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Analysis of patent records related to the prevention and signaling of falls in Brazil

Análise dos registros de patentes relacionadas à prevenção e sinalização de quedas no Brasil

Análisis de registros de patentes relacionados con la prevención y señalización de caídas en Brasil

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ABSTRACT

Objective: To analyze patent records aimed at preventing and signaling falls in a Brazilian database.

Method: Electronic documentary research carried out in the database of the *Instituto Nacional da Propriedade Industrial* using the word "fall" in the search resource. Patent records related to the prevention and signaling of falls at home and in care environment applied from 2000 to 2021 were included. Tabulated data were evaluated using absolute/relative frequencies.

Results: From the 45 patents, 91% were published starting from 2011, with an average of 1214 days between application and publication, 11% of applicants were from public universities and 9% of the inventors were nurses, physician or physical therapists.

Conclusion: There was a delay in the publication of the patents and small participation of researchers linked to the academic area and health professionals, revealing the need to equip universities and health services in order to guarantee the development of innovations.

Keywords: Accidental falls. Patient safety. Patent. Science, technology and innovation indicators.

RESUMO

Objetivo: Analisar os registros de patentes voltados para prevenção e sinalização de queda em base de dados brasileira.

Método: Pesquisa documental eletrônica realizada na base de dados do Instituto Nacional da Propriedade Industrial utilizando-se a palavra "queda" no recurso de busca. Foram incluídos registros de patentes relacionados à prevenção e sinalização de quedas em domicílio e ambiente de cuidado, depositados no período de 2000 a 2021. Os dados tabulados foram avaliados por meio de frequências absolutas/relativas.

Resultados: Das 45 patentes, 91% foram publicadas a partir de 2011, com média de 1214 dias entre depósito e publicação, 11% dos depositantes eram vinculados a universidades públicas e 9% dos inventores eram enfermeiros, médico ou fisioterapeuta.

Conclusão: Observou-se morosidade na publicação das patentes e pequena participação de pesquisadores vinculados à área acadêmica e profissionais da saúde, revelando necessidade de instrumentalizar universidades e serviços de saúde a fim de garantir o desenvolvimento de inovações.

Palavras-chaves: Acidentes por quedas. Segurança do paciente. Patente. Indicadores de ciência, tecnologia e inovação.

RESUMEN

Objetivo: Analizar los registros de patentes destinados a la prevención y señalización de caídas en una base de datos brasileña.

Método: Búsqueda documental electrónica realizada en la base de datos del *Instituto Nacional de Propiedade Industrial* utilizando la palabra "caída" en el buscador. Se incluyeron registros de patentes relacionadas con la prevención y señalización de caídas en el hogar y en el ambiente asistencial presentadas desde 2000 hasta 2021. Los datos tabulados se evaluaron mediante frecuencias absolutas/relativas.

Resultados: De las 45 patentes, el 91% fueron publicadas a partir de 2011, con un promedio de 1214 días entre presentación y publicación, el 11% de los solicitantes estaban vinculados a universidades públicas y el 9% de los inventores eran enfermeros, médicos o fisioterapeutas.

Conclusión: Hubo retraso en la publicación de patentes y poca participación de investigadores vinculados al área académica y profesionales de la salud, revelando la necesidad de equipar universidades y servicios de salud para garantizar el desarrollo de innovaciones.

Palabras clave: Accidentes por caídas. Seguridad del paciente. Patente. Indicadores de ciencia, tecnología e innovación.

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INTRODUCTION

The global scenario of economic and social instability has brought uncertainties about sources and funding for research and development. In Brazil, the lack of access to education, health and basic public services resulting from social inequality also resulted in the lack of relevance and visibility of science[1].

However, the pandemic revealed that investments in the health area, especially with regard to technological innovations, are essential for society[1,2]. In this context, patents stand out as intellectual property, as they are a set of exclusive rights granted to an inventor or assigned for a limited period in exchange for detailed public dissemination of an invention[3].

