



Patents and records of computer health care management software

Patentes e registros de software de gerenciamento dos serviços de saúde

Patentes y registros de software de gestión sanitaria

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ABSTRACT

Keywords: Patent;
Health information management;
Software.

Objective: To map the patents and computer software registration used by health professionals for the management of health services. Methods: Scope review took place in Web of Science (Derwent Innovations Index), World Intellectual Property Organization – Patent scope, and Brazilian Institute of Industrial Property, with 237 documents being selected. Cluster analysis was used. Results: Thus, the patents were grouped into two clusters, namely “Information technology and communication of health data” and “Health management supervision data processing system”. Software records were also grouped into two clusters, that is, “Health data management system” and “Information system technology for data processing and storage”. Conclusion: Documents on information processing, communication, storage, and data supervision were the most prominent, and addressed the enablement of health services management and clinical decision-making.

RESUMO

Descritores: Patente;
Gestão da Informação em Saúde;
Software.

Objetivo: Mapear as patentes e registros de programas de computador utilizados por profissionais de saúde para a gestão de serviços de saúde. Métodos: Revisão de escopo realizada na Web of Science (Derwent Innovations Index), World Intellectual Property Organization – Patente e Instituto Brasileiro de Propriedade Industrial, com 237 documentos selecionados. A análise dos dados ocorreu através de análise de cluster. Resultados: As patentes foram agrupadas em dois clusters: “Tecnologias de informação e comunicação de dados de saúde” e “Sistema de processamento de dados de supervisão de gestão em saúde”. Os registros de software também foram agrupados em dois clusters, ou seja, “Sistema de gerenciamento de dados de saúde” e “Tecnologia do sistema de informação para processamento e armazenamento de dados”. Conclusão: Prevaleram documentos sobre processamento, comunicação, armazenamento e supervisão de dados, os quais abordaram sobre a capacitação da gestão dos serviços de saúde e a tomada de decisão clínica.

RESUMEN

Descriptores: Patente;
Gestión de Información en Salud;
Software.

Objetivo: Mapear las patentes y registros de programas informáticos utilizados por los profesionales de la salud para gestionar los servicios de salud. Métodos: Revisión de alcance realizada en Web of Science (Derwent Innovations Index), Organización Mundial de la Propiedad Intelectual – alcance de Patentes e Instituto Brasileño de Propiedad Industrial, con 237 documentos seleccionados. El análisis de los datos se realizó mediante análisis de conglomerados. Resultados: Las patentes se agruparon en dos grupos: “Tecnologías de información y comunicación de datos en salud” y “Sistema de procesamiento de datos de supervisión de la gestión en salud”. Los registros de software también se agruparon en dos grupos, a saber, “Sistema de gestión de datos de salud” y “Tecnología de sistemas de información para el procesamiento y almacenamiento de datos”. Conclusión: Prevalcieron los documentos sobre procesamiento, comunicación, almacenamiento y supervisión de datos, que abordaron la capacitación en la gestión de los servicios de salud y la toma de decisiones clínicas.

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INTRODUCTION

A patent refers to an intellectual property ownership, the information of which on the development of technologies and their characteristics is documented. Patents recording protects the rights of the technological product against infringement, replication, redistribution, or sale for a certain period without authorization from the holder. Internationally, a patentable product is one that offers a technical solution to a given problem. The invention shall present technical information disclosed after its registration. Software can be patentable if it presents any innovation with industrial applicability, or can be only registered, according to the laws in force in each country⁽¹⁾.

Patent laws managed by the “World Intellectual Property Organization” (WIPO), together with the laws from the Paris Convention, Patent Cooperation Treaty, Strasbourg Agreement concerning the International Patent Classification, Patent Law Treaty, and Budapest Treaty, constitute a vast international legal framework for their records⁽¹⁾. In Brazil, patents are governed by Law No. 9.279, of May 14, 1996, which describes requirements for patentable inventions and utility models⁽²⁾. The differences between the requirements of Brazil compared to other countries is associated with the legislation, in which in Brazil the evaluations of documents are based on the legislation Law No. 9,279. Based on this law, not all products are patentable, that is, computer programs are only registered, which is different in other places in the world, which go through the patenting process⁽²⁾.

Among the patentable elements in Brazil, the structural part of software, has to meet the requirements of novelty, inventive activity, and industrial application with functional improvement, from its use or manufacture⁽²⁾. The logical part encompassing the programming language, on its turn, is only registered, based on the Brazilian computer software registration (RPC)⁽³⁾. According to Law No. 9.609, of February 19, 1998, computer software is a set of programming language contained in a physical structure of any nature, which is applied in automatic information processing machines, devices, instruments, or equipment⁽³⁾. Thus, the computer software is treated as a protected work and shall be registered in accordance with the Copyright Law - Law No. 9.610, of February 19, 1998⁽⁴⁾.

