Authentication In The Use Of Health Sensors To Remote Patients With Covid-19: A Proposal For The Telehealth Center In The Ebserh Network

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RESUME

Viruses will continue to emerge and bring challenges to the global public health system with emerging viruses through respiratory contagion that cause pandemics. This study aims to propose a way to use constant monitoring during the period of treatment of the patient with COVID-19 and, thus, reduce the negative indicators of death in the Brazilian territory. Methodological techniques were used in meta-analysis and systematic reviews in the selection of included studies when used in the construction of this systematic review. 05 articles were selected for inclusion in this critical analysis.

Keywords: Remote sensor, health monitoring, security, smartphone sensor, COVID-19, telemedicine.

INTRODUCTION

Telemedicine is an emerging technology that has benefits health care areas worldwide and especially the patients. It is considered an application in the medical field through the use of information technology that allow the patient to have control of his/her data outside the hospitalization system and uses this technology (01), for example, through the use of videoconferencing or digitized image (11-17). Therefore, this knowledge required interdisciplinary advances, particularly in the use of telecommunications, computer science and instrumentation for the purpose of exchanging and managing health data (05, 08, 14). Currently, the use of health sensors to monitor patients has attracted considerable attention in research due to the development of new technologies applied specifically to health. Some previous studies have demonstrated that the use of telemedicine applied in a wireless body area network known as the "wireless body area network" allowed continuous and real-time monitoring of the patient favoring assistance multidisciplinary in health (14-17).

For example, in the first coating of the sensor the patient can obtain his vital signs through small wireless sensors used in artificial intelligence and thus, sends them to the second coating known as personal

gateway or smartphones (12), this data transfer is carried out through protocols of small area network such as Bluetooth or Zigbee and WBAN (09). That is, these health data are sent from the level considered secondary to the tertiary level that the health service provider in hospital institutions (03-07), through wide area wireless communication protocols or Internet service (06-08).

Generally, healthcare provider at the third level carry out procedural actions that will generate services that are sent back to the patient in response (14-19). Specifically, the primary and secondary level will represent the patient's side and that patient can receive care through mobile care and the third level is side by side of the server (17, 18).

This health technology is a proficient tool that allows coordinated efforts among health professionals who can improve care and responses in real time (05). In the current days of the COVID-19 pandemic, this technology can be used to train the health team (10, 19), in diagnostics, in carrying out preventive or post-curative verification or monitoring of patients (19-25), in therapeutic procedures and monitoring, in the prescription of medications and in providing services to the patient or user of the SUS network (19, 20). In the world in relation to the last decade, it suffered from three major epidemiological outbreaks in the interval of 100 years and due to the occurrence of these outbreaks it was possible to perform the clinical identification of the action of these viruses, such as COVID-19 (19, 20). In early April, in Brazil (19, 20), severe pneumonia caused by COVID-19 (SARS-CoV-2) hit the country in populous regions such as the cities of São Paulo, Manaus and Rio de Janeiro (19). Due to the ease of transmission and lethality, the virus has reached regions in the interior of Brazil (19, 20). COVID-19 has its transmission similar to other forms of influenza, in short from humans to humans and the aggravation generally occurs according to the patient's previous clinical and immunological conditions that induces the main aggravation such as severe viral pneumonia (19, 20).

In Brazil as well as in other countries, severe pneumonia leads to death and its frequency increases in patients over the age of 60 years after the initial period of infection (19), however, death is largely related to the underlying health of patients and that is why we have highlighted the need for continuous monitoring of patients with COVID-19 mainly with a history of chronic diseases (02, 19, 20). Monitoring is possible because the patient with COVID-19 maintains a constant of symptoms, such as, high fever (≥ 38.0º C), fatigue, non-productive cough, dyspnea and diarrhea (02, 20).

Therefore the guiding question of this systematic review without meta-analysis in relation to the use of sensors in COVID-19 is (19, 20): How to use health sensors to monitor COVID-19 patients remotely in telehealth centers on the EBSERH network? In order to bring new opportunities for patient monitoring and follow-up, this study aims to propose a way of using constant monitoring during the patient's treatment period with COVID-19 and thus reducing the negative indicators of death in the Brazilian territory.