By patenting a product or process, the holder acquires the right to prevent third parties from producing, using, selling, or importing, in addition to being able to license the patent to third parties, upon payment or not. In Brazil, the National Institute of Industrial Property (*Instituto Nacional da Propriedade Industrial* – INPI) is the responsible body for registering and granting Trademarks, Patents, Industrial Design, Technology Transfer, Geographical Indication, Computer Software and Integrated Circuit Topography. There is two types of patents that are configured as Invention Patent (IP), applied to new technologies associated with products or processes and Utility Model patent (UM) designated for new forms of objects of practical use resulting in improvements in their use or manufacture[4–5].

Among the innovative solutions, there is a significant growth in assistive technologies that can help people overcome visual, auditory, motor disabilities, among others. These investments are justified by the number of individuals who need this type of technology, in the current world scenario more than one billion people, with prospects of doubling in the next decade due to population aging[6].

In this sense, innovations aimed at fall prevention have socioeconomic relevance, since this type of accident is the second leading cause of death from unintentional injuries and causing significant morbidity and mortality problems for public health. Annually, globally, it is estimated that there are 684,000 fatal falls and 37.3 million severe events that require medical attention and that may lead to long-term care and institutionalization[7].

From the perspective of longevity and gerontechnology economics, the increase in the number of elderly people in the community should directly reflect on environmental adaptations, thus avoiding domestic accidents and delays in providing care and possible complications such as muscle weakness, pneumonia, hypothermia, and dehydration. In this sense, the prevention of falls, as a technological innovation, must be highlighted, since this type of incident occurs more frequently in this age group and as a consequence, it can cause complications of physical and emotional aspects in the affected elderly person[8–10].

In the hospital setting, falls are responsible for impairing the patient's quality of life, increasing care costs and length of stay, in addition to represent the event most notified by hospitals[7,11].

However, preventive measures for falls still seem limited and require further investigation. The results of this study can benefit diverse groups such as children, people with disabilities and the elderly, considering that population aging and its demands, such as decreased functional capacity and increased use of health services, are in exponential growth[7,11].

In addition, knowledge about innovative devices can favor the incorporation of technologies to promote health care effectively in the prevention of falls, thus reducing the gaps between the field of research and practical application, thus providing the knowledge translation[12,13].

Faced with a scenario in which we observe a withdrawal in investments in science, innovation and technology and in a translational perspective, seeking a more robust design for the practical application of patents, a subject little explored and contextualized in the nursing scenario, this study aimed to analyze the patent records aimed at prevention and signaling of falls in a Brazilian database.

METHODS

This is an electronic, descriptive, retrospective and quantitative documentary research, whose research question was: what is the profile of patents related to the prevention and signaling of falls available in a Brazilian database? The sample consisted of patent records related to the prevention and signaling of falls.

Data were collected from the patent record database of the e-INPI system from INPI[4], in the option Patent, available on the INPI Database Query page with the advanced search resource. For the search, in the date field, the period from 01/01/2000 to 04/26/2021, the initial day of data collection was stipulated for the application date.

In the keyword field, the keyword "fall" was used to search for titles and abstracts. Due to the impossibility of using Boolean descriptors between the title and abstract in this

system, a search was carried out first for records that included the word fall in the title and then in the abstract. Data collection took place from April to November 2021.

The record data, such as the application number, date, title, and International Patent Classification (IPC), resulting from the search, were copied in full in the table. Through the hyperlink resource, available in the order number, it was possible to access the registration page on the INPI website and consult the title, abstract and PDF descriptive file, a document that provides information such as field, fundamentals and description of the invention and claims.

All patent records related to the prevention and signaling of falls at home or care environment were included in the study, in addition to those used by people with motor and visual disability, applied from 2000 to 2021, a time frame that results with the publication of the report "To err is Human"[14], a document that aroused and revolutionized worldwide concern about the theme "patient safety" and treatments related to adverse events. Records related to accidents at work, suicide, no descriptive file available for content analysis and duplicate requests were excluded.

Data regarding the title of the record, year of application, year of publication, IPC, type and duration of the patent were extracted from the record page. After reading the descriptive file, the researchers evaluated whether the record had its applicability focused at signaling and/or prevention of falls and to which audience it was intended for, being divided into newborns, children and adults and elderly with risk of fall. Regarding the applicability setting, it was analyzed whether it was intended for the hospital and/or extra-hospital. The classifications hospital, home, nursing home, rehabilitation clinic and daycare center were used on the place of applicability. Regarding functionality, the records were identified as electronic or mechanical, that is, without any electrical resource.

