Interchangeable face-to-face treatment-telehealth model using cloud system

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ABSTRACT
to bring assistance to rural areas of the United States. Although relevant, social and technological factors have limited the advancement of this type of service. However, the worsening of the health crisis caused by the coronavirus highlighted the importance of this type of tool and the need to improve them for the new social, economic and regulatory context. This work presents a new interchangeable face-to-face-telehealth treatment model mediated by an integrated system with cloud operation that combines traditional care with synchronous and asynchronous interactions regulated in Brazil. The system was validated in two medical clinics with the help of several health professionals. After two years of operation, 7,542 appointments were made and 3,677 consultations were recorded in electronic medical records, 1,434 asynchronous consultations were also performed, most of which were returns. Preliminary results indicate that the model is potentially viable for the various branches of health, even if the volume of synchronous consultations is still low.

Keywords: Telehealth, Online service, Synchronous, Asynchronous, Cloud system.

1 INTRODUCTION

The search for viable telemedicine solutions began to gain prominence in the 1960s in the face of the needs of NASA and the Nebraska Institute of Psychology (1). Initially proposed to facilitate access to basic care in rural regions (2,3), the adoption of teleservice was initially slow because of factors such as lack of technological infrastructure, limited devices and because it was very expensive for the time (1).

However, the worsening of the health crisis caused by the coronavirus (4) has put the topic of telehealth back at the center of the debate, expanding the use of this mechanism on a global scale (5) and changing the way people access health services. Technological limitations were attenuated,

teleservice systems were improved and resistance to the remote model was overcome by the need to provide assistance to the population.

This new scenario has required the countries of the world to advance both in technology and in improving the laws that govern health systems. In Brazil, for example, the use of telemedicine (4) was initially authorized during the COVID-19 pandemic, through Law No. 13,989 and definitively regulated as a form of medical service mediated by synchronous and asynchronous communication technologies by resolution No. 2,314 of the Federal Council of Medicine - CFM (6), in May 2022.

These changes, previously viewed with fear, are proving to be positive, as recent studies show that the perception of patients and health professionals are converging on the use of technological solutions. In some specialties, for example, the degree of satisfaction of patients treated by telemedicine varies between 90% and 100% and the rate of absence (*no show*) is lower than in face-to-face care (7, 8). The health professionals were also satisfied with the teleservice, especially when they engaged in the process of developing the solutions and had technical and administrative support during the use (7).

Although the studies indicate a favorable condition for the use of telehealth and there are solutions available in the market to meet this demand, some problems are still open, such as the implementation of interchangeable care processes, that is, that alternate between face-to-face, synchronous and asynchronous meetings, constituting treatment cycles that are defined by the professional and integrated into the patient's electronic medical record.

1.1 PROPOSAL

Observing the open problems, this work presents a proposed solution for telehealth integrated with a technological platform of cloud operation. This tool enables synchronous and asynchronous services in an innovative way. The synchronous service is realized through video call, while the asynchronous uses questionnaires and sending files. These resources, when combined with face-to-face care, allow the creation of cyclical care processes combining face-to-face with telehealth, regardless of how treatment was initiated, creating an exchange between these modalities. This strategy allows to reduce the operational costs of service providers, as well as increase the practicality, economy and comfort of patients.

1.2 CONTRIBUTIONS

In essence, this study presents (i) asynchronous telehealth modeling with consultation and return; (ii) interchangeable modeling of synchronous and asynchronous telehealth; (iii) the implementation of synchronous and asynchronous telehealth integrated into the electronic medical record; (iv) and the results of validation of the solution using computers, smartphones and tablets in

clinical medicine. This solution proposes to make life easier for patients and health professionals by streamlining care, removing the need for transportation and increasing, in general, access to health.

