RIASE
REVISTA IBERO-AMERICANA DE SAÚDE E ENVELHECIMENTO
REVISTA IBERO-AMERICANA DE SALUD Y ENVEJECIMIENTO

DIGITAL TECHNOLOGIES USED FOR FALL PREVENTION IN HOSPITALS: INTEGRATIVE REVIEW

TECNOLOGIAS DIGITAIS UTILIZADAS PARA PREVENÇÃO DE QUEDAS NO AMBIENTE HOSPITALAR: REVISÃO INTEGRATIVA

TECNOLOGÍAS DIGITALES UTILIZADAS PARA LA PREVENCIÓN DE CAÍDAS EN EL AMBIENTE HOSPITALARIO: REVISIÓN INTEGRADA

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Received/Recebido: 2023-07-06 Accepted/Aceite: 2023-08-13 Published/Publicado: 2023-08-28

DOI: http://dx.doi.org/

ABSTRACT

Objective: To identify scientific evidence in the literature on the use of digital technologies to prevent falls in hospitals.

Method: An integrative review carried out in seven databases in February 2022. The PICo strategy was employed to devise the research question. The collected articles were from the period 2017-2021. The Rayyan® software was used to delete duplicated documents in the databases, as well as blinding assessors in the title and summary reading stage (first assessment) and in the full reading stage (final assessment). Document analysis was carried out on data treated by a quantitative-qualitative approach.

Results: Six hundred and ninety-five (695) articles were identified; of these, 47 were selected for full reading. A final sample consisting of 14 articles was produced. American and Brazilian studies were predominant. Regarding digital technologies to prevent falls, a prevalence of pressure and wearable sensors was found. In a smaller number, the technologies applied were location tracking sensors and individually customized electronic tools to assess and guide patients with high risk of falls. Other studies suggest that the use of multiple resources associated with digital technologies presented good results in reducing fall events in hospitals.

Conclusion: There are different technologies that can be used to prevent falls. When they are associated with interventions, they are capable of promoting a positive impact in reducing fall events in hospitals.

Keywords: Accidental Falls; Accident Prevention; Digital Technologies; Nursing.

RESUMO

Objetivo: Identificar na literatura as evidências científicas do uso das tecnologias digitais na prevenção de quedas no ambiente hospitalar.

Método: Revisão integrativa realizada em sete bases de dados, em fevereiro de 2022. Utilizou-se a estratégia PICo para elaboração da questão de pesquisa. Os artigos coletados foram do período de 2017 a 2021. Empregou-se o *software* Rayyan® para a exclusão de documentos duplicados nas diferentes bases, assim como para o cegamento dos avaliadores na etapa de leitura de título e resumo (primeira avaliação) e na íntegra (avaliação final). A análise documental deu-se com base em dados tratados pela abordagem quantitativo-qualitativa.

Resultados: Foram identificados 695 artigos, dos quais 47 foram selecionados para leitura na íntegra, obtendo-se amostra final de 14 estudos. Predominou a publicação estadunidense e brasileira. Em se tratando de tecnologias digitais para prevenção de quedas, encontrou-

-se a prevalência do uso de sensores de pressão e sensores vestíveis. Em menor número, as tecnologias utilizadas foram sensores de rastreamento de localização e ferramentas eletrônicas personalizadas individualmente para avaliação e orientação ao paciente com alto risco de quedas. Outros estudos apontam que o uso de múltiplos recursos associados às tecnologias digitais apresentou bons resultados na redução de incidências de quedas no ambiente hospitalar.

Conclusão: Existem diferentes tecnologias digitais que podem ser utilizadas para prevenção de quedas. Quando associadas com intervenções, são capazes de promover impacto positivo na redução das ocorrências de quedas no ambiente hospitalar.

Palavras-chave: Acidentes por Quedas; Enfermagem; Prevenção de Acidentes; Tecnologia Digital.

RESUMEN

Objetivo: Identificar en la literatura las evidencias científicas del uso de las tecnologías digitales en la prevención de caídas en el ambiente hospitalario.