The computer software is included in the field of artificial intelligence, which addresses computational implications characterized by the use of symbolic computations instead of numerical ones. The computer software is an instrument that allows systems to make decisions independently, accurately, and supported by digital data, with the rational ability of human beings to solve practical problems and simulate situations more broadly⁽⁵⁾.

Technology and innovation are increasingly present in all human activities, in particular in the health care.

This allows the development of applications that can have their use expanded in devices with different purposes. Specifically for health services management, they are used to help control patient information at different moments, such as at diagnosis, treatment, and/or care, being a patient monitoring instrument for health professionals⁽⁶⁻⁷⁾.

Computer software can assist with management activities, including patient clinical outcomes improvement, creation of a healthier work environment, recruitment and promotion of more skilled and engaged professionals, as well as with the maintenance of care productivity and cost-effectiveness for the patient⁽⁷⁾.

Therefore, when considering the growing trend of technology and innovation, the categorization and analysis of patents information through reviews become relevant, being an important method for knowing the prevalence and/or directions of the technologies used in science. Likewise, the results of this type of survey are convenient for researchers to know the mapping of new technologies being launched in the world, as well as to determine the direction of research and development of patents⁽⁸⁾.

The concentration of studies on the analysis of health technology patents has been identified in the literature⁽⁸⁻⁹⁾, however, none of them was focused on computer software for health services management, nor on Brazilian systems records. Thus, the objective of this study was to map the patents and RPC used by health professionals for the management of health services.

METHODS

Scope review of patents and RPC, aimed at answering the following question: “Which patents and RPC are used by health professionals to manage health services”? The definition of the review question was based on the key elements in a structured way by the acronym/mnemonic PCC: P (Participants): Health professionals; C (Concept): patents and RPC about management e C (Context): Health services⁽¹⁰⁾. For this review, the guidelines of the Joanna Briggs Institute (JBI) and of checklist Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (supplementary material)⁽¹⁰⁾.

Inclusion criteria

Patents and RPCs on health care services management used by health care professionals and/or patients, written in English, Portuguese or Spanish were included. Patents and RPCs that did not present descriptive documents were excluded.

Search Strategy

The search was performed in the databases Web of Science (Derwent Innovations Index); World Intellectual Property Organization (WIPO) – Patent scope; National

Institute of Industrial Property (INPI) (patent); and INPI (Computer software). The search in the international and Brazilian databases is due to the difference in the documentation process, in which, in Brazil, computerized programs are only registered and are not patented.

The search strategy consisted of keywords and descriptors. In international databases, such as Web of Science (Derwent Innovations Index) (patent search database) they were: TS = (Software OR computer software OR engineering, software OR software tool OR software validation OR software, computer) AND TS=(Portable Software Application OR notebooks OR desktop) AND TS=(Health Services OR Personal Health Services OR Hospitals OR Hospitals, Private OR Hospitals, University OR health institutions OR institutions OR workplaces), resulting in 330 documents; and, WIPO – Patent scope (patent search database): EN_ALLTXT: (“Software, Computer” OR “Computer Programs and Programming” OR “computer program”) AND (“Mobile Application” OR “App, Portable Software” OR “User-Computer Interface” OR “Computer Software Applications” OR “Computer Systems”) AND (“health service”), with 588 documents. In the Brazilian bases, in the INPI (patents) (patent search database), the following was used: (Title: health; abstract: health), recovering 457 documents, and in the INPI (Computer software) (RPC search database) only the descriptor “Health” was used, resulting in 278 documents. Only the descriptor “health” was used, as it covers all areas of health, in order to identify as many documents as possible. In addition, the use of descriptors, such as nursing, medicine, and technologies, for example, narrowed the search, totaling zero documents. A total of 1,651 documents was retrieved in the four bases in the search.

Source of evidence selection

Study selection (both title/abstract screening and full document screening) was performed by two reviewers, in an independent double-blind manner. Selection differences were discussed between the two reviewers. The selection of patents and RPCs in the databases took place from February to March 2021, by the article’s main author, with the help of Microsoft Excel and the software Rayan. There was no time cut for searching the documents. Among the 1,373 patents, 85 were duplicated and were included only once. Thus, 1,288 patents and 278 RPCs were analyzed. The review corpus consisted of 237 patents and RPCs, which were assessed for data quality and their relationship to the research problem.

Data extraction

For the analysis, a data extraction table was built containing the following information: Patents (title, identification of data sources, International Patent Classification (IPC) code and registration number) and RPC

(title, registration number, type of software, field of application, and programming language). The extraction was performed by one of the reviewers and the second reviewer reviewed the information, which was adequate and corresponded to the purpose of the review⁽¹¹⁻¹²⁾.

Analysis of the evidence

Data analysis was performed using the software R, from descriptive statistics and cluster analysis through k-means. The k-means algorithm is a multivariate cluster regression analysis, and works based on a set of defined data, which uses centroids to form the clusters⁽¹³⁾.

