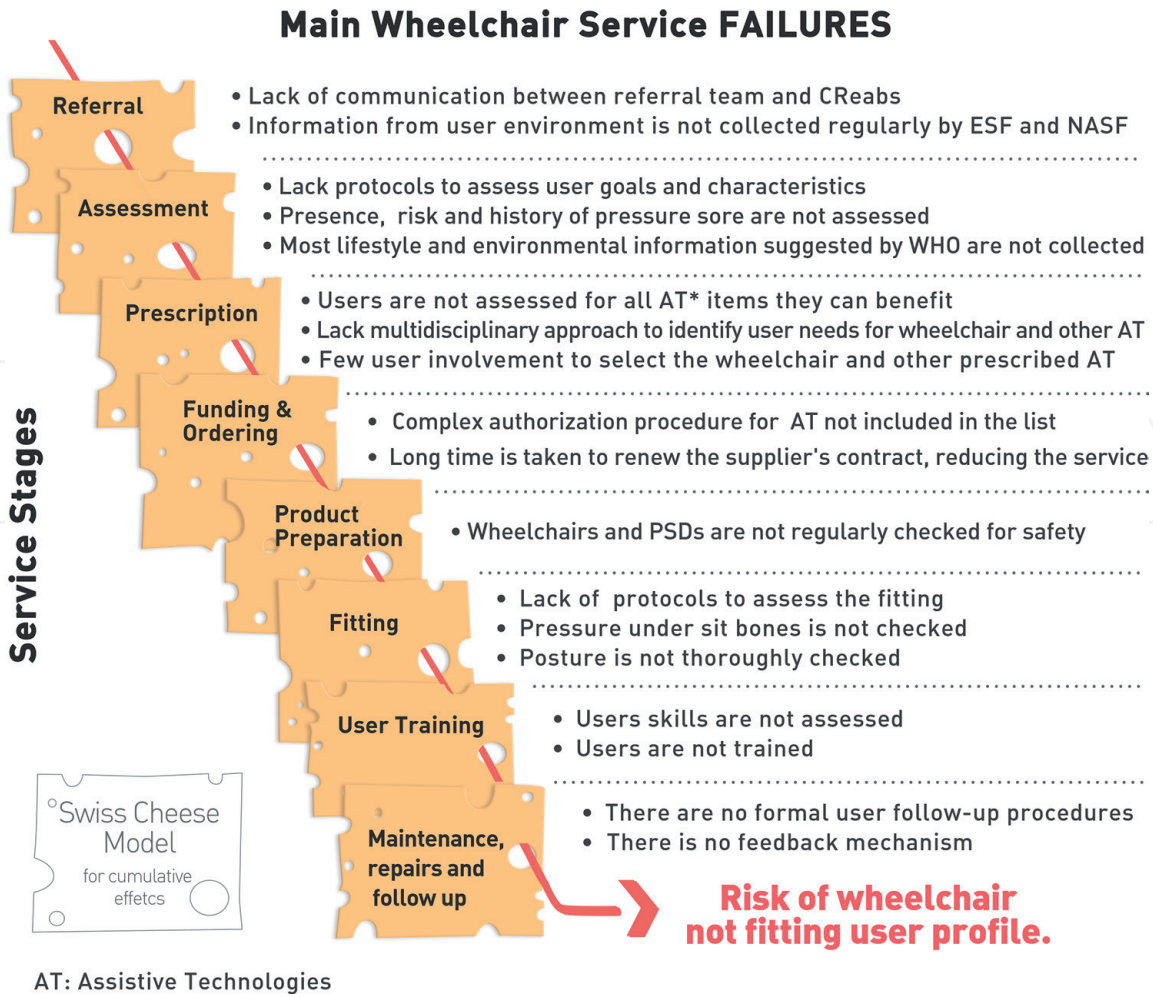


Figure 2.
Main failures to apply the wheelchair service good practices.