Método: Revisión integrada realizada en siete bases de datos, en febrero de 2022. Utilizado la estrategia PICo para elaboración de la encuesta de investigación. Los artículos recolectados fueron del período de 2017 a 2021. Empleado el *software* Rayyan® para la exclusión de documentos duplicados en las diferentes bases, así como para el ofuscamiento de los evaluadores en la etapa de lectura de título y resumen (primera evaluación) y en la íntegra (evaluación final). El análisis documental basado en datos tratados por el enfoque cuantitativo--cualitativo.

Resultados: Fueron identificados 695 artículos, de los cuales 47 fueron seleccionados para lectura en la íntegra, obteniéndose muestra final de 14 estudios. Predominó la publicación estadunidense y brasileña. En tratándose de tecnologías digitales para prevención de caídas, se encontró la prevalencia del uso de sensores de presión y sensores vestibles. En menor número, las tecnologías utilizadas fueron sensores de rastreo de localización y herramientas electrónicas personalizadas individualmente para evaluación y orientación al paciente con alto riesgo de caídas. Otros estudios señalan que el uso de múltiples recursos asociados a las tecnologías digitales presentó buenos resultados en la reducción de incidencias de caídas en el ambiente hospitalario.

Conclusión: Hay diferentes tecnologías digitales que pueden ser utilizadas para prevención de caídas. Mientras asociadas con intervenciones, son capaces de promover impacto positivo en la reducción de las ocurrencias de caídas en el ambiente hospitalario.

Descriptores: Accidentes por Caídas; Enfermaría; Prevención de Accidentes; Tecnología Digital.

INTRODUCTION

The Ministry of Health (MH), via Ordinance no. 529/2013, established the Patient Safety National Program (PSNP) in order to promote patient safety, improve care service, and create a safety culture at health spaces and services. The PSNP states the need of setting goals, creating protocols, guides, and manuals on patient safety in several areas, among these, fall prevention(1).

Falling is defined as an unintentional event in which an individual suffers an impact on the ground or goes to a level lower than the initial one. This event may cause damage and even serious lesions(2). Falls are a public health matter globally. According to the World Health Organization, nearly 684,000 fatal falls occur every year. This is the second main cause of death due to unintentional lesions, only after lesions caused by traffic accidents(3).

More than 80% of fall-related deaths occur in low and middle income countries such as the Western Pacific and Southeast Asia regions, which account for 60% of these deaths(2). In Brazil, data divulged in the Patient Safety and Health Service Quality Report inform that falls amount to 11% of the incidents related at health services(4).

The fall severity degree is linked to intrinsic factors, that is, individual characteristic factors, such as: their aging processes; gait changes; sight and hearing difficulties; comorbidities; base pathology; polymedications; previous history of falls and behavioral problems. Extrinsic factors are linked to hospital ambient conditions, such as an unknown ambient, presence of stairs, slippery floor, objects far from reach. These factors are associated with behavioral characteristics(5). In hospitals there is a larger number of people who present such characteristics and make the risk of falls a present, daily concern for health institutions(6).

The prevalence of falls in health services is one of the main indicators that measure care service quality. Falls are events that usually cause complications of several magnitudes for patients. Some of them are: extended length of stay; comorbidities; premature death; high demand for adaptations in family arrangements to provide care; increase hospital costs(7).

Despite all care and concerns about the promotion of actions to prevent falls, this is an unfortunate prominent reality. It instills researchers from various countries to find strategies to minimize such events in hospitals. One of these strategies is the use of digital technologies in hospitals. This has been increasingly discussed and it may become a reality at many health institutions(8,10). Moreover, there is a possibility of creating digital technologies to be integrated with actions to prevent falls in hospitals. It is against this background that this study was carried out. It aims to identify scientific evidence of the use of digital technologies to prevent falls in hospitals in the literature.