METHODOLOGY

The studies chosen to be included in this systematic review at the first level, were the studies that made use of treatments with hospital monitoring widely considerable in the patients of COVID-19 and in the second level the authors used the filtering of the studies in the respective platforms according to their base security, in this case, PubMed, Medline, Cochrane and EMBASE (Elsevier and Lancet). In order to

achieve a significant sample we use combinations of Keywords groups. In the first research group, the Keywords "hospital system", "tele monitoring", "E-health", "telemedicine", "telehealth", "remote monitoring", "medical-mobile" and "priority" were included which used the Boolean operators “OR”, “AND” and “AND NOT”. In the second research group, the terms “priority”, “priority” and “serious” were included. In the third research group on the platforms mentioned above, only the terms “sensor”, “COVID-19” and “Coronavirus” were included. The selected publications included original articles, pre-proof with acceptance, from 2010 to May 2020 (Figure 01) and without language restrictions. 1075 references were identified in four databases or repositories of scientific evidence. We use the “Rayyan - QCRI” manager for initial screening of titles and abstracts and removal of duplicate articles in the bibliographic survey, carried out by two reviewers. At the end, there were five primary studies that supported the conclusion of this review (Figure 01).

Figure 01 - Flowchart of the selection process for studies included in the systematic review

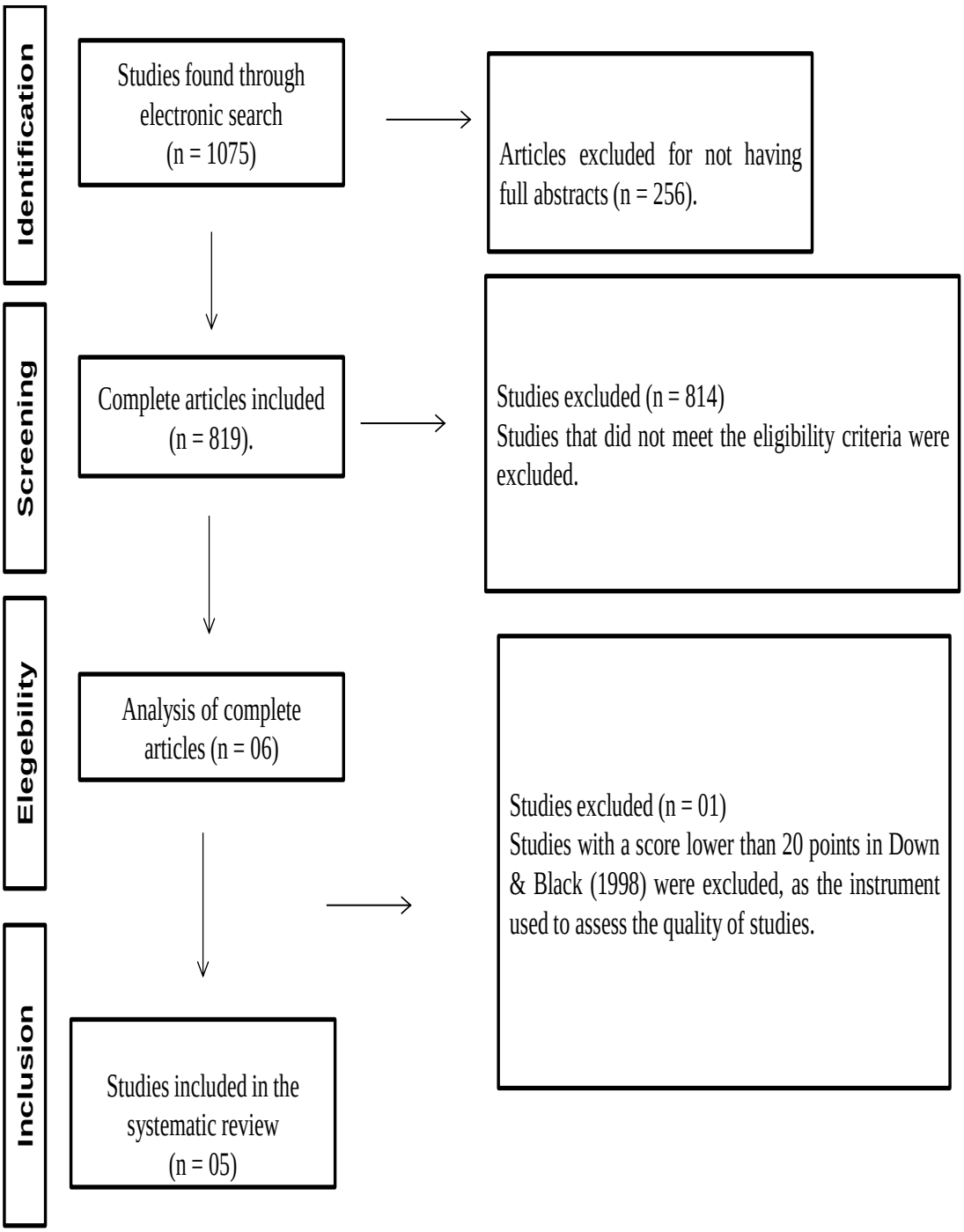

Identification
Studies found through electronic search (n = 1075)
Articles excluded for not having full abstracts (n = 256).
Screening
Complete articles included (n = 819).
Studies excluded (n = 814)
Studies that did not meet the eligibility criteria were excluded.
Elegebility
Analysis of complete articles (n = 06)
Studies excluded (n = 01)
Studies with a score lower than 20 points in Down & Black (1998) were excluded, as the instrument used to assess the quality of studies.
Inclusion
Studies included in the systematic review (n = 05)

Table 01 - Identification and classification of the methodological quality risk of the included studies according to Down and Black (1998).

Article Identification	Reporting (0 – 10)	External validity (0-03)	Internal validity – bias (0 – 07)	Confusion - bias of selection (0-06)	Power (0 – 5)	Total score
Zhang et al (2010)	10	03	04	03	00	20
Ping Guo et al. (2015)	10	03	04	03	00	20
Koch (2006)	10	03	05	03	00	21
Steven et al. (2015)	10	03	05	04	00	22
Michael Marschollek et al (2012)	09	03	04	05	00	21

SOURCE: SARA, H. D.; BLACK, N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health. v.52. p.377–384. 1998.

RESULTS

Remote sensor used in skin

