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The use of personalized medicine combined with artificial intelligence to monitor people with Covid-19

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Abstract

Since the emergence of the pandemic caused by the SARS-CoV-2 virus (coronavirus disease or COVID-19), the generalities since its emergence, from the clinical picture, as well as the findings observed in AI (Artificial Intelligence) diagnostic methods applied to medicine personalized. This article is a literature review regarding the use of personalized medicine combined with artificial intelligence to monitor people with covid-19. The continuous evolution of intelligent systems aims to provide better reasoning and more efficient use of collected data. This use is not restricted to retrospective interpretation, that is, to provide diagnostic conclusions. It can also be extended to prospective interpretation, providing an early prognosis. That said, physicians who could be assisted by these systems find themselves in the gap between the clinical case and in-depth technical analyses. What is missing is a clear starting point for approaching the world of machine learning in medicine.

Keywords: artificial intelligence; personalized medicine; monitoring

1. Introduction

The study of Artificial Intelligence (AI) is intertwined with several lines of exploration and the variety of learning of this processing machine provides the computer with the ability to perform functions previously performed exclusively through human intelligence (LUDERMIR, 2021). Over the last decade, so-called precision or personalized medicine has rapidly advanced in the scientific and healthcare industry landscapes internationally. Precision medicine can be defined as a research approach to the development of products and services individually designed for the user, based on genetic information and other biomedical data from patients. Such approaches are capable of producing more accurate diagnoses of certain genetic diseases (or the propensity to develop them), new inputs and medicines, and systems for monitoring and managing environmental and lifestyle data to prevent, monitor or treat patients (DA SILVA; IRIART, 2021).

With the increasing expansion of AI, the development of algorithms related to learning how to use machines, especially in their use on neural networks, allows the construction of various tools that stimulate the expansion of computer science, especially in what concerns health (LEITE, 2019).

Associated with AI, the use of precision medicine stands out, which presents an advance in studies related to human health as a factor in the optimization aimed at the necessary and particular adjustments to an individual, considering their genetic data and all their specificities for the search for the best possible

therapeutic prescription, in addition to the fact that these advances end up giving more precision to the treatment where it involves scientific means, which allow safety and effectiveness (RODRIGUEZ, 2019). According to George (2013) we have the following definition of artificial intelligence:

> Artificial intelligence (AI) can be defined as the branch of computer science that deals with the automation of intelligent behavior. This definition is particularly appropriate for this book because it underscores our conviction that AI is part of computer science and therefore must be based on sound theoretical and applied principles in that field.

The use of sensors for monitoring and evaluating patients attracts attention every year in research due to the development of new technologies specific to health (GUO; WANG, 2015). This advance in technological knowledge requires interdisciplinary changes, mainly in the use of Artificial Intelligence (AI), computer science and instrumentation for the purpose of exchanging and managing health data (FAN, 2011).

Monitoring has been presented as an aid in this precision medicine that seeks a holistic look at the patient who needs frequent supervision, for example, in the production of technologies that evaluate patients from a distance to obtain their vital signs through small wireless sensors and thus , sends them to devices known as personal gateways or smartphones and this data transfer is carried out through small area network protocols such as Bluetooth or Zigbee and WBAN (GUO; WANG, 2015; STEINHUBL; MUSE; TOPOL, 2015).

After these data are collected, they are sent from the level considered secondary to the tertiary level to the health service provider in hospital institutions that, through wide area wireless communication protocols or Internet service, can interpret these processed data (MARSCHOLLEK *et al.*, 2012).

Generally, healthcare providers at the third level carry out procedural actions that will generate services that are sent back to the patient in the form of a response at the primary and secondary levels, and will represent care for the patient, and the patient may receive care through the care furniture articulated to its particularity (KUMAR; LEE, 2013). This healthcare technology is a proficient tool that allows coordinated efforts among healthcare professionals who can improve care and responses in real time (HSU; LEE; SU, 2013), indicating assistance in the post-pandemic period caused by the coronavirus.

Coronavirus (SARS-CoV-2) is the name given to an extensive family of similar viruses that cause respiratory infections, and within this family there are several types of coronaviruses, including SARS-CoVs (severe acute respiratory syndrome - SARS) this by in turn causes infections in humans and is called Covid-19. This virus is encapsulated, single-stranded RNA, with zoonotic origin and belonging to the Coronaviridae family (BACKER *et al*, 2020). The SARSCoV-2 virus is transmitted from human to human and the patient develops mild symptoms with aggravations capable of causing death due to pneumonia, in addition to sequelae that are being researched (NANSHAN *et al*., 2020).

