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Digitalization in Telehealth: An integrative review

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***Keywords*— computing in healthcare, patient electronic register, healthcare technologies, telehealth.**

Abstract *— The aim of this article was to identify the applicability of digitalization and digital systems within the scope of both Telehealth services and correlated remote services. An integrative literature review was utilized as methodology, and the results were classified by sections, among which: Healthcare information systems (HIS); electronic register (ER); telediagnosis; healthcare Big Data; metrics and Healthcare Technology Assessment (HTA) and digital technologies, professional capacitation & investments. Digitalization and digitalization processes in healthcare, in accordance with Big Data techniques, brought several benefits such as agility in diagnosis processes and treatment of illnesses; gathering, storage and data analysis to provide support for decision-making processes in healthcare management. When it comes to difficulties, we found the lack of investments and professional capacitation, which results in lack of quality to fill the data, as well as the lack of institutional and physical investments, therefore, we identify the opportunity and the potential offered by electronic registers to document ionizing radiation doses of patients submitted to Radiodiagnosis exams.*

I. INTRODUCTION

The development of digitalization and the incorporation of new technologies in the healthcare area have not only provoked changes, but are still shaping both the present and future relations between users (customers/patients) and services. An individual is able to virtually schedule an in-person appointment or digitally share a diagnostic image with the physician (utilizing smartphone VoIP apps, accessing desktop platforms) and the report is almost instantaneous and further added to the patient's medical records.

Regarding the influx of digital technologies in a global context, we can comprehend digital technologies in healthcare as the utilization of techniques and/or transforming processes of the relations between the users and healthcare services. The speed of the processes gives the healthcare managers an in-depth view of aspects such as epidemiology or quality markers, besides the costs involved in a given healthcare system or subsystem. However, the users are the biggest benefited by remote services, they are the ones who find the crucial information necessary to individually or collectively take care of their health, because the access is agile and easy.

The utilization of CITs (Communication and Information Technologies), more precisely, the digitalization associated to the development of the Internet, which acts as an intermediary to implement and apply such technologies, made possible the surfacing and constant development of a new way of providing healthcare, both by means of innovations in therapeutic areas (personal medicine, biomedicine, etc.) and digital practices (digital therapy, based telehealth and mobile devices (Sandoval, Giangreco, Gómez, González & Dalub, 2017; WHO, 2020a).

In 2000, the Information Society Program (SocInfo) was unveiled in Brazil with the goal of tracking the foundations to integrate development and applicability of CITs in favor of decreasing social inequalities, increasing social inclusion and democratic access to information. Back in the day, the information society was seen as a new socio-technical paradigm expected to transform all the sectors of the society, promote innovation, increase social participation and

strengthen the Brazilian culture with an emphasis on cultural diversity (Takahashi, 2000).

Three pillars supported the transformation proposed by SocInfo, among which stood out: the technological base convergence, possible through the digitalization of data and the sharing of images, videos, texts, etc., called "content"; the industry dynamics that made electronic equipment more affordable and the global growth of the Internet, which was much bigger, as opposed to other media channels, such as TV and radio (Takahashi, 2000).

Within the technological and digital scope, changes are not static. 21 years after SocInfo was launched, we face a new paradigm, the digital transformation one (Rogers, 2020), which not only consolidates many expectations of that time, but also designs the profile of social relations on medium and long terms, with an emphasis on businesses and services, in a continuous spiraling development process that impacts all sectors.

The set of healthcare services offered by digital means is known as Telehealth. The WHO describes the concept as:

> [...] delivery of health care services, where patients and providers are separated by distance. Telehealth uses ICT for the exchange of information for the diagnosis and treatment of diseases and injuries, research and evaluation, and for the continuing education of health professionals. Telehealth can contribute to achieve universal health coverage by improving access for patients to quality, cost-effective, health services wherever they may be. It is particularly valuable for those in remote areas, vulnerable groups and ageing populations (WHO, 2009b).

According to a WHO's research from 2016, 50% of the nations that were part of a global survey do have a national telehealth policy (WHO, 2016f). According to the Brazilian Federal Council of Medicine (CFM number 2.227, of December 13, 2018), telehealth is defined as "the exercise of Medicine through the utilization of interactive methodologies of audiovisual communication and data, with the goal of provide assistance, education and research in healthcare." Rahimi, Nadri, Afshar & Timpka (2018) identified the three main areas that utilize CITs in healthcare as: telemedicine, electronic registers and mobile applications.

Within this scenario, we're able to find: a) Medical digitalization, characterized by the application of different technologies such as the EHR (Electronic Health Records); b) the telemedicine, which involves the sharing of information between doctors-doctors and doctors-patients, which should be mentioned branches such as teleradiology, telepathology, telesurgery, among others; c) the medical-oriented social media such as MyBubble and FENAM NETWORK, besides medical communities such as Medical Dignity (Facebook) (de Camargo & Ito, 2012).

Telemedicine works through a digital ecosystem that comprises software, platforms, devices, internet, computers, smartphones, etc., which enable healthcare services to reach both the local and the most isolated and hardest to access communities. Highlights for the services of: a) tele-appointments, in which the patient is served by professionals and experts in various areas; b) assistance, such as remote monitoring of a patient (telemonitoring), issuing diagnostic reports of radiological imagery (teleradiology); and c) education that favors capacitation and sharing of information between professionals (Rahimi et al., 2018; Morsch, 2019).

This is the area of greatest interest in the field of TAM applications research, with large acceptance by doctors and nurses. Some of the most common factors that justify the applications of TAM are self-efficiency, experience, training, compatibility and habit, which can serve as base models for most technologies in a logical context (Rahimi et al., 2018).

As for teleradiology, according to the WHO (2009b) it's the most consolidated medical modality in the landscape of remote services. For Bashshur R. L., Krupinski, Thrall, Bashshur N. (2016), teleradiology is a medical modality that allows the acquisition, processing and sharing of images through a digital system via Internet.