Despite being widely used as a non-hierarchical cluster analysis method, the k-means (non-hierarchical) method has some limitations. To start the algorithm, the user needs to specify the number of clusters in which he wants to group the elements and then the algorithm randomly selects the initial composition of these groups for the calculation of centroids (means of variables). Due to this randomization process, each time the method is computed, different final results may be obtained. This makes the method sensitive to the initial choice of groups.

To get around this problem, the hierarchical k-means clustering technique was proposed, a hybrid technique involving hierarchical and non-hierarchical clustering. The method was implemented in R in the k-means function of the fact extra package⁽¹⁴⁾.

Initially, a hierarchical grouping is performed, based on the Euclidean distance. Elements that have smaller distances from each other are more similar and are therefore grouped into the same group. Next, the k groups formed in this cluster are selected and the centroids of each cluster are calculated in order to perform the clustering of the k-means, using as an initial set of clusters, those formed by the hierarchical method. In the Euclidean distance, patents are being evaluated according to the IPC codes and RPC application codes.

The ideal number of clusters was calculated in the software R Package NbClust, based on 25 criteria: KL, CH, Hartigan, CCC, Scott, Marriot, TrCovW, TraceW, Friedman, Rubin, Cindex, DB, Duda, PseudoT2, Beale, Ratkowsky, Ball, PtBiserial, Frey, McClain, Dunn, Hubert, SDindex, Dindex and SDbw. Where the cluster number is chosen based on the prevalence among the 25 criteria. Patents clusters were carried out based on the IPC codes, and the RPCs based on the field of application codes.

The international classification of patents takes place through IPC codes, which are divided into large areas and their respective alphanumeric variations, according to Table 1. The letter that corresponds to each of these large groups is added with new numbers and letters that will indicate the section, class, and subclass of each patent. This classification helps in the search and retrieval of patent documents in its organization, to facilitate access to technological and legal information contained in these documents.

The RPC application field codes are Brazilian classifications of computer software, which are divided into large areas and their respective alphanumeric variations, according to Table 1.

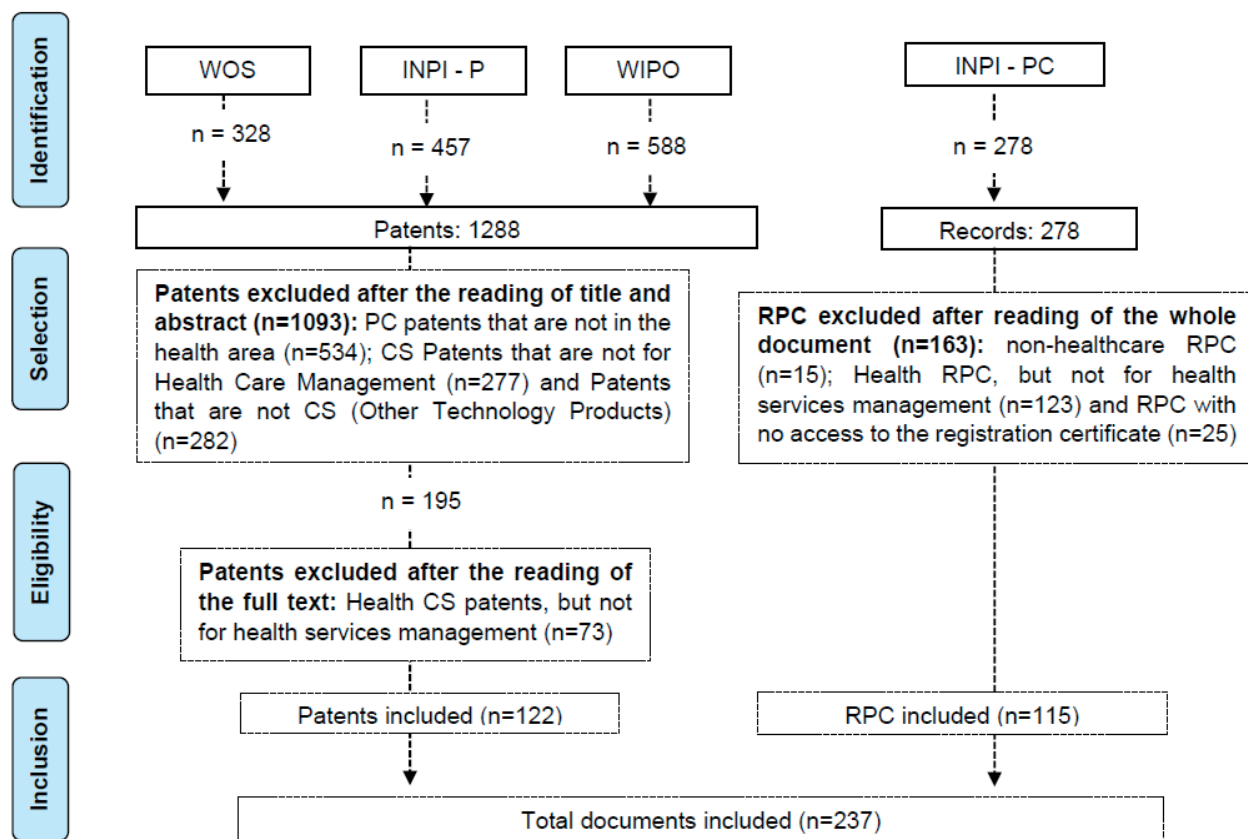
Table 1. Classification by patent IPC codes and by RPC application field codes