In Brazil, severe pneumonia has led to death in patients with COVID-19 and its frequency increases in patients over 60 years of age after the initial period of infection, however, death is largely related to the underlying health of patients and therefore highlights There is a need for continuous monitoring of patients with COVID-19, especially with a history of chronic diseases (RAMOS *et al.*, 2020).

In the current days of the pandemic caused by COVID-19, there are many unanswered questions,

but AI mediated by monitoring sensors can be used to train the health team, diagnose, perform checks or monitor the patient in a preventive way. or post-cure, in therapeutic procedures and monitoring, in prescribing medications and in providing services to patients in the private network or users of the Unified Health System - SUS (RAMOS *et al.*, 2020; ELMANNAI *et al.*, 2017).

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 (BACKER *et al.*, 2020; RAMOS *et al*, 2020; DOUGHTY, 2016).

Therefore, the objective of this study is to analyze the functionality of the use of technology that monitors patients affected by COVID-19, or other viral diseases, remotely, using artificial intelligence as its modulator. The literature review of this study will help to ratify the importance of using AI and personalized medicine, to facilitate not only diagnoses, but also to contribute to this process of recovery of human health.

2. Methodology

This is an applied study, exploratory objective, quantitative approach and bibliographic procedure The research was carried out at the Federal University of Mato Grosso do Sul (UFMS) – Faculty of Medicine (FAMED). We searched for articles with a 10-year periodicity, related to biomedical engineering, where specifications related to Artificial Intelligence and personalized medicine were used to monitor people with COVID-19. There was active research using the authors' computers on reliable database sites, looking for specific results between the years 2011 to 2021.

Table 1: Free access digital databases used in research

DIGITAL LIBRARY	SITES
Health Sciences Descriptors	https://decs.bvsalud.org
Academic Google	https://scholar.google.com.br/?hl=pt
Latin American and Caribbean Literature in Health Sciences	https://lilacs.bvsalud.org/
MEDLINE/BIREME/OPAS	https://bvsalud.org
PUBMED	https://pubmed.ncbi.nlm.nih.gov
SciELO	https://www.scielo.org

Source: Authors.

3. Literature review

3.1 Artificial intelligence and personalized medicine

Artificial intelligence (AI) based on two types of decision systems, white box and black box. A white box AI-based decision system encircles affinities and translucency between the principles for analyzing incoming data and is preferably created using controlled algorithms such as the decision tree algorithm. (ALI *et al*., 2017).

On the contrary, black box-based AI has obscure algorithms and their processing and reasoning are executed to deliver the referent results that are difficult to explain (SIGHAL; COWIE, 2020). AI facilitates the development of personalized medicine through extemporaneous risk prognosis, caution and therapeutic interference. Analytical and biological data will contribute to the optimization, effectiveness and quality of AI-based tools. In addition to clinical results, it is also worth mentioning the potential of Big Data and AI to improve the competence and sustainability of laboratories, identifying areas of waste, improving processes and streamlining requests (MOLERO *et al*., 2021).

3.2 Stages with worsening health of patients with COVID-19.

The main clinical signs for COVID-19 in patients who present worsening are persistent high fever ($\geqslant 38^{o}$ C), constant and excessive fatigue, dry and frequent cough, change in respiratory rate and the presence of diarrhea (BACKER *et al*., 2020; RAMOS *et al*., 2020). In severe cases, the disease progresses to viral pneumonia and quickly in a few days to difficult-to-treat septic shock, metabolic acidosis and coagulation dysfunction which leads to death.

The cases that resulted in death occurred in patients with lymphopenia and inflammation secondary to pneumonia, that is, the complication in death is directly related to pre-existing diseases of the patient (RAMOS *et al*., 2020). However, it is possible to highlight in this illness process that other patients are able to recover with little or no medical and hospital intervention (BACKER *et al*., 2020).

3.3 The use of artificial intelligence in the control of Covid-19

In relation to continuous monitoring of heart rate and respiratory rate or blood pressure during the day and carrying out daily activities of the patient with COVID-19 can help and redefine the complete diagnosis of these changes, such as increased respiratory rate, through various distinct phenotypes (FONSECA *et al*., 2020).