For this work, regarding the initial research concerning digitalization in healthcare, some of the points observed in the literature were: the importance of the Healthcare System Information (HSI) as a whole (Galdino, Azevedo, Tenorio, Teixeira, Medeiros, Costa & Dantas, 2016; Rover, 2008); the possibility of evaluation metrics (de Alkimim, Parreiras, Santos, Reis & Muylder, 2016; Schall, Cullen, Pennathur, Chen, Burrell & Matthews, 2017); the monitoring of results (Fernandes & Tareco, 2016); the support of Information Management (Galdino et al., 2016; de Souza, Borges & Fernandes-Sobrinho, 2020); the patient's integral care (Pissaia, da Costa, Moreschi, Rempel, Carreno & Granada, 2018); the data standardization and questions related to patient's data safety (da Costa & Linch, 2020); the utilization of smartphones, tablets and apps such as WhatsApp (Sandoval et al., 2017).

The aim of this work was to understand the relationship between digitalization and healthcare, identify correlated studies and the viability of researches over patient's electronic register and healthcare Big Data and categorize the applicability of computing in healthcare, with an emphasis on remote services, in order to point out topics of interest for computing research in healthcare.

For that, we sought to answer the following questions: 1) What are the benefits of digitalization when it comes to

developing the healthcare area? 2) What are the examples of digitalization applicability in a healthcare system? 3) What are the implications and barriers to implement computerized services in healthcare? The results were grouped by similarity and then, it was introduced a discussion about the findings.

II. BACKGROUND

The development of the medical area had and still has a direct impact over the increase of life expectance, quality of life and the decrease of child mortality. About 80% of the medical area data are images, whereas the other 20% are originated from data that comes from documents and texts (de Freitas & de Souza Poletto, 2019). Such development has been supported and potentiated by the healthcare digitalization, mainly regarding the management and sharing of data and patients' clinical data.

Citizen's data that goes through the Healthcare Information System (HIS) characterize them as fragmented personas whose information are scattered throughout several systems that in many cases don't communicate with each other, which can confuse the trackability and integrity of the data that concerns a given citizen (Moraes & Gómez, 2007).

However, digitalization and sharing of data bring speed to processes that involve attention, promotion and information in healthcare. By means of connecting and interconnecting information, because of system's integration and interoperability, is possible that a decentralizing healthcare system, such as Brazil's Unified Healthcare System (SUS), could have centralized data, services convergence, epidemiological mapping, among other possibilities.

Information and Communication Technologies (ICTs) present a crucial role in the implementation of new relations in the current society, focusing more and more on social inclusion. There is a major advancement of emerging technologies in healthcare, such as business intelligence (BI), digital certification and Electronic Health Records (EHR) (Roberto, Costa & Puga, 2019).

The utilization of Information and Communication Technologies (ICTs) in healthcare is known as e-Health (WHO, 2021c). The utilization of computers and software is beyond the data organization, data structure and the healthcare information are building a new culture and new relations between the citizens and the healthcare systems.

The 71st World Healthcare Assembly (WHA), which took place in 2018, discussed the Resolution WHA71.7 for developing digital healthcare among those member states, pointing out the topics that involve a development by means of a digital healthcare (WHO, 2019d; WHO, 2018g). According to (WHO, 2019d), investments in this area can contribute to the reduction of health inequalities:

> Linking digital investment to public health and health promotion and disease prevention goals requires strategic approaches and organizational changes based on identified needs. Without such approaches, the digitalization of health systems risks introducing new or increasing existing health inequalities – creating divides where resources are not aligned with social needs and where the benefits do not reach the most vulnerable people (WHO, 2019d, p.2).

The WHA71.7 brought important appointments concerning digital technologies and their role alongside healthcare strategies to promote health, prevent illnesses and provide sustainability and innovation in all member states. It became evident the healthcare model focused on citizens with an emphasis on interconnection between different digital technologies (WHO, 2018g).

Some recommendations for the member states, regarding digital technologies, include: the access to digital systems at different levels; the way of integrating previously different systems; and the interoperability and better data treatment between citizens, healthcare professionals and the government; and better cost-benefit, with the goal of establishing an inclusive healthcare model accessible to everybody (WHO, 2018g).

Smartphones also have an important role for everybody involved in healthcare processes: the professionals, the institutions and the citizens. Mobile technologies promote the ubiquity of services and instant access to the information. The designed term referring to the utilization of mobile technologies in e-healthcare strategies was described by the WHA71 as mHealth (mobile health) (WHO, 2017e).

The WHO (2016f) recognizes the global role of digital technologies in healthcare systems, because of their capability to manage data across different areas; register and personal monitoring of patients; non-communicable risk factors' trackability, alcoholism and sedentary lifestyle; follow-up of patients with chronic diseases such as diabetes, cardiovascular conditions and cancer and increase the overall health safety, besides improving the engagement among people.

Since the beginning of the Covid-19 pandemic, announced by the WHO in March 13, 2020 (WHO, 2020a), there has been an accelerated follow-up of the digital transformation, adaptation and innovation of companies and their services in different segments, something that was already happening (Rogers, 2020). This accelerated process has been possible because of the level of technological development and the engagement we have witnessed among

people, which has brought several benefits for healthcare in a global scale.

According to decree number 2.546, of October 27, 2011 (Art. 12, § 1º), Telehealth "is the autonomous establishment that utilizes information and communication technologies to perform assistance and education in healthcare, across geographic and temporal distances". Some of the services described by Novoa & Netto (2019) include Telemedicine, Telereport and Telepharmacy.

In 2010, the Brazil Telehealth Program was implemented by decree number 402, of February 24, 2010, which revoked decree number 35, of January 4, 2007, and was further enlarged into Brazil Telehealth Networks, by decree number 2.546, of October 27, 2011.

The national program Brazil Telehealth Networks deals with the structure and organization of services such as tele-education, teleconsulting, telediagnostic and Formative Second Opinion, a service of scientific answers for questions originated from teleconsulting. It also defines the safety standards for managing the data of the Electronic Healthcare Record (EHR) and interoperability criteria between the Program and other SUS systems.

Two historic moments pointed out by Zundel (1996) as telemedicine milestones are: the utilization of the telephone in 1900 and 1930, for medical communication with remote areas of Australia and Alaska and the introduction of television in the 50s, which allowed the sharing of imagery and results of lab exams.

Telemedicine is a modality that surfaced thanks to the development of communication tools, transforming the relationship between healthcare services and customers/patients. Through telemedicine is possible to perform treatment, prescriptions, appointments and continuous professional education. Thus, the need of a faster service was contemplated and the geographic distance between physicians and patients was shortened (Wurm, Hofmann-Wellenhof, Wurm R., Soyer, 2008).