Classification	Area classification
International classification of patents based on the IPC of each area	Human necessities (A); Performing operations, Transporting (B); Chemistry, metallurgy (C); Textiles, paper (D); Fixed constructions (E); Mechanical engineering, lighting, heating, weapons, blasting (F); Physics (G); Electricity (H)
Brazilian classification of computer programs based on the field codes of application of each area	Administration [AD]; Agriculture [AG]; Anthropology and Sociology [AN]; Human Settlements [AH]; Biology [BL]; Botany [BT]; Knowledge and Communication [CO]; Civil Construction [CC]; Law [DI]; Ecology [EL]; Economy [EC]; Education [ED]; Energy [EN]; Finance [FN]; Physics and Chemistry [FQ]; Geography and Cartography [GC]; Geology [GL]; Housing [HB]; Hydrology and Oceanography [HD]; Industry [IN]; Information [IF]; Mathematics [MT]; Environment [MA]; Meteorology and Climatology [ME]; Pedology [PD]; Policy [PL]; Social Security and Assistance [PR]; Psychology [PS]; Sanitation [SM]; Health [SD]; Services [SV]; Telecommunications [TC]; Work [TB]; Transport [TP]; Urbanism [UB]

RESULTS

A total of 237 documents (n=122 patents and n=115 RPC) was included and analyzed in this review, as shown in Figure 1.

Figure 1. Patent and RPC search

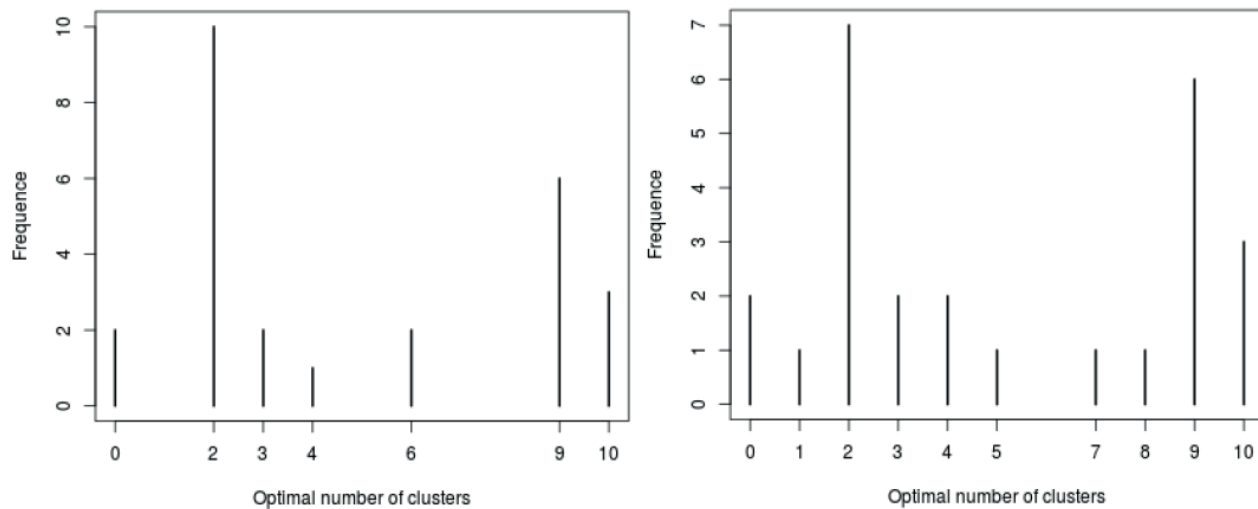


Legend: WOS: Web of Science (Derwent Innovations Index); INPI - P: (National Institute of Industrial Property - patents); INPI - PC: (National Institute of Industrial Property - Computer software); WIPO: World Intellectual Property Organization - Patent scope; CS: Computer software; RPC: Computer software registration.

In Figure 2, among the 25 criteria, in 10 it was observed that the ideal number for the presentation of clusters of both patents (left image) and RPC (right

image) for health services management is two, which had the highest prevalence.

Figure 2. Optimal number of patent (a) and RPC (b) clusters



In Figure 3, the patent clusters are presented in the form of a Cluster plot. Clusters were performed according to the IPC codes in which each of the 122 patents were classified, being mainly grouped within the following codes: H04l: Transmission of digital information/telegraphic communication (n=8); G06f: Electric digital data processing (n=92); H04w: Wireless communication networks (n=4); G08b: Signaling or calling systems/order telegraphs/alarm systems (n=5); A61n: Electrotherapy/magnetotherapy/radiation therapy/ultrasound therapy

(n=1); G16h: Health care informatics/information and communication technology specially adapted for handling or processing of medical or health care data (n=51); G06n: Computer systems based on specific computational models (n=7); G06q: Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory, or forecasting purposes (n=58), and A61b: Diagnosis/surgery/identification (n=20). It should be noted that each patent could be classified into more than one IPC category.