The hypothesis of sensor use in diagnosing diseases like COVID-19 can be supported by forecasts and financial analysts and they estimate that the market for the use of sensor technology will grow at an annual rate of almost 55% i.e. to 31.5 billions of dollars by 2021 (FONSECA *et al*., 2020).

Several systematic review and meta-analysis studies in Brazil conclude 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 and infectious diseases such as COVID-19, including hospital care or care delivery. health (FIGUEIREDO *et al*., 2015; FONSECA *et al.*, 2020).

The use of sensors in the clinical follow-up of the COVID-19 patient adds a layer of substantial complexity, however, initiating trials around non-standard care systems brings a substantial percentage of complexity and is significant if it is to inform the healthcare community about a roadmap for transforming COVID-19 patient care. (FIGUEIREDO *et al*., 2015; FONSECA *et al.*, 2020).

3.4. Personalized monitoring in the patient with COVID-19

To apply in order to support the clinical evaluation of the patient with COVID-19 for highly satisfactory results, one can, for example, measure the gait activities during the daily life of the patient with COVID-19 in home monitoring (FONSECA *et al*., 2020). For example, during daily activity in which the human

organism requires lower limb stability, 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 1, a network of sensors in the patient diagnosed with COVID-19 monitor vital functions (AYDAY; FEKRI, 2012; MARSCHOLLEK *et al.*, 2012).

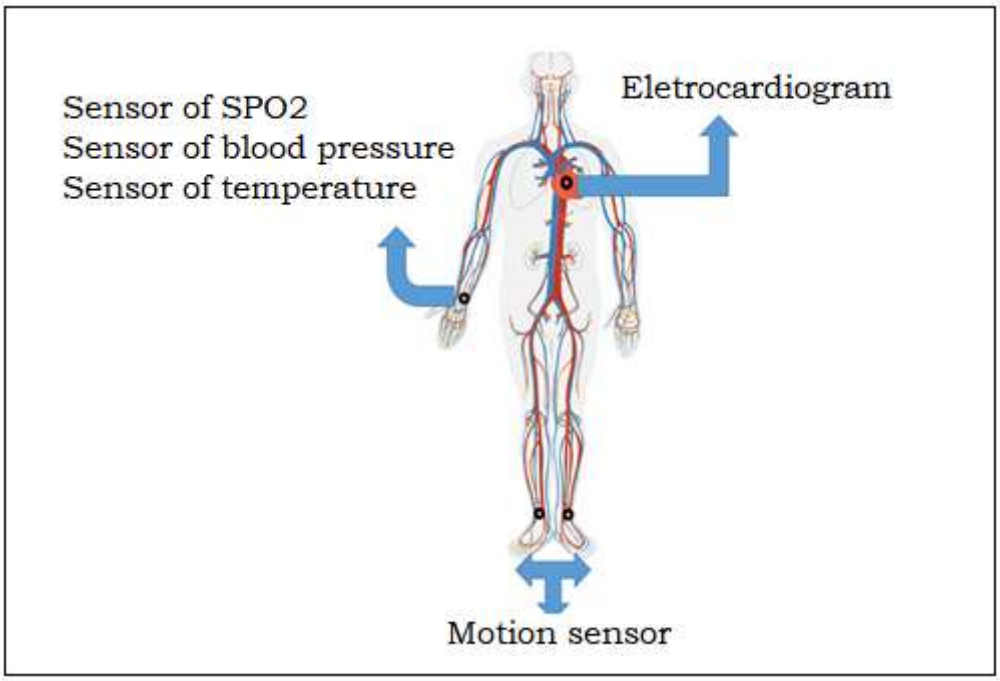
Fonseca *et al.* (2020) brings the information that oximetry sensors is a non-invasive technology and used to assess heart rate and oxygen saturation (SPO_2) and these two parameters are critical for the patient with COVID-19 according to the World Health Organization.

To assess the heart rate (HR), the pattern of light absorption over time was used, due to the contraction of blood vessels and expansion with the patient's pulse. The electrocardiogram (ECG) is intended to measure the electrical activities of the heart and is considered specific to employ continuous telemetry (CURTIS *et a.l,* 2008; FONSECA *et al.*, 2020).