The applicant's title/name was extracted from the INPI platform and classified into company, private and university/hospital/foundation. About the inventors, data such as title/name, physical qualification and location were extracted from INPI. The nationality and region of activity of the Brazilian inventors were obtained through the analysis of the geographic location. Regarding the inventors' area of activity, a triple check was carried out including the INPI website, the Lattes Platform and the LinkedIn business social network.

Data were tabulated using Microsoft Office Excel®, software, performing descriptive analysis using tables, showing absolute/relative frequencies and percentages.

The study is linked to the project Patent records related to nursing, CAAE: 47943621,5,0000,5411 and approved by the Research Ethics Committee of *the Faculdade de Medicina de Botucatu*, UNESP under opinion 4,841,423.

RESULTS

The initial search resulted in 1,878 records, 224 from the search by title and 1654 by abstract. Initially, duplicate records were checked, resulting in the exclusion of 156 items. After reading the titles and abstracts, 1585 records were excluded. The descriptive files of 137 records were analyzed and of these, 45 records were selected to the final sample, listed in Chart 1.

There was a predominance of records classified as invention patent, representing 88.9% (40) of the sample, followed by 11.1% (5) of utility model. Table 1 presents the data on the patent records analyzed.

The average between the application date and the national publication of the patents was one thousand two hundred and fourteen days, with the shortest time being one hundred and ninety and the longest, three thousand seven hundred and fifty days. Seventeen (37.8%) records had patents in effect and 28 (62.2%) were archived, that is, in public domain. Twenty-two patent records (48.9%) had their applicability aimed exclusively at signaling the moment of occurrence of the event, sixteen (35.6%) were devices to prevent falls and seven (15.5%) were intended for both purposes.

Table 2 shows data about applicants and inventors. Among the inventors, only two nursing professionals, one physical therapist and one physician were identified, totaling 8.9% of the records evaluated.

Application	Patent title
BR 11 2021 020866 6	Systems and methods for identifying predictive environmental fall risk
BR 10 2019 026049 1	Device and monitoring system for detecting the presence or fall of bedridden or disabled individuals
BR 10 2019 023077 0	Safety device of the visual and audible alert for indicating the opening and closing of the incubator door, phototherapy and heated crib for babies
BR 11 2020 017342 8	Consumer application for mobile assessment of functional capacity and fall risk
BR 11 2020 015636 1	Connected stand for real-time assessment of fall risk
BR 10 2018 070596 2	System and method for prevention and prediction of postural fall risk
BR 10 2018 002453 1	System and monitoring of vital signs and activities
BR 20 2017 026551 5	Device for safe transport of the newborn in a hospital setting
BR 10 2017 014785 1	Device and process to trigger emergencies using bed data using wireless technology with direct access
BR 10 2016 028991 2	Device and process for monitoring and assessment of body positioning and movement
BR 20 2016 023608 3	Safety device for adult patient dependent on armchair
BR 20 2016 007553 5	Intelligent and sustainable stick to aid transportation and inclusion of the visually and physically disabled and the elderly
BR 10 2015 033080 4	Multifunctional device for monitoring health, human activity and well-being
BR 10 2015 031297 0	Safe baby diaper changer
BR 10 2015 016261 8	System and method to assist visually disabled people
BR 11 2016 013924 0	Method to respond to a detected drop; computer software product; and device to provide a response to a detected drop
BR 10 2014 025532 0	Safety wheelchair
BR 11 2016 008139 0	Device and method to convert a movement of a user into a tension, device, method and system for monitoring user, fall detector and method for detecting a possible fall
BR 10 2014 017599 7	Emergency alert device and process using wireless technology
BR 11 2015 023961 7	Method to detect a fall of a user, computer software product, fall detector and fall detector for detecting falls of a user
BR 11 2015 012303 1	Method and device to identify transitions between a standing posture and a sitting posture in measurements of a user's movement, method for determining a user's leg-standing time and a risk of falling, computer software product, device that is set to be worn next to a user's body, and system
BR 11 2015 012301 5	Method to estimate a user's fall risk, computer software product, device to estimate the user's fall risk, device that is configured to be worn against a user's body and system