The definition of telemedicine in Brazil, as well as similar services such as tele-appointments, telemonitoring, telesurgery, among others, was defined by the Federal Council of Medicine (CFM) with decree number 2.227/2018, although it was revoked by decree number 2.228/2019 because of the amount of suggestions proposed by doctors.

That's probably because of the endless possibilities of innovation and creativity through the utilization of technologies for healthcare application, which may cause the lack of consensus regarding standardization. Meanwhile, during the Covid-19 pandemic, the utilization of Telemedicine has been endorsed by law number 13.989, of April 15, 2020.

One of the medical branches that already stood out in a digital ecosystem is Teleradiology. Through a system named PACS is possible to share diagnostic imagery in a specific format named (DICOM) in various modalities such as CT scans, X-ray (DR and CR), MRI scans among others.

Sharing this imagery speeds up the issuance of physician's reports, thus contributing to the process of hospital admission, interventions and early treatment of diseases, cost reduction with unnecessary admissions to hospital environments and medical diagnostics for people in remote regions (Bashshur et al., 2016).

The term e-health is utilized to express the utilization of information and communication technologies in the healthcare area. Its actions can contribute to the organization, agility and availability of information flow, thus contributing to managing and governing processes, and even in processes of professional education (Eysenbach, 2001; Ministério da Saúde, 2017).

Besides the data convergence, the interoperability and integration of systems points out to the fact that the utilization of digitalization in healthcare plays a role that is both intermediary, as it gives support to information paths and relations between users and services, and similar to a driving force, as long as the computing development and innovation propels the healthcare up to higher levels (Ministério da Saúde, 2017).

The e-health system in Brazil comes to provide support to the National Healthcare Program (NHP) and to the SUS principles. Among the benefits offered by the e-health that stands out the most, we highlight the patient's instant access to appointments and medications, appointment schedules and remote appointments. The e-health structure aims to strengthen intersectoral strategies for a decentralized governance, a SUS characteristic, as well as to build initiatives, align actions, promote a tight relationship between research, innovation and health, create standards and certifications, among others (Ministério da Saúde, 2017).

The importance of the e-health is also oriented towards social development, as long as it allows an aperture for technological innovation and further job opportunities (Ministério da Saúde, 2017). This has also been witnessed in areas of digital commerce, which created initiatives during the Covid-19 pandemic that are considered crucial to businesses survival.

III. METHOD

In order to gather material from the database, it was initially performed an in-depth search in the CAPES/MEC Periodic Portal, with the goal of identifying the structure of digital systems in overall Healthcare, with an emphasis on overall telehealth modalities and treatment of patients data,

followed by a research in the Virtual Health Library (VHL), in which we selected articles from LILACS and MEDLINE database, aiming to locate those works addressing documentation or register of doses through technologies or digital systems. Next, we searched in the Scientific Electronic Library Online (SciELO), by repeating the query goals and criteria utilized in the VHL research.

The advanced search in the CAPES/MEC Periodic Portal utilized the following query strategy: it must keep the keywords "teleradiology" or "digitalization in healthcare" in any part of the work; it must have been published over the past 5 years (2016 a 2020); the type of material must be "articles", excluding books, sites or any other source; it must have been written in any language, but it must select only those in Portuguese, English, Spanish or French; it must be reviewed by pairs, which resulted in 14 items related to healthcare systems and 02 items related to applications, out of 795 found items.

Besides the aforementioned content, we sought as content inclusion criteria, those works with an emphasis on subjects such as: electronic register documentation; healthcare information digital systems; teleradiology. We excluded those works that had an emphasis on educational processes or any other topic that diverged from the inclusion criteria and addressed only applications, essays, duplicate articles, dissertations and thesis, regardless whether they had the aforementioned search keywords.

The works were selected according to their titles and then the summaries were read in order to select those which adhered to the inclusion criteria. A total of 14 works were selected and presented in a framework in the results section, those being classified in reviewing and original articles.

As for the VHL search, we utilized the following keywords in the query strategy: (telerradiologia) OR (teleradiology) OR (teleradiología) OR (téleradiologie) OR (coordenador clínico de telessaúde) OR (clinical telehealth coordinator) OR (coordinador clínico de telesalud) OR (coordonnateur clinique de télésanté) OR (aplicações de informática médica) OR (medical informatics applications) OR (aplicaciones de la informática médica) OR (applications de l'informatique médicale). All the above described were characterized on DeCS (Descriptors in Health Sciences) of BIREME.

The following filters were applied: Database: MEDLINE & LILACS; Main Subject: Medical Computing Applications, Medical Computing & Teleradiology; Type of Study: Economical Evaluation in Healthcare, Systematic Reviewing, Evidence Synthesis and Healthcare Technology Assessment; Language: Portuguese, English, Spanish & French; publishing interval from 2016 to 2020.

After we applied the filters, the query returned 59 articles. The same inclusion and exclusion criteria of the research conducted in the CAPES/MEC Periodic Portal were here applied. A total of 5 articles were selected and presented in a framework in the Results section, those being classified in reviewing and original articles.

As for the SciELO research, we utilized the same keywords utilized in the VHL research and applied the following filters: Collections: All; Periodic: All; Language: All; Year of Publishing: from 2016 to 2020; SciELO theme areas: Health Sciences; WoS Theme Areas: Healthcare Sciences & Services, Medical Computing, Politics and Healthcare services and Medical Laboratorial Technology; Type of literature: Article and Reviewing article.

After the application of filters, the research returned 17 articles. The same inclusion and exclusion criteria of the research conducted in the CAPES/MEC Periodic Portal, were here applied. A total of 03 articles were selected and presented in a framework in the Results section, those being classified in reviewing articles and original articles.

After applying the procedures to select the articles, these were fully read for data gathering. On this step, 01 out of 22 resulting articles were excluded over their low or almost nonexistent adherence to the subject of study, resulting in a final sample of 21 articles. After evaluation and critical readout of the works, the data necessary to build the text body was gathered, analyzed and interpreted.