7. Overcoming barriers through participatory design

To improve service quality and promote wheelchair service good practices, the researcher adopted a participatory approach to understand contextual barriers and engage the service stakeholders in the design of a series of interventions. During 3 months, service providers were observed on a variety of wheelchair service procedures ($n = 153$) to understand how user information was collected and used in comparison to existing good practices. After observations, semi-structured interviews ($n = 12$) and a follow-up survey ($n = 11$) were conducted with service stakeholders to understand the applicability of existing good practices and design the interventions. The intervention consisted of a set of forms and a checklist based on the WHO wheelchair service training package [7, 8]. The intervention contained:

- A referral form
- An entry-level form to collect information about the user environment
- A measurement tape to be given to the user with which to collect raw data
- An assessment form
- A wheelchair fitting checklist
- A leaflet for the user about pressure sore prevention and care.

The interventions were tested in 95 service procedures, by the end of which a copy of the suggested forms and checklists tested were collected. Follow-up interviews were conducted with practitioners using the suggested forms and checklists ($n = 17$) to understand the barriers encountered and how to improve the forms and checklist to the service context. Follow-up interviews were also conducted with service managers and administrators ($n = 9$) to investigate possible ways to mitigate the barriers encountered and meet the different stakeholders' requirements. Key stakeholders identified were the wheelchair user and its caregivers, healthcare practitioners from CReab and suppliers, administrative staff from CReabs and management staff from CReab, suppliers and Belo Horizonte Municipal Department of Health. The intervention tested was modified and presented to each CReab centre. On the opportunity, an executive summary was delivered to service managers containing a summary of the research findings, the updated protocols and suggestions on feasible implementation guidelines.

8. Not just the right for a wheelchair but the right wheelchair

Initially, many practitioners recommended that the information collected in the suggested interventions should be added to the SISREDE to guarantee that every care comply with good practices. Nonetheless, the bureaucracy to suggest changes in the SISREDE system proved to be a huge barrier, and it was not possible to pilot it during the study. Instead, two types of files were made available to CReab practitioners when testing the protocols suggested in the intervention: digital interactive fillable forms in pdf format and printed forms.

Some participants from the screening stage showed signs of resistance to test the interventions designed for this stage, suggesting that they required more time and training. CReab coordinators noticed that this resistance occurred mostly between

participants that had not been involved in the early studies or did not engage in the study presentations, proving the importance to engage as many practitioners as possible from the early stages of interventions. A critical suggestion from participants using the interventions for the screening was to clarify how service users can accurately gather information from their environment in order to bring to the assessment stage.

Interventions designed for the assessment stage, the assessment form, were well received by all participants. Even though there was a minor increase of 2–5 minutes in the average time spent when using the assessment form, the increase did not reach statistical significance (as $P > 0.5$) [20]. It called the attention that most participants did not complete the form sections related to the presence, risk or history of pressure sores even though the cushion to relieve the pressure was one of the latest items included in the list of devices offered by the SUS. The reasons are likely related to other findings such as the lack of staff training to assess the users' pressure sores and the lack of criteria to prescribe the pressure relief cushions. As a result, there was no prescription of cushions to relieve pressure within the study observations.

There were various modifications to the assessment form. A key modification was including the assessment of other assistive technologies provided by the SUS that are directly involved with the wheelchair use such as activity table, transfer board and cushion to relieve the pressure.

Although no resistance was encountered to use the proposed wheelchair fitting checklist, the CReab participants did not check the pressure under the user seat bones, an activity suggested in the form. The main modification to the fitting checklist was inserting an observation entry field at the end of each section to accommodate practitioners' notes observed to support informed decisions.

It was recognised that training is necessary to formally implement the protocols in the service and overcome existing barriers. Most of the suggested trainings can be achieved using the resources from the WHO wheelchair service training package basic level [7], available in Portuguese language.