Chart 1 – List of patents, registered in the INPI Patent Database, with their respective application record. São Paulo, São Paulo, Brazil, 2021

Application	Patent title
BR 10 2013 015705 8	Electronic system for remote, continuous and automatic monitoring of individuals
BR 11 2014 025988 7	Piece for floor covering for fall detection
BR 20 2012 033155 7	Electronic device that makes an emergency telephone call to assist people in danger with remote control activation
BR 10 2012 012753 9	Electronic system for children protection and adults at home
BR 20 2012 007712 0	Electronic system for children protection in the crib
PI 1105215-5	Lighting device and emergency sound signal for use on canes, crutches and walkers
BR 11 2013 027244 9	Method for operating a fall detector, computer software product and device
MU 9002347-1	Helmet for saline
BR 11 2012 012229 0	Fall detector for use in detecting a fall by a user, method for estimate a vertical speed and/or a vertical displacement of an object comprising an accelerometer, method for use in detection of a fall by a user of a fall detector comprising an accelerometer and computer software product
PI 1010050-4	Device to detect the fall of a user, pressure sensor for measuring atmospheric pressure, method of detecting the fall of a user and method of measuring atmospheric pressure
PI 1006542-3	System and method to detect a fall of a user
PI 0915249-0	Device to indicate a fall of a user by an alarm message, fall detection system and fall detection method
PI 0914046-8	Fall detection system, method, and non-transient computer-readable medium
PI 0914089-1	System for fall detection, method of operating a system for fall detection and computer software product
PI 0913494-8	System for fall detection, method of operating a system for fall detection
PI 0913517-0	Systems for fall prevention, method for single-user fall prevention, and non-transient computer-readable medium
PI 0903522-2	Fall and impact sensor for people with motor difficulties
PI 0912961-8	System for fall detection and/or prevention, and method of training a fall detection and/or prevention algorithm
PI 0803122-3	Bed for bathing or resting people with physical disabilities
PI 0718640-1	System and method for fall prevention of a user
C1 0205747-6	Bed seat and transport without lifting disabled
PI 0303725-8	Surgical immobilizer
PI 0205747-6 A2	Bed seat and transport without lifting disabled

Chart 1 – Cont.
Source: Patent Record Database of the *Instituto Nacional da Propriedade Industrial*, 2021.

Table 1 – Distribution of patent records by year of application, publication, public, environment and place of applicability, functionality and IPC classification, São Paulo, Brazil, 2021

Variables	n	%
Application year		
2000 to 2005	3	6.7
2006 to 2010	13	28.9
2011 to 2015	17	37.8
2016 to 2021	12	26.6
Publication year		
2000 to 2005	3	6.7
2006 to 2010	1	2.2
2011 to 2015	11	24.4
2016 to 2021	30	66.7
Audience		
Newborns and Children	4	8.9
Adult and elderly at risk of fall	40	88.9
Adult and elderly at risk of fall and child	1	2.2
Applicability environment		
Hospital	5	11.1
Extra-hospital	27	60.0
Hospital and extra-hospital	13	28.9
Applicability location*		
Hospital	18	40.0
Residence	39	86.7
Rest home	17	37.8
Rehabilitation clinic	6	13.3
Day care center	2	4.4
Functionality		
Electronic	36	80.0
Mechanic	9	20.0
IPC Classification		
A – Human Necessities	25	55.5
G – Physics	17	37.8
H – Electricity	3	6.7

Source: Research data.
Note: *Some patents were destined for more than one location, justifying the sum of the items being equal to eighty-two.

Table 2 – Distribution of types of applicants, inventor's area of activity, nationality and Brazilian inventors' region of activity. São Paulo, Brazil, 2021

Variables	N	%
Type of applicant		
Company	21	46.7
Private	19	42.2
University/Hospital/Foundation	5	11.1
Inventor's area of activity		
Health Sciences	12	26.7
Exact Sciences	19	42.2
Human Sciences	2	4.4
Unidentified	12	26.7
Inventor's nationality		
Brazilian	25	55.6
Foreigner	20	44.4
Brazilian inventors' region of activity*		
North	0	0
Northeast	2	8.0
Midwest	1	4.0
South	6	24.0
Southeast	16	64.0

Source: Research data.
Note: * Twenty inventors were classified as foreigners and were not included in the distribution Brazilian inventors' region of activity.