METHOD

This is a six-stage integrative review of the literature (IRL): 1) creating the guiding question; 2) defining study inclusion and exclusion criteria; 3) selecting information to be extracted from the selected studies; 4) assessing the studies included in the integrative review; 5) interpreting results; 6) knowledge synthesis[(11)]. This study was carried out according to the guidelines and recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol[(12)].

The PICo strategy was utilized to create the guiding question, in which: P – Population (patients); I – Interest phenomena (digital technologies); and Co – Context of the study (hospitals)[(13)]. Thus, the following question was created: "What is the scientific evidence in the use of digital technologies to prevent falls in hospitals?"

The databases were set according to relevance and impact to the health context. They are as follows: Scopus; the US National Library of Medicine National Institutes of Health (PubMed), the Web of Science (WoS), the Cumulative Index to Nursing and Allied Health Literature (CINAHL), the Scientific Electronic Library Online (SciELO), the Medical Literature Analysis and Retrieval System Online (MEDLINE) and the Scientific Health Information from Latin America and the Caribbean countries (LILACS).

Articles with full texts, available in English, Spanish and Portuguese, were included in this study. They were published in the period 2017-2021 and answered the research question. Undergraduate theses, dissertations, theses, integrative review articles, literature review articles, whether they were historical or reflective were excluded from this study. Simple and expanded summaries, reviews, editorials, letters to the editor, and studies presenting serious methodology issues found by the reviewers during critical analysis were also excluded from this study.

Controlled descriptors were used in accordance with the Health Sciences Descriptors (DeCS), Medical Subject Headings (MeSH), Scopus, and CINAHL by using Boolean operators "AND" and "OR". *Accidental Falls*; *Accident Prevention*; *Hospitals*; *Technology Assessment, Biomedical*; *Instructional Film and Video*; *Digital Technology, Mobile Applications*; *Educational Technology*. In order to organize sample collection, an advanced search form was used. Each database peculiarity was observed. An independent researcher carried out this task by standardizing the descriptor use sequence and crosschecking in each database. To guarantee a broad data search, the articles were accessed through the journal portal of the Coordination for the Improvement of Higher Education Personnel (CAPES). The descriptor synonyms were added and made available in the controlled vocabularies.

The indexed study search took place in February 2022 and produced a sample of 695 articles. The results were exported to the Rayyan® software, a tool designed to aid sample storing and selection, duplicates identification, and assessor blinding(14). After the duplicates were excluded, studies were screened via title and summary reading in a double-blind fashion. A third assessor was added when there were disagreements regarding the inclusion or exclusion of an article. In the second stage, two assessors fully read 47 articles and observed the same methodology process. There were classified as eligible or non-eligible to compose this IRL. In the articles where there was a disagreement in the assessment, the decision was independently resolved via consensus by a third assessor.

To extract data, the information of interest of the selected studies were previously set. They were obtained by use of a specific form devised for this study. The following data were collected: author name, title, journal, country of origin, year of publication, study objective, delineation, main outcomes, type of technology and evidence level.

The classification proposed by the Oxford Centre Evidence-Based Medicine was utilized in order to assess the evidence level (EL). This classification proposes ten levels: 1A – systematic reviews and meta-analyses of comparable clinical trials; well-delineated randomized, controlled studies with a relevant clinical outcome; 1B – randomized, controlled studies with a narrow confidence interval; 1C – "all or nothing"-type results, controlled case series study; 2A – homogenous systematic review of cohort studies (with comparison groups and variable control); 2B – cohort study with poor randomization, control or without long follow-up, cross-sectional cohort study; 2C – research results (therapeutic results or clinical evolution findings); 3A – homogenous systematic review of control-group case studies; 3B – case studies with control group; 4 – case and series reports with no definition of control cases; 5 – opinion of reputable authorities and specialists; non-systematic literature review[15].

The results were categorized and grouped as per their similarity in order to be critically analyzed. This produced an outcome synthesis and quantitative data extraction as per an aforementioned form that was specifically created for scientific evidence findings.