Using remote skin sensors to monitor health parameters would be the ideal method for patients with COVID-19 at the time of epidemiological peaks (08). At the initial moment of the laboratory diagnosis, the patient with COVID-19 would be implanted and would measure continuously and remotely, wirelessly, and report the patient data related to the main clinical signs of the coronavirus and worsening of the disease (08, 12, 14, 25). Without restricting or affecting the patient and maintenance would not be necessary as artificial intelligence such as smartphones would be used (08,12). The only obstacle to the application system would be the excessive energy consumption that would present the need to recharge and maintain the smartphone device more frequently (12, 14). The best proposal for the development of the prototype will be the four axes of mobility, connection, property, measurement and measurement process in order to organize the sensors with the parameters related to health and in the future to develop a more advanced scheme (16). In this study, according to the study included in this systematic review, it defined as a sensor system for skin monitoring for application in the health area the risk assessment of worsening the patient through physiological changes such as respiratory or heart rate and analysis of the patient's thermal function (16), however, the authors emphasize that there are several other advanced designs using other skin monitoring sensors that will be mentioned in this systematic review (12-16).

Assessment of patient worsening with COVID-19 using a sensor

When analyzing the difference in cases of severe death between certain regions in the Chinese province which presented the initial outbreak, it is possible to verify useful information regarding the pathogenicity of the viroses (19). It is possible to observe that in countries like China, Italy and Brazil the patients with the highest incidence are male with a history of one or more comorbidities (19, 20), for example, kidney, cardiovascular, cerebrovascular disease, diabetes and hypertension. But what has been observed in these pandemic days is that COVID-19 has a direct relationship with comorbidities related to immune deficit and an indirect relationship with secondary bacterial infections (02, 20). The cases that presented death as a result occurred in patients with lymphopenia and inflammation secondary to pneumonia, that is, the death complication is directly related to the patient's pre-existing diseases. It is possible to highlight in this process of illness that other patients are able to recover with little or no medical and hospital intervention (19, 20). The main clinical signs for COVID-19 in patients with aggravation are persistent high fever ($\geq 38.0^{o}$ C), constant and excessive fatigue, frequent and dry cough, changes in respiratory rate and the presence of diarrhea (19, 20). In severe cases, the disease progresses to viral pneumonia and quickly in a few days to septic shock that is difficult to treat, metabolic acidosis and coagulation dysfunction which leads to death (19, 20).