When interviewed after testing the interventions, practitioners were asked again about adding the forms and intervention to the SISREDE system. Many have changed their mind not to add it to the system stating that it would only add one more step as they would have to print the forms to attach to each user archive. Another point raised was the system's lack of stability. Many practitioners were observed taking hand notes or using a word processing software before transferring their notes to the SISREDE system, afraid to lose their assessment annotations.

9. The future of SUS and the use of smart technologies

Although Brazilians have access to free of charge public healthcare services, there is still a long way to improve service quality in order to comply with existing good practices.

Restricted funding is certainly a crucial concern in stopping SUS development. Reports indicate that the private healthcare sector invests more than the government, although the SUS is the main source of care for nearly three-quarters of the Brazilian population [21]. Besides, the government healthcare expenditure per year with each citizen has been way below the world's average rate [21]. Also, there is a limited resource of around 24.5 million Brazilian reais—approximately 6.6 million US dollars at quotation in 17/01/2019—for the annual costs regarding the assistive technologies procedures at the SUS [22]. During this study, the suppliers' participants often complained about the low price paid on most assistive technologies, only updated once in 7 years while Brazil inflation had grown drastically in recent years. The consumer price index used to measure country inflation was 6.4% in 2014 and 10.6% in 2015

when the study was conducted [23]. With healthcare investments frozen from 2017 to 2037, there is no indication that the situation will improve but actually will worsen as the population relying on the SUS has been growing as a consequence of the financial crises lived in Brazil [24]. On top of that, there is still the danger for current social advancements and programmes to be discontinued or started from scratch whenever a new political party assumes the power [25, 26]. It is difficult to believe that the quality of the service can significantly improve without increasing the budget not only for the assistive technology procedures but for the SUS service overall.

The current financial restrictions only emphasise the importance to make better use of the existing electronic system to promote service quality. Considering that the current electronic system can incorporate existing healthcare protocols and good practices, more effort should be put to alleviate the bureaucracy involved in improving the system. Modification should consider not only practitioners' personal requirements but also the integration between the needs of different service stakeholders. Users in need of assistive technologies should be assessed for the entirety of assistive solutions required or at least for those provided by the service. Also, the system should be more reliable, so it can record procedures without having to require the staff to take additional notes or print the information collected.

The research proved a great interest from practitioners to implement existing good practices. The primary barrier to improving the service quality on their own is the lack of time due to service queue and difficulty in accessing information. Participants complained that academic institutions researching the SUS hardly ever return to the service to share the results, provide recommendations or engage in service improvement. One result illustrates the need for more conversation between academic institutions and local healthcare. Brazilian government created in 2010 an open university network for the SUS' practitioners to deal with the lack of training and lack of access to information. The platform includes four modules related to assistive technology provision with 30 hours course load each [27]. However, only two CReab participants reported enrolling any of the modules offered even though the course was developed by a federal university located in Belo Horizonte [28]. Future research and public policies should address this gap and encourage academic institutions to be more engaged in local healthcare service provision, helping to identify issues and not only providing care solutions to its community but also helping to implement them.

It appears that in order to provide better quality service, public healthcare in Brazil may have to rely on 'not-so-smart technologies' for a while.

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Conflict of interest

I hereby declare that I have no affiliations with or involvement in any organisation or entity with any financial interest or nonfinancial interest in the subject matter or materials discussed in this manuscript.

Appendices and nomenclature

AAATE	Association for the Advancement of Assistive Technology in Europe
BI	business intelligence
CReab	Centro de reabilitação
ESF	Equipe de Saúde da Família
NASF	Núcleo de Apoio à Saúde da Família
OPMAL	Órteses, próteses e meios auxiliares de locomoção
PSD	postural support devices
PSF	Programa Saúde da Família
SISREDE	Sistema Saúde em Rede
SISREG	Sistema de Informação de Regulação das Ações de Saúde
SUS	Sistema Único de Saúde
WC	wheelchair
WHO	World Health Organisation
WSTP	Wheelchair Service Training Package

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