DISCUSSION

The study revealed that most patents were applied from 2011 and with excessive delay in their publication. Most of it is aimed at adults at risk of falls in an extra-hospital setting. A little more than half were applied by Brazilians, mainly from the Southeast region, with only 11% of inventors linked to universities, with a low representation of nurses and physicians, even though these devices are used in the health area.

This short number corroborates the information presented in the Global Innovation Index 2020 Report, in which Brazil ranks only the 62nd position, and the first positions are occupied by Switzerland, Sweden and the United States respectively. This ranking considers the mean scores of innovation supplies and products that encompass knowledge, technology and creative products, and patents are used as indicators of economic growth and technological innovation[1].

Most applications and publications of records occurred from 2011, more than ten years after the publication of the report "To err is human", indicating that in Brazil this concern was late. It should be highlighted that only in 2013 the National Patient Safety Program was published, resulting in movement towards the adoption of safe practices, mobilizing professional categories to research and review processes, products and work systems, in addition to the structuring of patient safety centers and the notification of adverse events in health services[14–15].

The excessive time regarding the date of patent application and publication corroborates a study conducted in the state of Minas Gerais, in which the waiting time for the granting of patents was close to three years, which can be considered a limiting factor for researchers and inventors and, above all, for the dissemination of new inventions, with one of the purposes of patents focusing on the dissemination of the product to the general public[16].

Furthermore, delay also becomes a favorable condition for issues related to corruption, especially in emerging countries. A Chinese study, consisting of a sample of 139 countries, including Brazil, raised the value for the frequency of bribery in patents from 2006 to 2016. The results showed that corruption has a negative effect on the innovative development of a nation and that the better is the government of a country, less will be the interference of corruption on the probability of innovation of companies[17].

The statistics of the study showed that most patent records were intended for adults at risk of fall. According to the World Health Organization (WHO), falls represent the second leading cause of unintentional deaths and adults over 60 years old are the population that suffers the highest number of fatal falls[7]. In 2018, the USA recorded approximately 2.2 million emergency room visits due to injuries caused by unintentional falls in adults over 65 years old, which is directly proportional to increasing age. Considering the cost that falls cause to the health system, the application and investment in appropriate technological resources can result in positive impacts on these values and results[18].

The study revealed that most of the records were intended for the home environment (86.7%), followed by the hospital environment (40%), converging with an epidemiological review that showed that the incidence of falls and injuries related to this incident is frequent in elderly who remain in care environments, including home care, a problem that also occurs at hospitals[19].

The low number of records of applicants linked to public institutions of higher education reveals the need to encourage teaching and research in the country, in addition to reinforcing the low investment in Science and Technology and in Brazilian universities[20]. In Brazil, the Technological Innovation Law (*Lei de Inovação Tecnológica* – LIT) that deals with incentives for innovation and scientific and technological research in the productive environment was only published in 2004. In the United States, the Bayh-Dole Act (BDA), American legislation that deals with the transmission of technology practiced with federal reserves to the rest of the economy, was sanctioned in 1980, twenty-four years before the Brazilian publication. Moreover, although the two legislations walk along the same pathway, there are differences in their objectives. While the purpose of the BDA is to allow universities to patent their innovations arising from research subsidized with public funding and to exploit them for profit, the LIT acts to stimulate creations without providing institutional structures so that it can be commercially exploited[21].

Despite the university setting contributes significantly to the elaboration of products and processes, applicable in the industrial sector, with benefits for the health area, there is a great imbalance between the numbers of scientific publications and patent applications by universities, revealing a very promising and opportune field. Data from a study reinforce this fact in the nursing academic universe in Brazil, in which a small number of patent records arising from academic master's research projects were observed, which may represent the lack of knowledge of nurses about this process and its benefits[20].