Health sensors a new technology proposed to patients with COVID-19 in care at the Brazilian Hospital Services Company

The sensor has resources capable of processing the connectivity offered by smartphones, which allows several health professionals (Doctor, Nurse, Nutritionist and Pharmacist) to be removed from the call center, in this case, the hospital and taken directly to the patient (08, 12, 16, 22, 25). This is due to the possibility of using a combination of microfluidic forms that use only volumes of nano or picoliters of fluids and the use of this technology in microelectronics uses the scanning of sweat (08), blood, saliva, urine, tears and breathing. Using this diagnostic feature improves the convenience of testing by increasing the possibility of entirely new diagnostic features that would be accessible practically in place or time for the patient (12, 16). For example, this technology can be used in various point of care tests with resolutive through microfluidic technology to allow rapid diagnosis of infectious diseases like COVID-19 and these diagnoses can be accelerated with the use of this technology and qualify individual treatment well such as population screening (19, 16, 25). In addition, using genetic diagnostic technologies binds the smartphone by allowing the use of new health technologies that are fast and accurate for n-types of pathogens and thus enable new technological application for clinical measures and clinical research, such as pharmacogenomics in which gene diagnosis will be favored by sensor technology (22, 25).

Steven et al (2015) (22) reports that the use of olfactory technological capabilities similar to that of a dog, known as “electronic nose”, associated with the smartphone can offer rapid and remarkable diagnostic capacity for a wide range of conditions including early detection cancer or diseases such as tuberculosis and COVID-19 (22, 25). Also, using high quality lenses from cameras and with smartphone screen resolution, simplifies your optical system for a number of applications, from photometric diagnosis to the resolution of complex medical imaging exams (12, 22, 25). This is due to the recently developed devices that allow the automated determination of refractive error with an individual look coupled to a

smartphone. Other options feature transportable imaging capabilities and involves the possibility of remote diagnosis through the use of a smartphone case with an otoscope which is connected to detect ear infections (22, 25).

Continuous monitoring of heart rate and respiratory rate or blood pressure during the day and with the daily activities of the patient with COVID-19 (19, 20, 22), can help and redefine the complete diagnosis of these changes, such as the increase in respiratory rate through several distinct phenotypes (16, 25). These individual data should propose a critical complement to the development of research programs focused on interdisciplinary and individualized with precision or personalized treatment (22, 25). Therefore, it must expand the evidence base as observed by these examples cited, therefore, there is great potential for the use of mobile health technologies linked to healthcare and this process should have a better meaning in the understanding of human physiology in health and illness (22, 25). The hypothesis of using a sensor to diagnose diseases such as COVID-19 can be supported by forecasts by financial analysts who estimate that the market for the use of sensor technology will grow at an annual rate of almost 55% (20, 25), that is, to 31.5 billions of dollars by 2021 (22, 25). Several studies of systematic review and meta-analysis in Brazil have concluded that there is a lack of high-quality scientific evidence for the use of sensors to effect behavioral changes in Brazilian society or to manage chronic diseases, infectious diseases such as COVID-19 in hospital care or healthcare provision (19, 20).

The use of sensors in the clinical follow-up of the patient with COVID-19 adds a layer of substantial complexity (22, 25), however, starting trials around non-standard care systems brings a substantial percentage of complexity and is significant if informing the health community a roadmap to transform patient care with COVID-19 that will be proposed to EBSERH by our research group (16, 22, 25).