Figure 3. Patent cluster plot. n=122



Note: Dim 1 means that the first principal component represents 17.5% of the total variation. Dim 2 means that the second principal component accounts for 14.4% of the total variation. Thus, together, they explain the 31.9% variation in the data set.

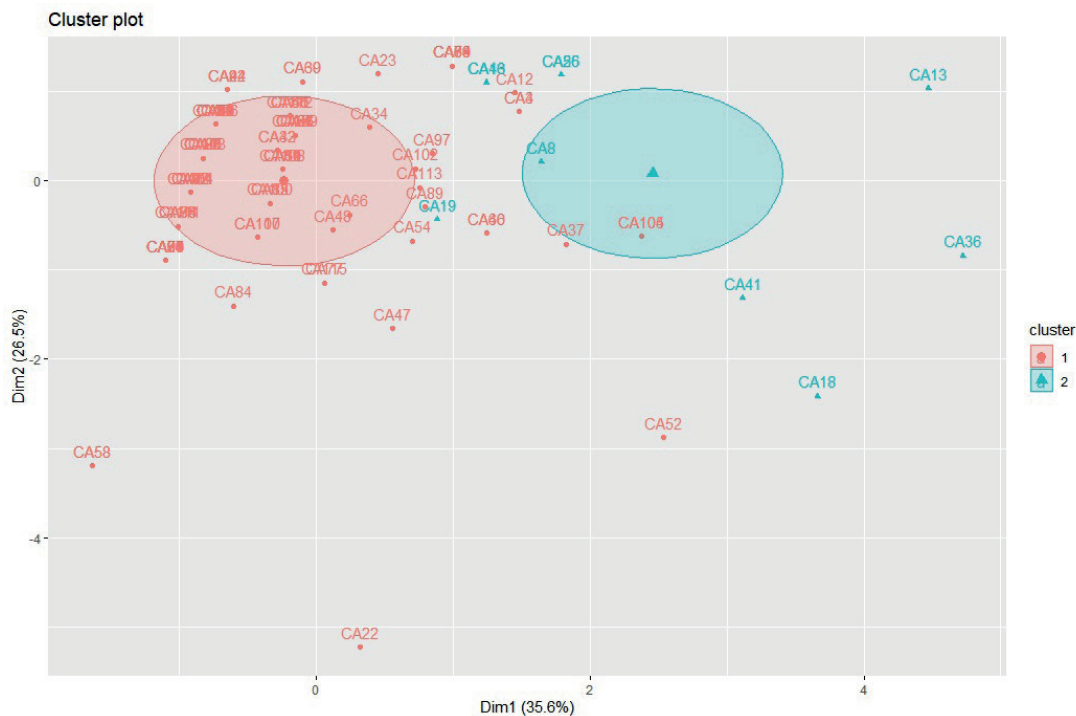
Patents were grouped into two clusters. In cluster 1, there are patents (n=107) on “Information technology and communication of health data” with the highest concentration of patents classified with the IPC code

G06f. In cluster 2, there are patents (n=15) on “Health management supervision data processing system” with the highest concentration of patents classified with the IPC code G06q.

In Figures 4, the patents clusters are presented in the form of Cluster plot. Clusters were formed according to their based on the codes of the field of application: AD (AD-01 to AD-11 on public administration, company, property, material and personnel); IF (IF-01 to IF-

10 on information system, processing and data storage programs); IN (IN-02 on technology) and SD (SD-01 to SD-11 are related to health, sanitation, disease, medical specialties, pharmacology, dentistry, biomedical engineering, medical care, and diagnosis).

Figure 4. RPC cluster plot. n=115



Note: Dim 1 means that the first principal component represents 35.6% of the total variation. Dim 2 means that the second principal component accounts for 26.5% of the total variation. Thus, together, they explain the 62.1% variation in the data set.

The RPCs were grouped into two clusters. In cluster 1, there are the RPCs (n=96) on “Health data administration system” with the highest concentration of RPC classified with the SD and AD application code. Cluster 2 consists of RPCs (n=19) on “Information system technology for data processing and storage”, with the highest concentration of RPCs classified with the IF and IN application code.

Regarding the types of RPC, products on “information management” (n=65) and “application” (n=57) prevailed. The most used programming languages in RPC were JavaScript (n=44); Java (n=43); PHP (Hypertext Preprocessor) (n=39) and HTML (HyperText Markup Language) (n=35). It should be noted that each RPC used more than one programming language at the same time.