Although it concerns an integrative review, the steps utilized to analyze the literature were based on Cochrane's systematic reviewing procedures, which are synthesized in: 1st) Question formulation; 2nd) Methods planning; 3rd) Protocol redaction and publishing (does not apply); 4th) Research developing; 5th) Search execution – localization and selection of database studies – the data gathering took place between the months of Jan. and Mar. 2021; 6th) Studies selection; 7th) Data gathering; 8th) Bias risk analysis; 9th) Data analysis; 10th) Interpretation of the findings.

IV. SELECTED WORKS

Next, we presented a synthesis of the selected works, in which the main goals and findings are described and grouped by database.

CAPES/MEC Periodic Portal

De Alkimim (2016) presented a review of the studies that involved Electronic Healthcare Record (EHR), Metrics for Objects Orientation (OO) and openEHR. There was an increase of publishing by 2008, with openEHR applicability. Local: Europe.

Fernandes & Tareco (2016) reviewed the Systems of Healthcare Information (SHI) and identified both the pros and cons of SHI in nursing, besides evaluating its applicability as a quality marker. SHIs comprise the

foundations of practical and clinical decisions, thus improving the healthcare process. Local: unavailable.

Galdino et al. (2016) sought to understand the research scenario regarding information management in the SUS, the importance of SHIs and issues like software malfunction and lack of personnel capacitation. Local: Brazil.

De la Escalera & de Azcarate (2018) reviewed the relations of Europe's public healthcare system and information management, besides Big Data contributions to this subject. A Big Data must become the foundation for analysis and planning in healthcare systems, thus contributing to effective changes in healthcare systems. Local: Europe.

Santos, Pereira & Silveira (2017) analyzed a SHI and the data with management support. The SHI can contribute to assertive decision-making processes in healthcare, but for that to happen, there's no need to standardize terminologies and feed correct data into the system. Local: Brazil, USA and Europe.

Pissaia et al. (2018) studied Nursing Care Systematization (NCS), in order to identify the impact of the implementation of Computing Systems in nursing services. It was identified the safety of healthcare management supported by SHIs. Local: Brazil.

Carrasco & Medina (2019) reviewed the digitalization in healthcare. There was a comprehension of the relations between healthcare workers and healthcare systems, and the SIGGES was pointed as a data centralizing technology. Local: Chile.

Da Costa & Linch (2020) studied Nursing Care Systematization (NCS) and electronic registers, which are present in different healthcare branches such as telehealth, clinical decision systems, among others, and there's a need to standardize the language in nursing. Sites: USA, Australia, South Korea, Switzerland, Finland, Argentina, Slovenia, Netherlands, Canada, Thailand, Brazil, Norway and Germany.

Alves, Kuroishi & Mandrá (2016) sought to identify the printing of the Patient's Electronic Health Record (EHR) in Speech Therapy. The EHR is a more efficient tool than conventional methods, when it comes to provide services of low/average complexity.

Gava, Ferreira, Palhares & Mota (2016) aimed to understand the experience of implementing the National Healthcare Card (NHC). The digitalization brought improvements for the service and widened the capability of healthcare management, which changed the reality of healthcare in a certain manner. Local: 44 cities, highlights for Aracaju City, SE, Brazil.

Galván et al. (2017) established the viability of a telediagnostic system for isolated populations in Paraguay. The practical application of telediagnostic not only strengthened the access to healthcare services, but also allowed an equal distribution with cost reduction. Local: Paraguay.

Lima, de Brito & de Andrade (2019) conducted a comparative study of Conitec with Australia, Canada and United Kingdom. They found differences of structure, technology analysis and program evaluation, making evident that Brazil still needs a continuous optimization. Sites: Brazil, Australia, Canada and United Kingdom.

Silva, Guedes, Síndico, Vieira & Andrade (2019) outlined the contributions of digitalization in healthcare. The electronic register (ER) becomes a crucial document to organize a healthcare system, regardless the isolated initiatives that cause the fragmentation of the SUS. Site: unavailable.

De Souza et al. (2020) understand the role of software in Simplified Data Gathering (SDG) and the role of the Citizen's Electronic Health Record (EHR) to integrate the healthcare service. Software are innovations whose implementation is gradual. The main limiting factors are related to the lack of technological structure and professional capacitation. Site: Goias, GO, Brazil.

Virtual Healthcare Library

Pashazadeh & Navimipour (2018) introduced the state-of-the-art, through a systematic reviewing regarding Big Data applied to healthcare in five categories, whose results point to positive benefits for behavioral change and decision-making processes to elaborate healthcare policies. Site: unavailable.

Rahimi et al. (2018) reviewed publications about Technology Acceptance Model (TAM) concerning the development of healthcare systems. The three main areas that utilize ICTs in healthcare are: Telemedicine, Electronic Registers and Mobile Applications. The application of different technologies in healthcare comprises a field of research in expansion. Sites: USA, Europe, Asia and Africa.

Neame, Chacko, Surace, Sinha & Hawcutt (2019) identified the main interventions of Information Technologies in healthcare (Health Information Technology, HIT). The main benefits identified by the application of Information Technologies in healthcare were: support to clinical decisions, Electronic Registers and digital data input.

Bashshur et al. (2016) documents the fundamentals of teleradiology that allows to acquire, broadcast and manipulate imagery, corroborating the radiologist's diagnosis with agility and assertiveness.

Schall et al. (2017) describes the process of developing and implementing a control panel to promote basecare based on evidence.

SciELO: articles for review

Sandoval et al. (2017) identifies the preference for ICTs among resident doctors in General Surgery. Users rather utilizing smartphones (97%), notebooks (34%) and tablets (20%). A study demonstrated the positive interest regarding the utilization of ICTs for education. Site: Paraguay.

Essop & Kekana (2020) sought to understand the experiences and identify the impacts of teleradiology over the local context, and they realized how radiologist doctors were extending the functions beyond the expected by the teleradiology service, and how the training of radiologist doctors was imperative, so that they were able to comprehend the actual challenges posed at countryside areas, thus seeking a bigger alignment with the local needs.

V. THEMATIC GROUPS

Next, we present the selected works grouped in the following categories: Healthcare Information Systems (HIS), Electronic Registers (ER), Telediagnostic, Big Data in Healthcare, Software, Metrics, Healthcare Technology Assessment (HTA) and Digital Technologies, Professional Capacitation & Investments.