How to use personalized sensor monitoring in patient health with COVID-19

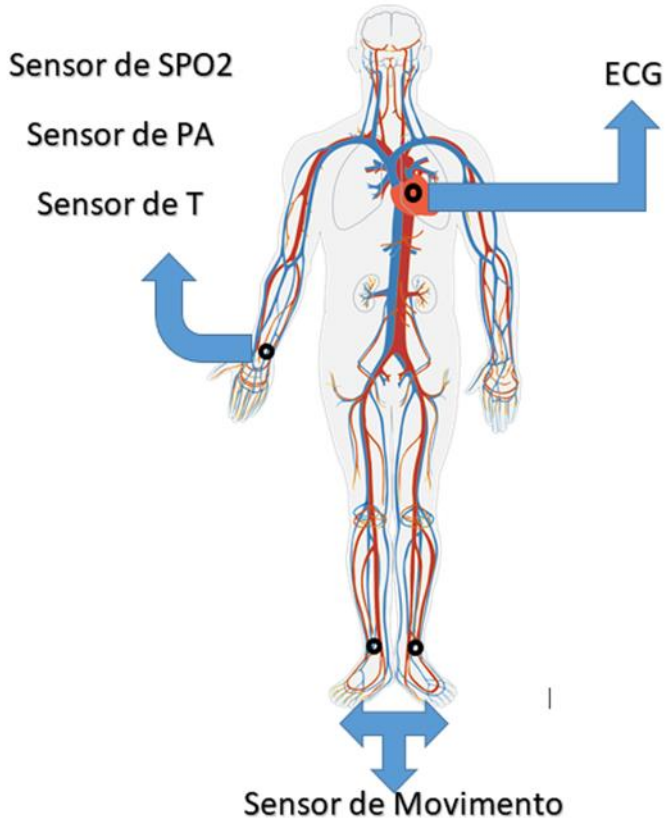
The studies used in this short review to build the proposal to be used in the telehealth center EBSERH, highlights that the sensors for the human body (Body Sensor Network - BSN) (08, 12, 16, 22, 25), are a system that make use of the n-sensor technology, which are interconnected wirelessly and powered by batteries (16, 22, 25). The sensor nodes are made by a processing unit, memory, interfaces and transducers, radio transmitter and receiver with a power and battery circuit (22, 25).

The body sensor network system is useful for monitoring uninterrupted and non-obstructive human health. The system can be applied to electrophysiological monitoring (16, 22, 25). In this case, the sensors are connected to the patient's skin in appropriate positions on the pelvis, thigh and upper limb stem with flexible tape in order to minimize the movement of the sensors (16, 22, 25). Fixing with flexible tape will restrict movements of the knee or pelvis and thus avoid distorted results (22, 25). The calibrations and virtual alignment of the sensors to the bone axes are performed by the temporal synchronization of the three sensory nodes (22).

Transient noises and data deviations from the sensors can be filtered through a bandpass filter using a linear model. To apply for the purpose of supporting the clinical evaluation of the patient with COVID-19 for highly satisfactory results (19, 22, 25), it is possible, for example, to measure walking activities during the daily life of the patient with COVID-19 in home monitoring (16, 22). For example, during daily activity in which the human body requires stability of the lower limb, sensors in the lower limb are able over time to detect changes in activity levels and thus correlate with increased fatigue or tiredness, in addition to detecting compensation movements or gait symmetry. In figure 02, sensor networks in the patient diagnosed with COVID-19 monitor vital functions such as (02, 20, 22): SPO2, ECG, FR, FC and T in the technology that includes health information servers and health professionals (16, 22, 25). The studies highlight information on the use of "Testbeds" platforms, allowing the use of tools for the purpose of scientific and computational experimentation and new technologies in a replicable and ethical manner (12, 16, 22).

The studies included in this short review propose the use of sensors developed in MicaZ technology and Telos Mote, since we can include pulse oximetry, ECG, movement and temperature sensors (12, 16, 22, 25).

Figure 02 - Use of sensors to monitor the patient with COVID-19.



The oximetry sensors will be a non-invasive technology and used to assess heart rate and oxygen saturation (SPO2) and these two parameters are analyzed for the patient with COVID-19 according to the parameters of the World Health Organization (19, 20, 22, 25). The oximeter of the pulse projects infrared light through the process of reflection of the blood vessels. By using the methodology to detect the amount of light absorbed by hemoglobin in the blood in two components of the wave, in this case, 650 nm^3 and 805 nm^3 (08, 12, 16), it is possible to use oxygen saturation in the patient's blood with COVID-19 (19, 20).