DISCUSSION

The patents were grouped into two clusters, with patents on “Information technology and communication of health data” being included in cluster 1. Among them, patents categorized with IPC code G06f prevailed. Cluster 1 showed a trend towards patents of systems related to organization and communication of health data

between the team and their patients, aimed at ensuring qualified care and patients informed and involved in their own care⁽¹⁵⁻¹⁶⁾.

This communication can occur during hospitalization and after the patient’s hospital discharge, with or without the system connected to the internet⁽¹⁷⁾. This is important to support health management in different locations, in urban areas and also in rural areas, where there is little access to health services, facilitating communication between patients and their medical staff⁽¹⁸⁾.

Likewise, health managers can benefit from artificial intelligence, to drive and better control thousands of pieces of data in electronic records, considering the different services, regarding the unification and maintenance of transparency of information from patients and professionals working in organizations⁽¹⁹⁾.

In cluster 2, the patents on “Health management supervision data processing system” were included, among which those categorized with IPC code G06q prevailed. It was noticed that, in cluster 2, patents are related to information management in health services, which is a potential support to managers and staff, aimed at providing clinical information updates and monitoring patients in real time^(6,20). Health management

supervision systems are increasingly prominent today, where the constant exchange of information is required to properly manage the health system⁽²⁰⁻²¹⁾.

In addition, the use of artificial intelligence in data processing is, an important information tool for patients, as it allows appropriate inferences from risk alerts and prediction of health outcomes⁽²¹⁾.

Regarding RPCs, in cluster 1, they were grouped on “Health data administration system”, with a greater concentration of documents classified in the SD and AD application fields. This demonstrates a greater trend of registrations of software for personnel and health-related materials management, as well as for disease diagnosis and clinical care⁽²²⁻²³⁾.

The literature addresses the use of artificial intelligence in health services among physicians, which denotes the importance of investing in the development of computer software for use by other health professionals⁽²⁴⁻²⁵⁾. The studies refer to the use of systems for patient diagnosis and aid in clinical decision-making among physicians^(6,24). This was also observed in patents and software registrations in this review⁽²⁶⁻²⁷⁾.

Some systems assist in clinical decisions, as a second opinion, with the software being a means of judgment⁽²⁶⁻²⁸⁾. Finally, the off-site diagnosis is increasingly present, which allows the remote observation of patients and provision of support⁽²⁹⁾. Besides helping with patient monitoring, computer software can customize treatment plans, as well as help making more appropriate decisions based on ethical health precepts^(24,30).

Cluster 2 grouped RPCs on “Information system technology for data processing and storage”, with the highest concentration of RPCs classified with the IF and IN application code^(27,31). This evidence suggests the use of systems aimed at organizing information and storing data from patients and health professionals⁽²⁴⁾.

Among the programming languages, the most used were Java Script, Java, PHP, and HTML. Java Script is one of the most requested languages on the market, due to its functionality, and it is used both inside and outside browsers. It is an easily adaptable language of high backward compatibility, even in its older versions that can work on more modern devices⁽⁵⁾. HTML, on its turn, allows users to create and structure sections, paragraphs, headers, and links to web pages or applications. PHP is a language that can be inserted into HTML documents, in many cases dispensing with the use of external files for any data processing, and it can be installed in operating systems for free, which facilitates its use⁽⁵⁾.

Consequently, these are the most used languages in android applications, being consistent with the RPC identified in this study, which are mostly classified as applications^(23,31). Paper documents have been gradually replaced by the information system, and this has prompted public health policies in many industrialized

countries, which tend to promote the use of applications to manage information. Currently, their use goes beyond communication and message exchanges, which aroused the interest of application in electronic medical records⁽³²⁾, according to some patents and technological records found in this study^(28,33).

Therefore, based on the results of this review, the presence of a large number of technological products in the information processing area can be observed, showing artificial intelligence as an adequate instrument to assist health services management and to prospect advances in assistance.

A limitation is the challenge of maintaining the methodological rigor through a large number of documents included in the review.

CONCLUSION

Both the patent documents and the RPCs were grouped into two clusters. Among the health service management patents, software on “Information technology and communication of health data” and “Health management supervision data processing system” prevailed, and they were grouped in clusters 1 and 2, respectively. For the health services management RPCs, on their turn, “Health data management system” and “Information system technology for data processing and storage” prevailed, and were grouped into clusters 1 and 2, respectively.

It should be noted that investment in artificial intelligence is required to assist in decision-making regarding ethical care issues, as well as in systems for the management of ethical practice, aimed at fostering work based on good practices. No patent mentioned the organizational climate, which has been understood as an attribute of health services management, but which is captured from the workers’ perceptions about the adopted management behaviors and styles. Moreover, there was no patent for systems guiding and regulating individual behaviors, in accordance with standards determined by the environment, or helping to manage interpersonal relationships and to choose appropriate strategies to promote quality practice based on ethical care.

In terms of contribution, this article found, as a result, the patenting and RPC of products on information processing, communication, and storage, as well as on data supervision, aimed at facilitating health services management and clinical decision-making.