The motion sensor is used to analyze the patient's difficulty in moving and thus relate to fatigue, a characteristic symptom of the patient with COVID-19 (STEINHUBL; MUSE. TOPOL, 2015). Remote monitoring by sensor is convenient than interrupting your routine schedules elaborated in the isolation process to carry out a medical appointment (AYDAY; FEKRI, 2012).

For temperature sensors, transducers will be used that modify their physical characteristics through interaction with the environment in which the temperature of the patient with COVID-19 is sought and these devices must have the ability to convert the physical quantity temperature into an electrical signal (FAN, 2011; FONSECA *et al.*, 2020).

Figure 1 - Physiological monitoring with sensors in patients with COVID-1.



Source: Fonseca *et al*. (2020).

4. Results and discussion

4.1 Weekly epidemiological update on COVID-19 (12th November 2021)

Table 3: Classification by Total Processes in Ascending Order

LOCATION	Total cases	New cases (1 day)	New cases (last 60 days)	Cases per million people	Deaths
GLOBAL	251.788.329	514.819	No data	25.178	5.077.907
BRAZIL	21.955.471	4180	11.092	21.955	611.318

4.2 Artificial intelligence tools developed at the beginning of the pandemic

Table 3: Artificial intelligence tools used to fight the COVID-19 pandemic.

Focus	Tool	Institution / company	Country	Description
Detecção precoce de surtos	BlueDot	BlueDot	Canadá	Issuing early warning of outbreaks and their dissemination to government entities
Detecção precoce de surtos	ProMED	ISID	EUA	Issuing outbreak early warning to government entities
Detecção precoce de surtos	HealthMap	Hospital Infantil de Boston	EUA	Issuing outbreak early warning to government entities
Detecção precoce de surtos	DETECTAR	Scripps Research Translational Institute	EUA	Early warning issuance based on COVID-19 symptom tracking from smart devices (wearables)
Diagnóstico	COVID-Net	Universidade de Waterloo	Canadá	SARS-COV-2 diagnosis using chest X-ray (CXR) imaging
Diagnóstico	CAD4COVID	Delft University of Technology	Netherlands	SARS-COV-2 diagnosis using chest X-ray (CXR) imaging
Previsão	Jiang *et al.* (2020)	New York University e Columbia University	EUA	Prognosis of the development of acute respiratory distress syndrome in patients with COVID-19 according to their medical history
Painel de dados	NextStrain	GISAID	Germany	Real-time monitoring of SARS-COV-2 genomic evolution worldwide
Painel de dados	Rastreador de IA do Microsoft Bing	Microsoft	EUA	Track COVID-19 cases globally in real-time
Painel de dados	JHU CSSE	Johns Hopkins University	EUA	Track COVID-19 cases globally in real-time
Tratamento e controle	Mente profunda	Google	EUA	Prediction of SARS-COV-2 protein structures from the genomic sequence
Tratamento e controle	QUERIDO	QUERIDO	South Korea	Analysis of molecular structures of existing drugs to treat COVID-19
Tratamento e controle	MEGVII e BAIDU	MEGVII e BAIDU	China	Using infrared cameras to detect body temperature
Tratamento e	ROBÔS	ORBBEC e	China	Robots programmed to disinfect hospital wards and deliver

Focus	Tool	Institution / company	Country	Description
controle		colaboradores		food and medicine to patients
Tratamento e controle	Código QR (aplicativo Alipay)	Alibaba	China	People tracking via mobile app to prevent the spread of COVID-19
Tratamento e controle	Camio	Camio	EUA	Detect, alert and report compliance with social distancing through cameras
Tratamento e controle	Flytnow	FlytBase	India	Using drones to monitor public spaces

Source: Rodríguez (2020).