To assess heart rate (HR) the literature selected in this short review, proposes the use of the light absorption pattern over time, since blood vessels constrict and expand with the patient's pulse. The electrocardiogram (ECG) is used for clinical care in order to measure the electrical activities of the heart and is considered specific to employ continuous telemetry. The motion sensor is used to analyze the patient's difficulty in moving and thus, relating fatigue to a characteristic symptom of the patient with COVID-19 (19, 20, 16 -25). These sensors are capable of communication wirelessly and transmitting this data to a base station (16, 22, 25). For example, hypertension it is a primary diagnosis in consultations with patients with COVID-19 and it can be used as a model the American technology of home monitoring and thus present an economy of the Brazilian public health system of around 40 million reais (16, 19, 22, 25). Remote sensor monitoring is more convenient than interrupting your routine schedules drawn up in the isolation process to perform a medical consultations (16, 22, 25).

Patients in home control by remote monitoring are more likely to achieve blood pressure control compared to those using current care systems (08, 16, 25, 25). Through hypertensive monitoring, blood pressure levels can be measured, especially in patients with COVID-19 and patients with hypertension (12, 19, 20). Its operation will be based on the detection of heartbeat and employs a simple oscillometric method that determines systolic and diastolic blood pressure (12, 19, 20, 25, 25). Control is carried out by changing the heartbeat amplitude. For your best performance specificity, measurement intervals, maximum pressure, precision and response time are considered (16, 25). For temperature sensors, transducers that modify their physical characteristics through interaction with the medium to which the temperature of the patient with COVID-19 will be used will be used, and these devices must have the ability to convert the physical quantity, temperature, into an electrical signal (08, 12, 16, 25, 25).

In addition, the monitoring of patients with COVID-19 by sensors in relation to the development of the disease, will consider, according to the authors selected in this short review, the time element, and this element is included in the patient's stored historical data (08,12,16,25).

Worldwide, there is uncertainty regarding the regulation of sensor monitoring in patients with diseases such as COVID-19. The patient using a sensor is also concerned with the privacy and ownership of his data related to his well-being in health (22). The included studies highlight the importance of securing health data that is the preferred target for cyber thieves (25). However, it is imperative to develop security methods based on biometrics in the cloud, transferring encrypted and remotely interrupted data, are some solutions that can at least be used to reduce this risk (22, 25). This increase in the use of sensors will enable a series of complex challenges including the need to summarize multiparametric and continuously collected

data in a meaningful and responsible clinical format (22, 25). The COVID-19 patient monitoring system is still in its initial formative stage (19, 20). Take advantage of the use of Moore's law with small circuits and at a lower cost that brings technological advances in practically all Brazilian public health centers (08). The use of this technology has the potential to lower the cost of both research and health care (16).

It should be considered that the cell phone is a health technology in a considerable assisted way, and that implanting this technology in the EBSERH network in clinical trials with patients being monitored at COVID-19 is a considerable promise and may follow the same path as robotics in surgery or therapeutic megavitamin techniques that are used without well-defined support data (08, 12, 16). The use of sensors in the Brazilian public health service, makes its incorporation in the routine care of health professionals so challenging and yet, potentially transformative (16). This assisted technology places the patient at the center of their health services and considers it normal in the context of the health parameter from a population perspective when comparing an individual to hundreds of other COVID-19 patients in a time-based perspective, or comparing an individual yourself before the presence of a sign of the disease or symptoms (12, 16, 25, 25).

CONCLUSION

The use of data sensor technology such as blood pressure, temperature or HR or RF in Brazilian public health, mainly in the EBSERH hospital network, brings a gain in resolving the monitoring of patients with COVID-19, o it incorporates the resolution of more complex cases care in an outpatient setting. The use of this new technological context in Brazil, raises a concern with aspects of security and confidentiality. However, it is imperative to develop a cloud of security methods based mainly on the biometric language that will offer solutions that can at least be used to reduce the risk of data leakage, o it is known that much has to be gained with this new perspective mainly with regard to reducing the number of patients waiting for emergency care only for daily monitoring, thus reducing the risk of infection from human to human.

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