As a future perspective, it is clear that health service managers should invest even more in artificial intelligence to support patient treatment and data organization, which tend to grow. The use of technologies, such as computer software, is interesting to reduce the institutions’ costs when compared to the handling of traditional instruments, such as paper, for example.

More and more managers and health professionals are progressively exposed to the use of technologies as instruments that help in decisions and in the work process. However, it is important to highlight its use excess, which can hinder the qualification of professionals and managers, especially in the reduction of autonomy in the face of clinical procedures, as well as in the face of challenges and discussion about patient care. Thus, it is important to expand the concern with the ethical implications of artificial intelligence, and its role in the formation of new professionals and health managers.

REFERENCES

- World Intellectual Property Organization. Patent Cooperation Treaty (PCT). (2001). <https://wipo.int/en/text/288637>.
- Brazil. Lei N° 9.279, de 14 de maio de 1996. Regula direitos e obrigações relativos à propriedade industrial. (1996). http://www.planalto.gov.br/ccivil_03/leis/19279.htm.
- Brazil. Lei N° 9.609, de 19 de fevereiro de 1998. (1998a). Dispõe sobre a proteção da propriedade intelectual de programa de computador, sua comercialização no País, e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/19609.htm.
- Brazil. Lei N° 9.610, from February 19, 1998 (1998b). Altera, atualiza e consolida a legislação sobre direitos autorais e dá outras providências. http://www.planalto.gov.br/ccivil_03/leis/19610.htm.
- Sebesta, R.W. (2018). *Conceitos de Linguagens de Programação*. Porto Alegre: Bookman;1-735.
- Shortliffe, E, H., & Sepúlveda M.J. (2018). Clinical decision support in the era of artificial intelligence. *JAMA* 320(21):2199–2200. <https://doi.org/10.1001/jama.2018.17163>
- Kutzko, J.D., & Wright, W.C.A. (2020). *Computer-implemented system and methods for predicting the health and therapeutic behavior of individuals using artificial, intelligence, smart contracts and blockchain*. WO Patent WO2020236481. <https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2020236481>.
- Qihong, J., & Liming, W. (2019). *Application research of patent information integration and analysis system in the era of big data*[J]. *Shandong Industrial Technology* 07:136.
- Frazier, R.M, Carter-Templeton, H. Wyatt, T.H., Anef, F., & Wu, L.M. (2019). Current Trends in Robotics in Nursing Patents - A glimpse into emerging innovations. *Computers, Informatics* 37(6): 290-297. <https://doi.org/10.1097/CIN.0000000000000538>
- Peters, M.D.J., Godfrey, C., McInerney, P., Munn, Z., Tricco, A.C., & Khalil, H. (2020). Chapter 11: Scoping Reviews (2020 version). In: Aromataris E, Munn Z (Editors). *JBIM Manual for Evidence Synthesis*, JBI <https://synthesismanual.jbi.global>. <https://doi.org/10.46658/JBIMES-20-12>.
- Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*, 8(1):19-32.
- Valaitis, R., Martin-Misener, R., Wong, ST., MacDonald, M., Meagher-Stewart, D., Austin, P., Kaczorowski, J., O-Mara, L., & Savage, R. (2012). Strengthening Primary Health Care through Public Health and Primary Care Collaboration Team 2012, 'Methods, strategies and technologies used to conduct a scoping literature review of collaboration between primary care and public health', *Prim Health Care Res Dev* 13(3) (2012) 219-36.
- MarufÖztürk, M., Cavusoglu, U., & Zengin, A. (2015). A novel defect prediction method for web pages using k-means++. *Expert Systems with Applications* 42(19). <https://doi.org/6496-6506>. 10.1016/j.eswa.2015.03.013
- Kassambara, A., & Mundt, F. (2017). *Factoextra: Extract and Visualize the Results of Multivariate Data Analyses*. R package version 1.0.5.
- Filho, J.S. (2020). *Sistema e método de interação entre usuário e serviço de gestão de saúde, sistema e método de estratificação de nivelamento de usuários e sistema e método de definição de gerenciamento de modelo de cuidado*. BR Patent BR10 2018 067929 5 A2. <https://busca.inpi.gov.br/pePI/servlet/PatenteServletController?Action=detail&CodPedido=1486157&SearchParameter=10%202018%20067929%205%20%20%20%20%20%20%20&Resumo=&Titulo=>
- Kartoun, U., & Ng, K. (2019). *Verifying medical conditions of patients in electronic medical records*. US Patent US20190189253. <https://patentscope.wipo.int/search/en/detail.jsf?docId=US244367570>.
- Kumar, J. (2019). *System for managing patient health care operational by user platform in hospital, has communications module coupled to medical data software application, where communications module allows remote wireless access to software application*. IN Patent IN201811021769-A. <https://www-webofscience.ez47.periodicos.capes.gov.br/wos/diwdw/full-record/DIIDW:2019A8136V>.
- Guo, J., & Li, B. (2018). The application of medical artificial intelligence technology in rural areas of developing countries. *Health Equity* 2(1): 174–81. <https://doi.org/10.1089/hec.2018.0037>
- Shickel, B., Tighe, P.J., Bihorac, A., & Rashidi, P. (2018). Deep ehr: A survey of recent advances on deep learning techniques for electronic health record (ehr) analysis. *J Biomed Health Inform* 22(5): 1589-604. <https://doi.org/10.1109/JBHI.2017.2767063>
- Gnanasambandam, N., & Anderson, M.H. (2020). <https://jhi.sbis.org.br/>