Healthcare Information Systems (HIS)

Fernandes & Tareco (2016) considered how Information Systems (IS) in nursing, comprise an important support instrument concerning the quality of information in healthcare environments. They also contribute to decrease mistakes and increase agility in the processes to obtain clinical and gestational data, besides reducing the data disproportion. As far as IS limitations go, the authors made explicit the need of technological knowledge and the importance of a proactive professional profile.

The authors delimited 3 levels of content in their research. The first level deals with management and operation, the second level deals with evaluation, audit and register of the patient and the third level deals with markers and decisions. The agility, safety and trackability of the data were evident, with positive impacts over the service quality and productivity through electronic registers, besides the importance of data documentation concerning management decision-making processes. On a negative note, highlights for the funding as a necessary requirement to execute an IS.

Galdino et al. (2016) divided the research results in two categories: the first one was Systems Functioning and Importance, whose aspects considered to be positive were: support to attention and promotion of healthcare; support to decisions and planning, development of a participative institutional culture; besides the storage of data for further analysis, with an emphasis on nursing and attainment of informative reports.

The second category outlined by Galdino et al. (2016) presented the Systems Problems, in which the main difficulties were: low quality or absence of data input; internal communication noise; low professional capacitation; lack of supervision over the data input process and lack of technological evaluation.

Santos et al. (2017) concluded how the HIS is important when it comes to make assertive decisions in healthcare and how it's necessary to feed data into the system with the biggest precision possible. The authors categorized the information in 4 distinct points that involve aspects such as management and difficult to implement a HIS.

For them, quality, synthesis or integration of patient data are crucial for the management and epidemiologic control in healthcare. The utilization of computing and networks enable the admission to a healthcare service, as well as the control of adhesion to medical treatments, allowing a general panoramic view of an individual's overall health state, as well as the efficiency of the approached clinical strategies.

Still according to Santos et al. (2017), regarding the implementation of HIS, the difficulties pointed by them were ruled by the lack of terminologies standardization and systematic data collection, adding up to the extra work that can occur in the computing processes, such as inputting data into the system. Besides, there's a lack of cohesion between the initiatives for utilization of digital technologies, which tend to meet local expectations and demands. That could disturb or prevent a technological plan within a national scope.

For da Costa & Linch (2020), the digitalization of healthcare processes is currently a rule, so as to give the utilization of digital technologies a much bigger role than simply replacing the documents that once were filed in paper sheets, thus allowing a panoramic and agile view of the usability issues and relations between users and healthcare services.

According to them, although there are countless seeming benefits, some institutions present problems in the processes that involve data imprecision and conflict of institutional interests, besides those questions related to hardware and software. Another point would be the need of a leadership capable to keep up the quality of data input in the registers, as well as the standardization of procedures, in order to create a useful database with as less mistakes as possible, which could have an impact over the whole management chain and clinical decision-making processes.

Gava et al. (2016) conducted a comparative study through a quiz, concerning healthcare systems, and described the process of implementation and analysis of the National Healthcare Card (NHC). One of the quizzes involved a non-computerized system (n=40), whereas the other addressed the digitalization of the same system (n=56).

The main changes identified after the implementation of a computerized system, took place in the physical realm,

such as the replacement of paper sheets for digital data, changes in the physical environment (furniture, physical space, etc.), having an impact over the whole work. The digitalization and the access to digital data promoted the digital inclusion of professionals, regardless of the necessary time to adapt to the system, streamlined the researches and provided a greater security to the patients' data, as long as there is no longer the possibility of misplaced papers.

On the other hand, the authors identified the difficult with codes and excessive information to be filled, which increased the appointment times, as long as the doctor spent more time to fill technical information necessary for registration. Despite the difficulties, the benefits of obtaining statistic data, both individual and collective, were evident.

The main benefits reported by Gava et al. (2016) regarding the utilization of the National Healthcare Card (NHC) were: the ease of patient data recovery (100%), the standardization of data and information (97,4%), the support to referral schedules (87,5%), the decrease of manuscript work (85%) and the ease to provide diagnostic, treatment and make decisions (75%).

Pissaia et al. (2018) analyzed the way the Nursing Care Systematization (NCS) would be influenced by computing technologies. The authors outlined four crucial points concerning the implementation of NCS, among which: 1) work methodology; 2) intermediation of information technology tools; 3) support tools for multi-professional teams; and 4) facilitation of healthcare service management processes.

They identified how the digitalized processes and digital technologies contribute to integral academic formation, to develop critical-thinking skills in the work environment due to the ease of correlating nursing data and prescriptions. They also pointed out an improvement in the relations between multidisciplinary teams and improvements in management with a direct impact over decision-making processes.

Carrasco & Medina (2019) analyzed the Sistema de Información de Gestión de Garantías Explicitas en Salud (SIGGES), in Chile. According to the authors, the system is characterized a mixed system in which state and private funds virtually integrate. It enables the monitoring of how the citizens are benefited by the healthcare system in accordance to their rights, taking in account aspects like medical appointments and reports.

The SIGGES is manually fed by different healthcare professionals who manually fill the "Formularios de Constancia de Información al Paciente GES" (Article 24th, Ley 19.966) (Carrasco & Medina, 2019 , p.8). They serve the purpose of registering the users' accesses to healthcare services and billing tools as well.

Still according to Carrasco & Medina (2019), among the difficulties to implement a healthcare reform in Chile, both the economic and organizational/administrative factors are directly related to capacitation and position attributions concerning professionals who were supposed to perform activities that feed the SIGGES databank. A counterpoint is that the SIGGES renders countryside areas invisible, because of the lack of access to computers or networks in those regions.

Pashazadeh & Navimipour (2018) take into account that there isn't a single system capable to embrace all the questions that are relevant to healthcare management processes. For them, the HIS needs to be a compound system in order to serve a vast demand for offers and services, and it would be nearly impossible to develop a single system capable to meet all the healthcare needs.

Electronic Registers (ER)

Schall et al. (2017) reported the development, evaluation and implementation of a control panel for healthcare registering, based on healthcare information technologies. The authors came to conclude that the tool could improve the speed and precision of clinical decisions. In order to keep the results in a positive and assertive manner, the authors took into account the need of having a visual order in the panel structure.