The research outcomes are in line with the literature showing that in the market we have a predominance of systems for fall detection, with the prevalence of record of products intended to signal the moment of the occurrence of the event, with the purpose of seeking help and reduce the time in which the individual would be left unassisted after the incident. However, it was observed a change in focus towards predicting and preventing falls, since this approach is considered more promising for preventing injuries and their consequences. In the hospital setting, there is a concern with preventive measures focused on the educational process of the patient and family. However, the incentive to invest in technologies to prevent this adverse event is still not visible. In this sense, the dissemination of patents can help in the propagation of these resources in order to avoid these occurrences[15,22].

Although the study shows that most of the records were from Brazilian inventors, recent research revealed that in 2019 most patent applications were filed by foreigners[23]. Regarding geographic regions, the southeast has the most representative innovative capacity in Brazil, corroborating research findings that also revealed that São Paulo is the state that occupies the first position in the country[24].

Faced with changes in the business world and due to increased operating costs, hospitals invest resources in innovations in the health area with the objective of developing care settings focused on efficiency and economy[20,25].

Nowadays, it is observed the increasing use of new technologies in care process. These advances, in addition to ensuring safe and efficient care, allow for the monitoring and treatment of patients in the extra-hospital environment, connecting the health team to the patient. Digital health technology has revolutionized the care environment and will certainly bring many benefits[26].

However, nursing still plays a minor role in this field, and it is necessary to invest in training and courses related to innovation. Moreover, hospitals could establish rewards to encourage nurses to participate in the development of innovative products and services, in addition to encouraging the record in patent systems. These measures would certainly increase the nursing team's motivation to transform creative ideas into real products[20,25].

It is worth highlight that well-structured product projects include the end user throughout their development process. In this line, nursing stands out as a key point for technology and innovation projects aimed at the health area, as it is inserted in the care process and is able to assist in the design, prototyping and clinical tests of medical products[27].

Despite nursing is seen as a differential for businesses related to care, it is observed that entrepreneurship in this area is still incipient and needs to be strengthened and expanded at universities. The inclusion of the subject in graduation can be an incentive for this professional practice, in addition to set the profession as science, technology and innovation. When it comes to issues aimed at patient safety, nursing has a great emphasis due to providing care to patients and understanding the context and the worsening factors in case the event occurs. In addition, these professionals understand the core of the innovations that need to be developed, being able to evaluate whether the application of the product would be technically feasible[15,20,25]. Thus, the low adherence of nursing professionals in the development of products intended for the prevention of falls may be reflected in less effective products or with less acceptance by users, bringing negative consequences for clinical practice[27].

The low number of records with patents in effect is justified by the principle of territoriality and the lack of a patent with global coverage, that is, for countries where the patent has not been applied for, its object is considered in public domain. Thus, it is up to the Brazilian authorities to analyze this phenomenon and its prospects, in addition to attributing and encouraging the development of research, teaching and extension activities in universities, aiming to guarantee development through the implementation of these measures[23].

CONCLUSION

The study revealed a small number of patents intended at fall prevention registered in a Brazilian database, in addition to presenting delays to their publication. Most of it is aimed at adults and elderly people at risk of falls at home or in a hospital setting, since the number of injuries resulting from falls is directly proportional to increasing age, finding a correlation with population aging.

University production linked to health services is short, with little or no incentive to patent products arising from research, revealing the need to stimulate and equip these areas for the development of innovations, using the structures made available by universities and hospital institutions, and better use of the multiprofessional knowledge.

Furthermore, even though these devices are widely used in health and care areas, there is a low representation of nurses and physicians inventors, in patent records, evidencing the demand for strengthening entrepreneurship during graduation and professional practice, aiming at continuous improvement of the quality of care and, consequently, patient safety.

The study has as a limitation the search of only the national database, a fact that can hide the existence of products available in the Brazilian market but registered in international databases.

However, this research contributes to the dissemination of existing patents for signaling and prevention of falls and their applicability, a subject little explored in the health area. This study also brings contributions and innovations for care, teaching and research, and may work as a way of consulting the resources available in the market for hospitals and other institutions, health professionals and family members. It can also be a source in discussion forums and disciplines at universities, in order to stimulate inventions and their records. In health services, in addition to consultation and application of products presented, it is expected to implement actions that encourage the team to disseminate their inventions, also bringing needs to create resources focused on patient safety.

The study also indicates the need for future studies on devices related to the prediction and prevention of falls, avoiding injuries and their consequences.

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