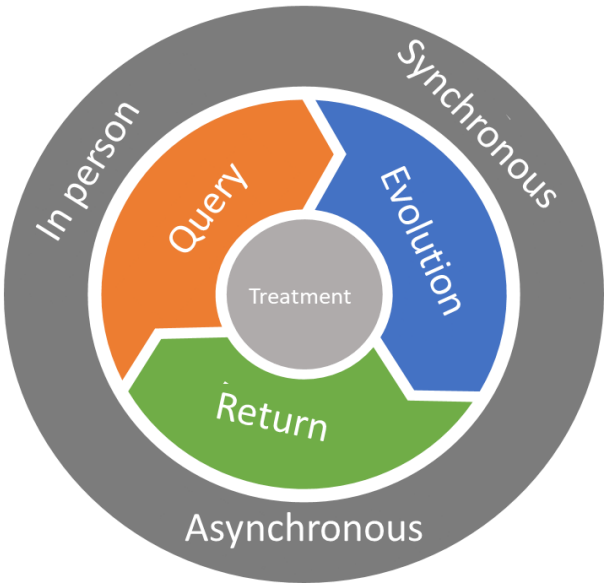
2 MATERIALS AND METHODS

This work was developed from experiences lived in a medical clinic with specialties in the areas of medicine, physiotherapy and psychology in operation during the COVID-19 pandemic. In this period, it was possible to carry out studies on the main technological needs of a medical clinic, which together with the legal regulations of Law No. 13,989 and Resolution No. 2,314 of the CFM, allowed to acquire the necessary knowledge to build a product that met the current demands of these areas.

The telehealth solution mediated by the proposed model works to improve the traditional care process, where the patient with some disease seeks a health professional to perform their treatment. In the traditional process, the consultation takes place with face-to-face contact between doctor and patient. This doctor-patient contact can happen again according to the evolution of the treatment of the disease, leading to a cycle of consultations and returns.

As an improvement of the care methodology, this work approaches the concepts of face-to-face consultations and telehealth (synchronous and asynchronous) as an integrated treatment cycle that allows up to nine combinations of forms of care that the professional can use in the conduct of treatment, as illustrated in the Figure 1. This means, for example, that a treatment initiated in person, through a consultation, can continue by telehealth and return to face-to-face according to the perception of the professional who is conducting it. This modeling, therefore, allows for any combination of these three forms of care during the treatment cycle.

Figure 1. Treatment cycles



2.1 MODELLING

The proposed treatment cycle model is designed to be flexible and allow the professional, together with his patient, to decide the type of consultation, return or evolution record that best fits the conduct of the treatment.

The Figure 1 illustrates the treatment model interchangeable face-to-face care and synchronous and asynchronous telehealth proposed in this work.

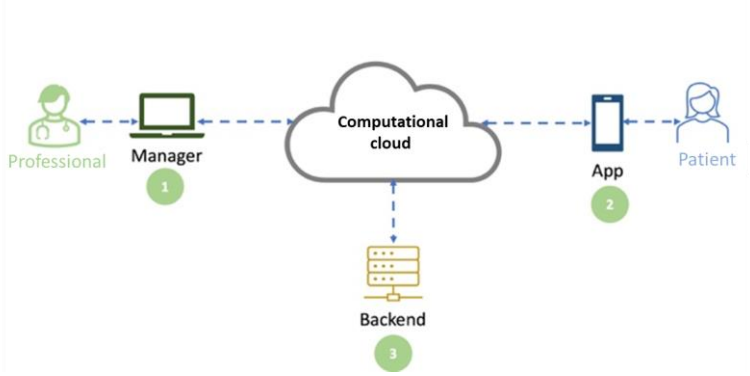
Treatment is at the center of the model and represents the perception of value for the patient who seeks a solution to their health complaints. These complaints are presented through an **initial face-to-face consultation** or by telehealth and analyzed by the professional, who indicates a conduct to resolve, mitigate or deepen the investigation. The **evolution,** in turn, indicates the current state in relation to the last record made in the patient's medical record and can be conducted through a return that can be performed in the face-to-face , **synchronous** or **asynchronous** modality.

The outer circle of the model containing the modalities of face-to-face, synchronous and asynchronous care described in CFM Resolution No. 2,314 gives the proposed model both flexibility to perform treatments and also ensures regulatory compliance.