In a SWOT analysis concerning the implementation of a healthcare electronic register, (Silva et al., 2019, p. 1136) demonstrated how it could have an impact on the work practice and contribute to standardize the information. On the other hand, the absence of an internal structure could contribute to the non-adhesion of other strategic sectors, thus causing divergences, moreover, the system could face interoperability difficulties regarding other systems, such as the E-SUS AB and Hospitalar, for instance.

Regarding the importance of Electronic Health Record (EHR) for speech therapists, Santos et al. (2017) indicated as positive points: organization and dynamism; bigger efficiency as opposed to physical health records; easy-handling and quick adaptation to the system; decrease of waiting times. The main data is that for group 1 (82,22%) and group 2 (100%), the EHR makes the clinical service easier and promotes overall benefits for users and professionals.

For Pashazadeh & Navimipour (2018), electronic registers can be stored in different formats with a high level of security for patients, but it is necessary a high level of management of the method. Furthermore, heuristic and meta-heuristic mechanisms are utilized in order to optimize solutions with high performance and service quality,

besides the fact that they stand out as more affordable methods.

The main benefits identified by Neame et al. (2019) regarding the application of electronic registers within the realm of healthcare information technologies were: support to clinical decision (Clinical Decision Support CDS), through the patients clinical analysis for evidence-based interventions; automation of processes through patients data organization; organization among systems; patients treatment order; medical conduct analysis on a case-by-case basis; access to information such as documents, guidelines and patients reports.

Silva et al. (2019) reported the difficulties to implement an electronic register system and the lack of both material and human resources. The insufficient infrastructure may comprise the lack of high-speed Internet, lack of equipment such as computers, certifications and normative requirements. On the other hand, there could be difficulties with under skilled labor or people unwilling to handle new tools and systems, which could cause failures in the administrative processes.

Another difficult, pointed out by Silva et al. (2019), regards the need of multidisciplinary service schedules, although the system points to a single register number for each patient, which makes the processes less fluid, thus causing extra work.

Telediagnostic

Rahimi et al. (2018) state that Telemedicine has been one of the greatest subjects of research in the TAM field. According to them, there is a major acceptance by doctors and nurses, due to the countless benefits of its applications, among which: self-efficiency; experience; training, compatibility and habit that could serve as a base model for most technologies in a logical context (Rahimi et al., 2018).

Bashshur et al. (2016) described the following benefits of Digital Radiology as opposed to Conventional Radiology: improvement in imagery quality; more assertive interpretations; decrease of patients transfers, mainly in rural areas; less need of re-exposing patients to X-rays, which makes for less doses; detection of large number of pathologies; cancer screening and early diagnosis; remote monitoring of stent patients and total cost reduction.

Galván et al. (2017) reported the implementation of a telediagnostic electronic system in Paraguay, based in open-source software and comprising three main modalities: Echography, Computerized Tomography (CT) and Electrocardiogram (ECG). The imagery was streamed through the Internet, for analysis and report issuance (Telelaudo) by the radiologists in charge.

The authors' cost-effectiveness analysis highlighted a reduction of costs in the remote modality. Case in point: patients bearing transportation costs to take themselves to wherever exams are done, or to go to the doctor in order to receive their report or even costs with food. This study addressed isolated populations of Paraguay, people who would certainly have elevate costs in order to travel to the capitol Asunción, for instance.

The three modalities researched by Galván et al. (2017) are: Echography (19 studies), ECG (21.111 studies) and CT (12.966 studies) constitute a golden standard in the medical diagnosis. The implementation of the system benefited 1.497.725 inhabitants distributed among 25 communities with identifiable hospitals and 6.503.976 inhabitants in areas influenced by hospitals, which represented a coverage of 92,7% of the nation's total population.

Big Data in healthcare

The systematic reviewing of Pashazadeh & Navimipour (2018) contributes to build fundamental aspects that involve Big Data within the healthcare scope. The authors classified the study results in five categories, among which: Machine learning-based, Agent-based, Cloud-based, Heuristic-based and Hybrid-based. They highlighted how artificial intelligence-based machine-learning for data treatment can bring high performance for healthcare management and medical care.

De la Escalera & de Azcarate (2018) pointed out interoperability as the main contribution of Big Data for healthcare services. That's because the data is organized and converted in practical actions in clinics and overall healthcare, oriented for decision-making processes in various realms. As a pre-requirement, the authors pointed out the need of a high-performance infrastructure network involving hardware and software.

Still according to the authors, it's necessary to overcome ethical and legal barriers, when it comes to handling patients' data. Furthermore, the efficient implementation of Big Data in a healthcare system is supposed to be attached to its capability of adding value and benefits to the patients, institutions and healthcare professionals. For that, it's firstly necessary to know the needs and problems to be solved through Big Data, thus being able to make a correct decision to implement digitalized systems in healthcare environments.

Software

De Souza et al. (2020) conducted a qualitative study of applied nature in order to understand the process to implement the free software CDS and PEC, in a tiny Brazilian town located in the state of GO. According to the authors, the CDS has a multidisciplinary dynamic, thus being utilized by different healthcare professionals and the data can be inputted offline, whereas the PEC enables online data input and the data is streamed directly to the Healthcare and Basecare Information System (HBISYS).

Concerning the software importance for managing the information in local healthcare, de Souza et al. (2020) identified how they contribute to organize healthcare unities, reduce the waste of paper, optimize the workflow and allow the trackability of a patient's complex and detailed report. When it comes to difficulties, they presented the lack of adaptation and professional capacitation, lack of technological structure, geographic troubles related to the countryside and population's instruction levels.

Concerning the software, Souza et al. (2020) reported the slowness of the CDS, besides constant setting errors, however, the offline data input was a plus, whereas the PEC has more advanced resources, besides greater agility, but the need of an internet connection is a major drawback, because it only works online.

Metrics and Healthcare Technology Assessment (HTA)

For de Alkimin et al. (2016, p. 3), the creation of a healthcare information system needs to clearly distinguish what is knowledge and what is information, and that would be possible with a multilevel modeling. When it comes to system operability in RES, the patterns found by authors' research were: the openEHR Foundation, CEN 13606, Heath Level Seven (HL7, Integrating the Healthcare Enterprise (IHE), DICOM and Medical Markup Language (MML).