- System and method for templating conversations with an agent and user-originated follow-UPS.* WO Patent WO2020077079. https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2020077079&_cid=P22-KWDG3Z-16117-1.
21. Agrawal, A., Gans, J.S., & Goldfarb, A. (2019). Exploring the impact of artificial intelligence: prediction versus judgment. *Política de Inf Econ* 1(47): 1-6. <https://doi.org/10.1016/j.infoecopol.2019.05.001>
 22. Souza, A.C.S., Santos, E.T.F., Lima, I.A., Pinheiro, I.M., Gama, K.M.M.B., Jesus R.J.A., Silva, S.S., & Cunha V.J.G. (2020). *Sistema de Monitoração da Saúde do Paciente*. BR Computer program registration. BR512020002528. <https://busca.inpi.gov.br/pePI/servlet/ProgramaServletController?Action=-detail&CodPedido=28331&SearchParameter=>.
 23. Costa, F.H.A., Costa, G.L.S., & Costa, H.L.A. (2019). *VersaSUS - Sistema de gestão da saúde pública integrado para municípios*. BR Computer program registration, BR5120200013384.
 24. Secinaro, S., Calandra, D., Secinaro, A., Muthurangu, V., & Biancone, P. (2020). The role of artificial intelligence in health care: a structured literature review. *BMC Med Inform Decis Mak* 21:125. <https://doi.org/10.1186/s12911-021-01488-9>.
 25. Soegoto, E.S., Wardana, M.E., & Oktafiani, D. (2021). Implementation of management information system at health agencies. *J Phys Conf Ser* 1764:01219. <https://doi.org/10.1088/1742-6596/1764/1/012191>
 26. Reynier, C. (2019). *Sistema e método para comunicar dados de saúde em um ambiente de cuidados de saúde*. BR Patent BR112019023976-6A2. <https://busca.inpi.gov.br/pePI/servlet/PatenteServletController?Action=detail&CodPedido=1528437&SearchParameter=11%202019%20023976%206%20%20%20%20%20%20%20&Resumo=&Titulo=>.
 27. Colito, A.H.G., Martins, C., Souza, F., Medeiros, F.C.J., Soares F.M.C.C., Junior G.S.T., Paiva, M.E.O., & Chaves, V.C. (2020). *CPQD3856 - Viver 360 – Solução para monitoramento da saúde de idosos com morbidades crônicas*. BR Computer program registration, BR51 20200020348. <https://busca.inpi.gov.br/pePI/servlet/ProgramaServletController?Action=detail&CodPedido=30089&SearchParameter=>.
 28. Kartoun, U., Lu, F., Ng, K., & Park, Y. (2019). *Second opinion decision support using patient electronic medical records*. US Patent US20190180874. <https://patentscope.wipo.int/search/en/detail.jsf?docId=US243321612>.
 29. Bokolo, A.J. (2020). Use of telemedicine and virtual care for remote treatment in response to Covid-19 pandemic. *J Med Syst* 44 (7):132. <https://doi.org/10.1007/s10916-020-01596-5>
 30. Kumar, A., Mccoy, A.C., Olsen, R.G., & Walters, P.L. (2017). *Method for creating and monitoring personalized health care plan for patient based on e.g., online food log, by using computing devices, involves outputting personalized patient care plan to patient computing device*. US Patent US2017091422-A1. <https://www-webofscience.ez47.periodicos.capes.gov.br/wos/diwdw/full-record/DIIDW:2017221182>.
 31. Silva, D., & Correa, E. (2020). *GTS - Gestão total de saúde*. BR Computer program registration. BR5120200021913. <https://busca.inpi.gov.br/pePI/servlet/ProgramaServletController?Action=-detail&CodPedido=30260&SearchParameter=>.
 32. Souiki, S., Hadjila, M., Moussaoui, D., Ferdi, S., & Rais, S. (2020). M-Health application for managing a patient's medical record based on the cloud: design and implementation. *International Workshop on Human-Centric Smart Environments for Health and Well-Being*, 44-47. <https://doi.org/10.1109/IHSH51661.2021.9378744>
 33. Pellizzoni, L. (2020). *Sistema de registros (banco de dados) de saúde (EHR) autônomo e adaptável para questionários coletados por pacientes (PROs) e para a pesquisa clínica*. BR Computer program registration BR5120200023789. <https://busca.inpi.gov.br/pePI/servlet/ProgramaServletController?Action=-detail&CodPedido=30450&SearchParameter=>.