2.2 ARCHITECTURE

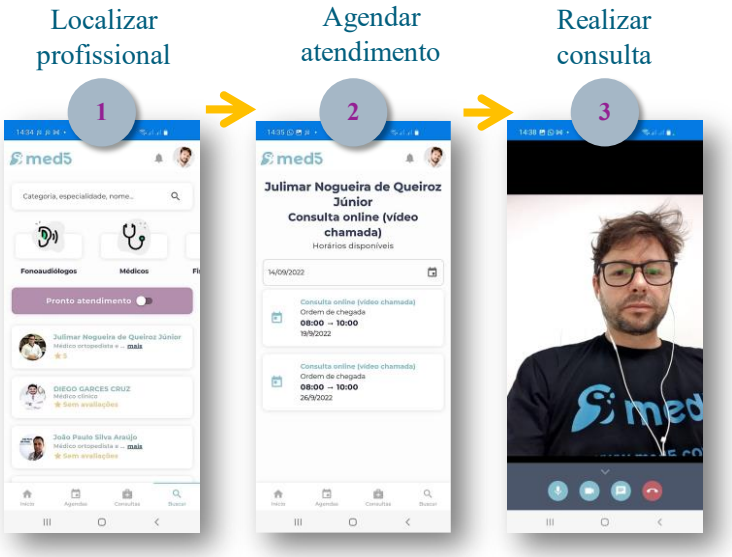
The proposed model was implemented through three distributed systems that operate in a computational cloud environment (10), as illustrated in the Figure 2. The first system (*Manager*) mainly manages professionals, agendas, services and medical records. The second (*App*) is used by patients to schedule, pay, perform appointments and access the electronic medical record. The third system (*Backend*) is dedicated to data management and allows communication between *Manager* and *App*.

Figure 2. System architecture



In the process to perform a synchronous care, for example, the patient seeks the desired professional, schedules the service and makes the appointment using the application (App), as illustrated in the Figure 3.

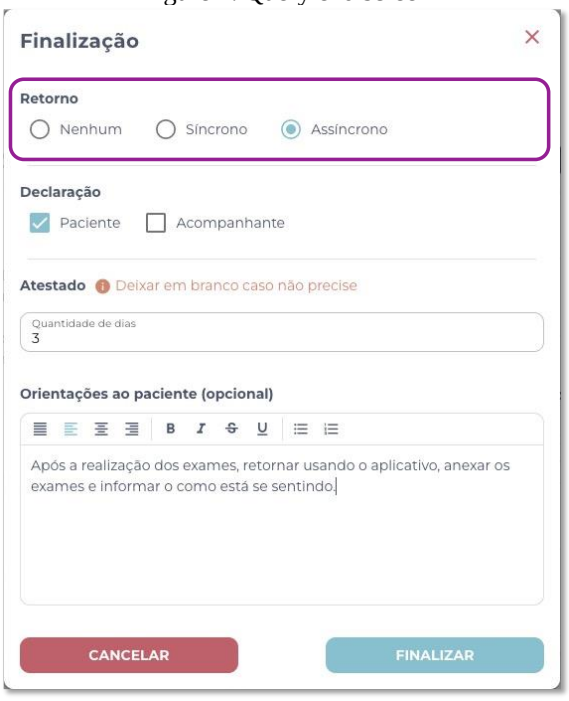
Figure 3. Synchronous query flow using the App



The professional, in turn, uses the *Manager system* to conduct the service, record the information in the electronic medical record and concretize the conducts.

After the treatment cycle has begun, the professional decides the modality of the next care during the end of the consultation or in the evaluation of the return, marking the option none, synchronous or asynchronous, as shown in the Figure 4. Each of these modalities produces a different behavior in the application.