The research conducted by de Alkimin et al. (2016) didn't find any studies that presented metrics to evaluate the openEHR model, but the authors mentioned the work of Ahn, Huff, Kim & Kalra (2013, p. 410) who developed quality metrics based on the ISO 9126 for Detailed Clinical Models (DCM). For de Alkimin et al. (2016), the implementation of RES is a hard task that can be minimized with the utilization of software metrics capable to simulate an actual system and promote a quantitative evaluation of the product.

De Alkimin et al. (2016) pointed out how metrics of Objects Orientation (OO) are more adequate to the openEHR standard, thus being able to contribute to develop aspects such as software reusability and extensibility. The authors indicated in a framework (de Alkimin et al., 2016, p. 9) those tools that are accessible for collecting OO metrics, among which:

- those that utilize Java code: CKJM, Classycle, DependencyFinder, InCode, InFusion, Iplasma, Jdepend, Jhawk, Metric (Plugin Eclipse), OO Meter, SourceMonitor, Understand e UniMetrics;
- those that do not utilize Java code: Cantata++, CCCC, ES2, JBOOMT, MetricView, QMOOD++, SDMetrics, Software Architecture Analysis Tool (SAAT), XLSTAT.

For Schall et al. (2017), evaluation markers can promote the extemporaneous interpersonal planning and can contribute in practice to improve the quality of reports, the cohesion of interdisciplinary teams and the identification of patients in case of vulnerability or risk. They also took into account how time is necessary so that patients learn how to properly utilize the tool.

Lima et al. (2019) conducted a comparative study between Conitec and the organs accountable for Healthcare Technology Assessment (HTA) in three nations regarded as highly relevant references for inclusion of new technologies: Australia, Canada and UK. The study evaluated the process of incorporation of new technologies under the viewpoint of an ongoing legislation and the Conitec electronic admission form.

The authors also conducted a literature review in order to understand how the process of incorporation of new technologies takes place within an international scope, through the methodology proposed by the Center for Evidence-based Policy. Besides, they answered questions about resources allocation and individual goals of each component, so as to compare the process goals.

Lima et al. (2019) reported that: Australia has an interconnected HTA program that provides support to the Healthcare & Aging Ministry; whereas in Canada the main characteristic is the fact that the HTA program is state-funded, although it does have a decentralized administration; as for the UK, it does have an independent program with government funds.

The steps for the Conitec process of technological incorporation were described by Lima et al. (2019) and presented according to the synthesis: attainment and analysis of the demand by soon-to-be-incorporated new technologies; literature analysis and economic studies, in order to understand the viability or validation of the technology in question; recommendation report for SCTIE; publishing on DOU; public publishing and implementation of reports in 180 days tops.

Digital technologies, professional capacitation and investments

In a study conducted with resident doctors in General Surgery (n=74), in services in Paraguay (Sandoval et al., 2017), it was identified the user preferences regarding digital technologies among the participants. The electronic devices identified by order of preference were: smartphones (97%), notebooks (34%) tablets (20%). WhatsApp was the main communication tool utilized by resident doctors (96%), both for exchanging information or images, and for making phone calls (34%).

Still according to the authors, the utilization of smartphones was a means to exchange medical information about doubts concerning clinical cases of patients or any

other correlated subject, to read scientific articles or to watch surgery videos, before performing an operation.

Santos et al. (2017) indicated the lack of investments or incoherent distribution of funds for digitalization projects in healthcare, because they are quite expensive. For them, digital tools must be seen as objects and mediators of the processes, but they never replace the final work of professionals. Adding to that idea, Galdino et al. (2016) pointed out that professional skill is so important that is pointless investing in technologies and systems if there's no capacitation to utilize the tools with quality and consciousness.

VI. DISCUSSION

HIS are facilitators to recover and integrate patients' data, favoring interdisciplinary communication. They help to cut costs with paper Gava et al. (2016), which in turn cuts the costs with service inputs. Besides, as seen in Fernandes & Tareco (2016) and Galdino et al. (2016), HIS collaborates with the practical management of healthcare services.

Such findings affirm Rogers' idea (2020) regarding the transformation of data in valuable information in the context of digital transformation. As we've seen in current times, especially because of pandemic context we're living in (years 2020 and 2021), the offer of remote services has exponentially increased and still increasing, mainly in healthcare areas such as Teleradiology, Tele-appointments, Telereport etc.

Carrasco & Medina (2019) highlighted how the SIGGES renders rural populations invisible, which corroborates Rover's (2008) work, presented at the introduction, as well as de Souza et al. (2020), who indicated pertinent questions concerning the implementation in the countryside, both because of the local geography and adhesion of professionals to properly performing the processes.

Among the benefits of Teleradiology, Bashshur et al. (2016) pointed the decrease of patient transfers from rural areas. That's because by having a report remotely issued, doctors would able to refer the most complex cases that actually need intervention of specialized services.

Da Costa & Linch (2020) suggested the need of a leadership over teams that perform tasks of electronic data register of patients, which would promote more quality in the final result of the databank. Thus, healthcare professionals, who see themselves taking the role of electronically registering patients' data, need to be aware of the importance of data quality for professionals who will base their treatments, diagnostics or healthcare management strategies, upon that information.

As for the difficulties to implement HIS because of the lack of both material resources (WHO, 2016f) and human resources (Silva et al., 2019), is crucial the study of viability and financing management that allows the identification of factors that either limit or prevent the propagation of healthcare services in more isolated communities.

Santos et al. (2017) and da Costa & Linch (2020) indicated the need to standardize HIS terminologies, what makes easier to recover patients' data. For this matter, it is paramount the attention and motivation of professionals in order to fill a register with excellence, reinforcing the authors' idea pointing out to the capacitation and professional engagement as important requirements to the HIS final result.

In some cases, they identified how the low quality of data could be due to the patient's own limitations. Although the patient strictly lacks all the necessary information to fill a form, it's necessary to pay close attention and be extra-careful concerning the provided data, thus avoiding or minimizing the construction of faulty database.

Some studies point out to the lack of professional preparedness to utilize TICS (Fernandes & Tareco, 2016; Galdino et al. 2016; Pissaia et al., 2018; Carrasco & Medina, 2019). Concerning that fact, Alves et al. (2016) offered professionals a previous training so they were able to utilize such technologies, with an emphasis on the perception of the clinical importance and evolution of patients in accordance to the effective filling of the EHR and the quality of it.