Because this study is an IRL, it was not submitted to the Research Ethics Committee (ERC). It did not include research in humans; nevertheless, it observed the publishing rights of the selected studies.

RESULTS

The study selection was parametrized as per the PRISMA stages, as shown in Figure 1↗.

The study search and selection resulted in the inclusion of 14 articles that answered the research question. Articles available on the PubMed (10; 71.5%)[8,10,17,18,21,23,25,26] database, followed by the SciELO (4; 28.5%)[16,19,20,24] database, were predominant. Of the selected studies, 4 (28.6%) were published in 2017[17,20,22,25]; 3 (21.4%), 2019[8,10,18] and 2021[9,16,21]; 2 (14.2%) in 2020[19,24], and 1 (7.2%) in 2018[23]. The analysis corpus contained 11 (78.6%) publications in English[8-10,17-19,21-23,25,26] and 3 (21.4%) in Portuguese[16,20,24].

The country with the largest number of publications was the United States[9,10,17,19,22,23,26], (7; 50%), followed by Brazil[16,20,24] (3; 21.4%); Australia (2; 14.2%)[18,25]; England[8], and China[21] (1; 7.2%). The study sample size varied between 13 and 2,148 participants. The predominant purpose of digital technologies was preventing falls in older persons (13; 92.8%), while only 1 (7.2%) study[16] had children as its target audience.

Regarding journals, 2 (14.2%) of them were published in the Journal of Medical Internet Research[10,26], while the other were single publications selected from the following magazines: Biosensors[21]; Injury Prevention[18]; International Journal of Evidence-Based Healthcare[23]; Journal of Emergency Nursing[19]; Journal of Medical Internet Research, Research Protocols[9]; Journal of Nursing Care Quality[22]; Plos One[25]; the Brazilian Nursing Review[24]; the Brazilian Journal of Geriatrics and Gerontology[20]; Sociology of Health & Illness[8]; Texto & Contexto Enfermagem[16]; The Joint Commission Journal on Quality and Patient Safety[17].

While the study methodology characteristics were assessed, 9 (64.4%) studies presented delineation that was stratified as experimental[9,20-22], randomized[8,17,18], control case[10], and intervention[19]. The other studies presented methodological[16,23-24] (3; 21.4%) and exploratory delineation[25-26] (2; 14.2%). Some digital technology development and validation studies deserve highlight, such as applications[20] and educational videos[16,24].

Chart 1↗ shows the objectives, types of technology, and evidence levels of the articles selected for this IRL. The following digital technology aspects deserve highlight: pressure sensors[8,17,19,23,25], wearable sensors[9,21], and location tracking sensors[18]. Good results were found regarding the incidence of falls in hospitals[19,21] in studies that utilized multiple digital technology resources, e. g., individually customized electronic tools to assess and guide patients with high risk of falls[26].

RESULTS DISCUSSION

The prevalence of studies directed to a public of hospitalized older persons. Even though the older people population is the most vulnerable to falls, this study found a lack in the use of digital technologies in other populations such as children, adolescents, pregnant women, and even hospital workers. Despite the lower occurrence, they also present falls during their daily practice in hospitals.

Digital technologies have been advancing rapidly and making an increasing number of devices available for use in hospitals. Recent publications on this topic reveal that there is a great international interest in developing, assessing, and validating these technologies to prevent falls(8,9,21), including investigating their impact(17,18).

Studies on the use of pressure sensor technology have been predominant in the alert technology research to prevent falls(8,17,18,21,26). Other studies used combined digital technologies(25,26), as was the case of a study that analyzed a multifactor approach with remote video monitoring (RVM), stretcher alarms, and implementation of a robust patient safety culture. The result was a 27%-decrease in falls and a 66%-decrease in falls with lesions(19).

However, a study that analyzed failures in the implementation of the pressure sensor technology questioned the subjectivity of how some digital technologies may affect hospital admission either positively or negatively in its results section(8). Adequate planning and the quality of conception, application, and use of digital technologies in hospitals must be considered in order not to become a hindrance and a waste of hospital admission time for the care and financial teams of health institutions.