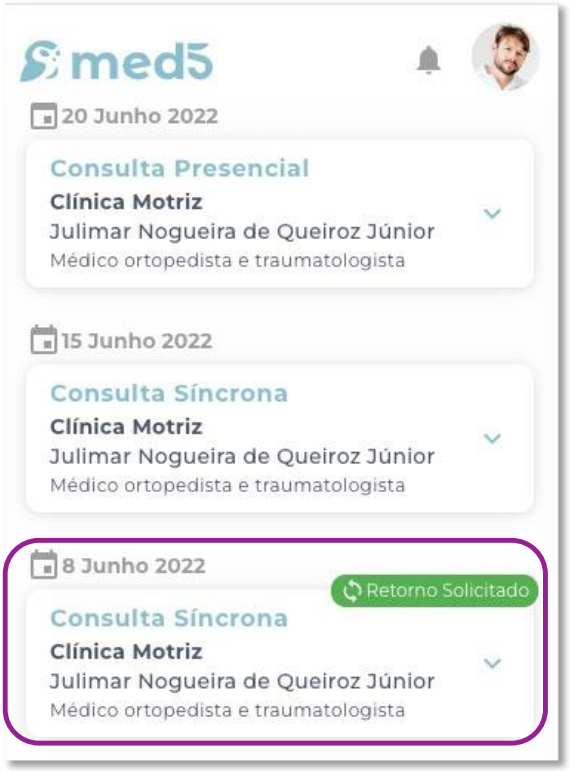
Figure 4. Query end screen



This allows the physician, for example, to record the evolution and adopt some conduct, modify or terminate the treatment cycle by communicating directly with the patient through the electronic medical record.

For the case of asynchronous returns, the application enables the option so that the patient can add files and describe their current state of health. The Figure 5 presents an example of asynchronous return requested for the June 8, 2022 query.

Figure 5. App screen with requested return



2.3 DEPLOYMENT AND VALIDATION

The validation process of the proposed solution took place along with the various stages of implementation in a clinic partner of the project. In the first stage, the electronic calendar functionalities were implemented in the *Manager system*. Afterwards, these facilities were implemented in the *App* used by the patients.

In the subsequent stages, other functionalities were implemented, such as Electronic Patient Records (EHR), asynchronous consultations and synchronous consultations. In all cases, the validation strategy used was based on agile methods, such as Scrum (11), through continuous deliveries of small increments that added some type of value to customers. The criticisms and suggestions pointed out during the validation process were compiled and incorporated into the following deliveries.

This way of working allowed the engagement of both the support team and the professionals involved in the implementation and validation process. Such engagement, with constant *feedback*

presentation and use in the production environment allowed the improvement of functionalities and the reduction of occurrence of errors in the system.

2.4 INFORMATION SECURITY

The information security aspects were addressed at all stages of the system construction process. In addition to the principles of confidentiality, integrity and availability, contained in the ISO NBR 27000 family of standards (12), the dictates of the General Law for the Protection of Personal Data – LGPD (13) and the requirements of the certification manual for Electronic Health Record Systems (S-RES) of SBIS (14) were also observed. In this last item, especially the NGS1 group, the systems have an average compliance of 80% for the items addressed, as indicated in the Table 1.

Table 1. Compliance with S-RES version 5.2 certification

Requirement	Compliance
NGS1.02	61%
NGS1.03	100%
NGS1.04	100%
NGS1.05	100%
NGS1.06	80%
NGS1.07	75%
NGS1.08	60%
NGS1.09	85%
NGS1.11	60%

Although several requirements of the certification manual have not yet been implemented, other security aspects for cloud services are present, such as self-scaling and fault tolerance.

3 RESULTS

This section highlights the results related to the treatment cycle model introduced in this paper.

In the period analyzed, which comprised the first two years of operation, a total of 7,542 appointments were registered in the system. Of this total, 68% were effectively attended and 32% did not show up for the service, as summarized in the Table 2.

Table 2. Scheduling indicators

Indicator	Total
Attendance	68%
Absences	32%

Absences include 27% of cancellations and 5% were those patients who confirmed but did not attend. The latter case is characterized as absenteeism or in the *show*.

In addition to the scheduling metrics, data related to appointments were tabulated with notes in the patients' electronic medical records. During this period, 8,181 interactions between professionals and patients were performed, distributed in the modalities of face-to-face care and telehealth (synchronous and asynchronous), as indicated in the Figure 6.