The initiatives regarding punctual applications of technologies, as in the case of the SUS national card (Gava et al., 2016) or RE (Schall et al., 2017), are the starting point to develop a system network, whether it's public or private, so that such applications enable the evolution of communication relations between services and individuals.

This support to healthcare management is clearly exemplified in services provided by companies, like Feegow (2021), that has several partners well known in the healthcare realm, in which the EHR becomes a centralized data service crucial for the management. As seen in Santos et al. (2017), we realize in practice how the private initiative has more service possibilities and that causes a heterogeneous and unbalanced development among public and private services.

Regarding the implementation of digital technologies in healthcare services that provide support for nursing, as seen in Pissaia et al. (2018) we understand how the data standardization can improve the communication between professionals of different areas, thus contributing to discuss cases and therapeutic approaches that improve the quality of the patient's service.

Such findings reinforce the data provided by Sandoval et al. (2017), in which the smartphone was the main electronic device selected by resident doctors, utilized for

studies, researches, sharing of information and discussion of cases, thus speeding up the processes and bringing more immediate answers to support clinical, therapeutic and surgical decision-making processes.

It's worth highlighting that the incorporation of new healthcare technologies in the SUS goes through the Conitec and, as seen in Lima et al. (2019), it does have a program attached to the government, similar to Australia and Canada. In that regard, we take into account the importance of researches and academic dialogues by experts and healthcare professionals, in order to contribute to the validation of technologies meant to be inserted in the SUS.

Among the found benefits concerning the implementation of electronic registers in healthcare: speed and precision of clinical decisions Schall et al. (2017), organization and dynamism Alves et al. (2016), high performance and security for the patients' data Pashazadeh & Navimipour (2018), clinical analysis for evidence-based support and intervention.

Schall et al. (2017) also indicate the challenges to implement an EHR, such as the interoperability with other systems, but they point out the possibilities to create standardized information. The authors indicate that an EHR needs to have a visual order in the access panel, a physical structure. Regarding the interoperability, de la Escalera & de Azcarte (2018) brought the alternative of the utilization of Big Data as a strategy to improve communication between different systems.

Interoperability seems to be the most important point of intersection of a project that seeks to install a wide, integrative and functional system. Without it, the systems would be limited to meet local demands, with local impacts, contributing even more to increase the differences in the access to an equal healthcare.

The utilization of smartphones has changed the way the societies relate and correlate within a global context; a fact that was potentiated by the Covid-19 pandemic context, in which people need to keep social distancing and communication has occurred mostly by digital means, during the periods of isolation.

Add to that, the development of social media and countless applications in an image-based landscape in which people interact more with companies and services, influencing their reputation, as seen in Rogers (2020). Besides, we notice the issue of a network society, as seen in Sandoval et al. (2017), in which doctors create discussion networks to address their own interests.

In all segments there is a quest for strategies that take us towards social inclusion and democratization of services. In a system like the SUS, for instance, whose main characteristic is decentralization, it's up to the public management organs to make sure this occurs, in order to minimize the impacts in the whole national system.

The lack of access to healthcare services and modern technologies in rural or isolated communities may soon provoke the discussion of subjects like regional management and investments, the absence of resources, besides highlighting the fact that expectations about current democratization and digital inclusion are not met.

We analyzed the ACR® Dose Index Registry (DIR), a system that operates since 2011 in the register and transmission of patients' automatic data, and we were surprised by the fact that not a single article addressing the "register of dosage markers and radiological protection" was found in the HIS.

Finally, some initiatives to register dose indicatives can be seen in:

- GE Healthcare (2020), that developed DoseWatch, a radiation and contrast dose management system used in CT scans, also applicable in mammography, radiographs and other modalities;
- Siemens Helthineers (2021), that offers teamplay Dose, a clouding dose management and continuous assessment system for multiple sources of ionizing radiation, which analyzes the protocols used in performing exams as well as the accumulated dose in patients;
- Philips Healthcare (2021), that developed the web-based Philips DoseWise software, which performs everything from the analysis to the presentation of dose reports, contributing to patient safety, in compliance with legislation. Through it, it is possible to view the dose in each exam performed, as well as the individual dose, the maximum dose for the skin and other organs; and
- OpenREM (2019), an application used to collect reference and representative dose data from patients, which presents the results through a web interface. It is free and open source and supports CT, X-rays, fluoroscopy and mammography. It can be installed on platforms running Pyton, so it is compatible with Linux, Windows, Mac PC or server operating systems.

VII. CONCLUSION

This article analyzed the works about HIS and the applicability of digital technologies in healthcare. Regarding the initial questions, we conclude that:

1) Digitalization in the healthcare realm does have several benefits, among which: concentration and recovery of patients' data, in order to be utilized for purposes of management and trackability, allowing the practice of evidence-based medicine; reduction of costs with paper, physical space; easy dialogues among interdisciplinary and multidisciplinary professionals, so as to promote health generation.

2) The applicability of computing in healthcare has examples like the ER or EHR; the utilization of applications, such as WhatsApp, to exchange messages among healthcare professionals; the utilization of smartphones for self-educative purposes; the support of Big Data to develop HIS, whose main factor regarding a system of broad scope, is the interoperability among the system's components.

3) As for the implications or barriers to implement a HIS, we can mention the lack of investment in personnel and structure; the lack of professional training to utilize a HIS; the lack of commitment by professionals, while feeding data into a HIS; the lack of terminologies standardization between systems, caused by initiatives with strictly local interests; the lack of communication between different HIS.

The main gap identified was the lack of markers, registers or trackability of ionizing radiation doses, from medical exposure to modalities such as digital radiology, computerized tomography, mammography, bone densitometry and nuclear medicine.

Maybe the results are different in other database or within other research scopes, but as far as the present work goes, it' implied that the subject is poorly researched and it's evident the existence of an aperture for research and development of systems similar to ACR® Dose Index Registry (DIR), mainly in Brazil.

Thus, we conclude that the benefits of a EHR could include trackability markers concerning the doses patients are submitted to, for purposes of dosage control and basecare of the negative effects from exposure to ionizing radiation. Therefore, the data would become valuable information to support the healthcare practices within the scope of Radiodiagnostic, thus contributing to the patient's safety, consequently promoting health.

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