4.3 Articles found

AUTHORS YEAR OF PUBLICATION	TITLE	OBJECTIVE	METHODOLOGICAL DESIGN	RESULTS
(FONSECA *et al*., 2020)	Authentication in the use of health sensors to remote patients with covid-19: a proposal for the telehealth center in the ebserh network	Reduce the number of patients is awaiting emergency care only for daily monitoring, thus reducing the risk of human-to-human infection	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).	Using remote skin sensors to monitor health parameters would be the ideal method for patients with COVID-19 at the time of epidemiological peaks. At the initial moment of the laboratory diagnosis, the patient with COVID-19 would be implanted and wouldmeasure continuously and remotely, wirelessly, and report the patient data related to the main clinical signs of the coronavirus and worsening of the disease. Without restricting or affecting the patient and maintenance would not be necessary as

				artificial intelligence such as smartphones would be used). 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.
(RAMOS *et al.*, 2020)	COVID-19, rate of Case Factors and Nutritional Characteristics of Patients Dying in Italy and Brazil: A Critical Analysis	Demonstrate that elements such as iron, zinc and vitamin D influence adaptive immunity by inhibiting B cell proliferation with differentiation and secretion of immunoglobulins that will supply the proliferation of T cells and this will result in a more pro-inflammatory response shift.	Search for works published from 2019 to 2020, involving several well-known bibliographic databases, such as PubMed, Lilacs, Medline and Cochrane.	Iron, zinc and vitamin D deficiency is a nutritional disorder with the highest clinical frequency in the world. And severe complications in vulnerable populations, for example, diabetics, hypertension, heart disease, anemics and hypovitaminosis D, worsens in cases of viral or bacterial diseases, for example, H1N1 and coronavirus.

"Precision Medicine" or "Personalized Medicine" must be understood in all its magnitude, as it not only encompasses diagnosis and therapy, but can also help in prediction and prevention (LIZARASO-CAPARO; RUIZ-MORI, 2018). Precision medicine is based on increasing the ability to read and analyze DNA (also RNA) in all its variants, including massive sequencing and assembly techniques so that the reading is consistent, accompanied by the analysis and interpretation of the data, in order to translate the results into clinical practice (VIDAL LEDO *et al*., 2020).

Among the most general aspects highlighted by research Silva; Iriart (2021) drew attention to the near silence of specific precision medicine journals on the topic of COVID-19 until mid-June 2020. Only one comment in the Journal of Precision Medicine addressed the pandemic directly in the issue published in March. In the June issue, the magazine published four articles on COVID-19 and an extended version of

the commentary published in March.

According to Vidal Ledo *et al*. (2020) these technologies include: dispensing, population classification process and its monitoring with compliance with a minimum evaluation frequency; analysis of the health situation, with community and intersectoral participation to identify and address the population's health problems; entry into the home, with its particularities according to people's conditions and health problems; community projection of specialties from hospitals to polyclinics and medical offices; family medical history and individual medical history; and active population research to identify health problems.

Among the goals of precision medicine, the design of "innovative" clinical trials to evaluate the effectiveness of drugs directed to specific molecular targets stands out. Currently, there are significant limitations to its use in daily clinical practice, mainly due to the lack of effective and useful pharmacogenomic tests, the lack of standardization among these tests, the lack of knowledge of physicians in genetics, the lack of investments and incentives, economic costs, coverage or not of the costs of personalized medicine by insurers and, finally, the lack of scientific evidence on its real efficacy and effectiveness (RODRIGUEZ PERON, 2019).

For Iriart (2019) the proposals and visions of the future of personalized medicine/precision medicine, however, are not consensual and have been the subject of much criticism by researchers and clinicians concerned about their impact on research, medical practice and sustainability. health systems, due to the high cost of new technologies. An important debate unfolds in leading health journals discussing the promises and impacts of personalized medicine/precision medicine, opposing its supporters and those who question the limits of the movement and the risks that it entails for global health.

Personalized medicine pursues its goals from an individualized perspective, but not for each person, but for groups of individuals with similar genetic characteristics (targeted treatments). It tries to understand the disease molecularly; understand how the response to treatments occurs; particularize said response; predict an individual's risk of developing disease or responding to medication; diagnose correctly and improve treatment to optimize the effectiveness of the drug, minimize adverse effects to achieve the expected therapeutic success (DIAZ FERNANDES; RODRIGUEZ FERREIRO, 2016).

5. Conclusion

The global COVID-19 pandemic has affected the demand for improved generation of information systems integration, the development of AI drivers and generated algorithms to identify images and interpret data related to the patient with Covid-19.

Artificial intelligence (AI) for monitoring patients with Covid-19 plays a fundamental role in the control and spread of the virus, and especially in the monitoring of patients, whether they have mild, moderate or severe symptoms. The application of these new technologies tend to be limited, due to lack of incentive, qualified labor, areas related to multidisciplinarity.

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