The results indicate a predominance of face-to-face care, representing 82%, in relation to telehealth with 18%. The main factors that explain this behavior are the operating time of the system and the cultural and technological barriers that still weigh in favor of face-to-face.

Even so, 1,434 asynchronous visits were recorded in twelve months of operation. What contributed most to this number were the returns of medical consultations. This modality proved to be practical and economical for both the professional and the patient.

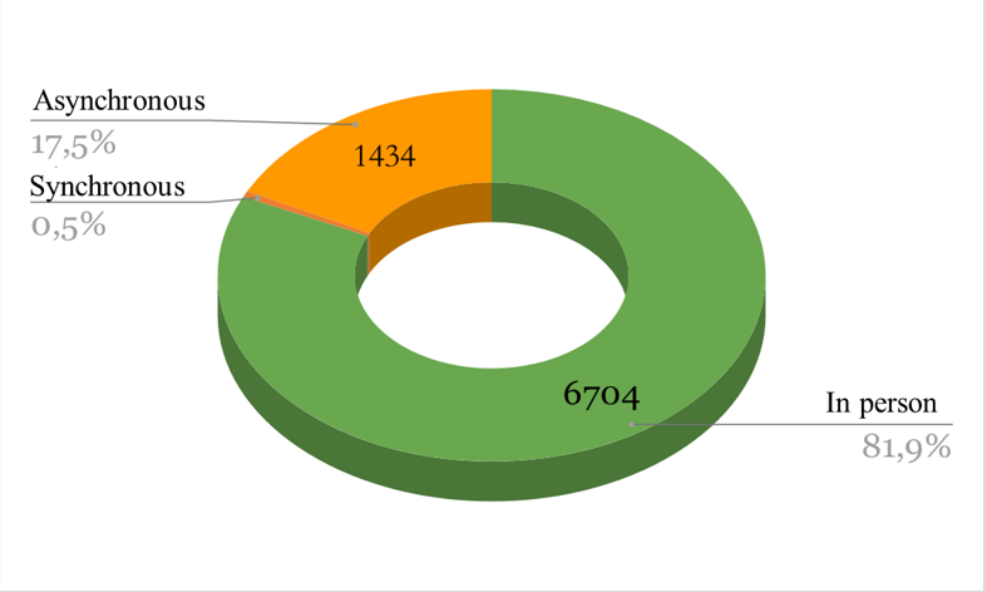
For synchronous visits, on the other hand, 43 visits were recorded. This lower number occurred mainly because this functionality went into operation in the last four months of the evaluation. In addition, this type of service does not have coverage by the agreements that allow the realization using third-party platforms.

Even in a smaller quantity, synchronous care using video call allowed to complete the validation of the model of interchangeable face-to-face care and telehealth in accordance with current regulations.

4 FINAL CONSIDERATIONS

This paper presented the health care model based on the face-to-face treatment-telehealth cycle. Through this model, the professional can decide what is the best care approach for each case. After two years of work, the model was completely validated in a production environment using a system running on a computational cloud service.

Figure 6. Distribution of care



The preliminary results show that the proposed system has the potential to assist in health care, bringing savings, safety and comfort to the patient. The performance of 1,434 asynchronous interactions between physicians and patients indicates that this modality can be applied in scenarios in which the conduct requires only the set of information existing in the medical record, such as examinations, reports and reports of the patient himself.

Throughout the journey, several manifestations of health professionals were reported. Most of the feedback presented was positive and in the sense of improving the system. However, technical and cultural difficulties and resistance to changes in work processes by health operators were also identified. In addition, cultural and technical barriers were observed on the part of patients to use the available resources.

Although the preliminary results are encouraging, the sample size is small to allow an assertive generalization that the model described is directly applicable to the various segments of health.

In future studies it is intended to expand the analysis of the proposed model when a larger and more diverse number of health professionals are using the system. Such analysis should be based on quantitative and qualitative indicators capable of measuring the performance of the system and evaluating patient satisfaction in the use of services. In addition, the planning includes the implementation of the other security requirements necessary to obtain SBIS version 5.2 certification.

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