The use of digital technologies has been used for assessing risks or detecting a fall event. In some cases, a wearable technology(9,21) was used; in others a mobile application(20), who was able to verify the oscillations found while maintaining the static balance of older individuals and distinguishing results in low and high risk of fall groups. To do so, a bag with an adjustable belt was utilized to connect a smartphone to the patient. However, this technology is limited to assessing fall risks. It needs more tests to implement new functionalities. The Apple Watch, another wearable technology that uses a wearable watch, may detect falls and alert caregivers, nursing teams, and doctors to the need of helping patients. Another feature of this technology is the possibility of objectively collecting data on gait, physical conditioning, and fall occurrence as part of clinical trials(9). Although these technologies have the potential to leverage studies on fall occurrence analyses, they have not been widely applied in practical terms.

In order to assess the adherence of the older population to wearable sensor technology, a study carried out in Canada in 2020 investigated factors affecting their intention to use wearable devices. This study showed that there was low adherence to this technology because it was hard for this population to read and interpreted the information displayed by the device(26). Such difficulty may be due to their low adherence to other digital technologies. For this reason, family engagement in their care is essential.

Patient and family engagement to understand the care and therapeutic plan is key to their success in preventing falls. This is stressed in some studies(22,23,27). One of them assessed a customized electronic tool to assess and guide patients with high risk of falls called Fall TIPS. This intervention utilized health information technology to provide support to clinical decision-making by linking fall risk assessment to customized interventions. Each Fall TIPS modality effectively facilitated patient engagement to prevent falls(26).

This review made possible to find that the fall prevention digital technologies are used as supplementary tools. The use of multiple tools alongside other care reduces this event in hospitals. This study aimed to promote discussions to analyze past events with more precision in order to use digital technologies. It finally highlights the importance of devising new strategies focused on patient safety.

As study limitations, one can mention the diversity and methodological fragilities of primary studies, hindering analysis. In some research and development studies, a clear description of methods was not found. Even though several databases were used, this led to a limited sample.

CONCLUSION

This global literature analysis highlighted several digital technologies that can be used to prevent falls, with predominance of pressure sensor and wearable ones. Moreover, it showed that the integration with practices based in evidence is an efficacious strategy to reduce fall rates and risks in hospitals. Thus, this integration can make a positive impact in fall rates.

This study results contributed to a critical reflection on the nursing practice and heal in hospitals. The analyzed studies suggested a future trend of digital technology implementation in the clinical practice of health institutions in order to prevent falls. This may occur via devices accessible by the patient or bedside monitorable ones alongside educational resources to aid patients, families, and health professionals. Finally, this may mitigate fall risks and promote patient safety.

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AP: Conceitualização, metodologia, gerenciamento do projeto, redação – preparação do original, revisão e edição, aquisição de financiamento, suervição, validação.
AL: Conceitualização, metodologia, redação – preparação do original revisão e edição, visualização.
JS: Conceitualização, coleta de dados, metodologia, redação – preparação do original, revisão e edição, visualização.
EM: Conceitualização, coleta de dados, metodologia, redação – preparação do original, revisão e edição, visualização.
LS: Conceitualização, coleta de dados, metodologia, redação – preparação do original, revisão e edição, visualização.
CL: Conceitualização, coleta de dados, metodologia, redação – preparação do original, revisão e edição, visualização.
Todos os autores leram e concordaram com a versão publicada do manuscrito.

Ethical Disclosures
Conflicts of Interest: The authors have no conflicts of interest to declare.
Financial Support: This work has not received any contribution, grant or scholarship.
Provenance and Peer Review: Not commissioned; externally peer reviewed.

Responsabilidades Éticas
Conflitos de Interesse: Os autores declararam não possuir conflitos de interesse.
Suporte Financeiro: O presente trabalho não foi suportado por nenhum subsídio ou bolsa.
Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

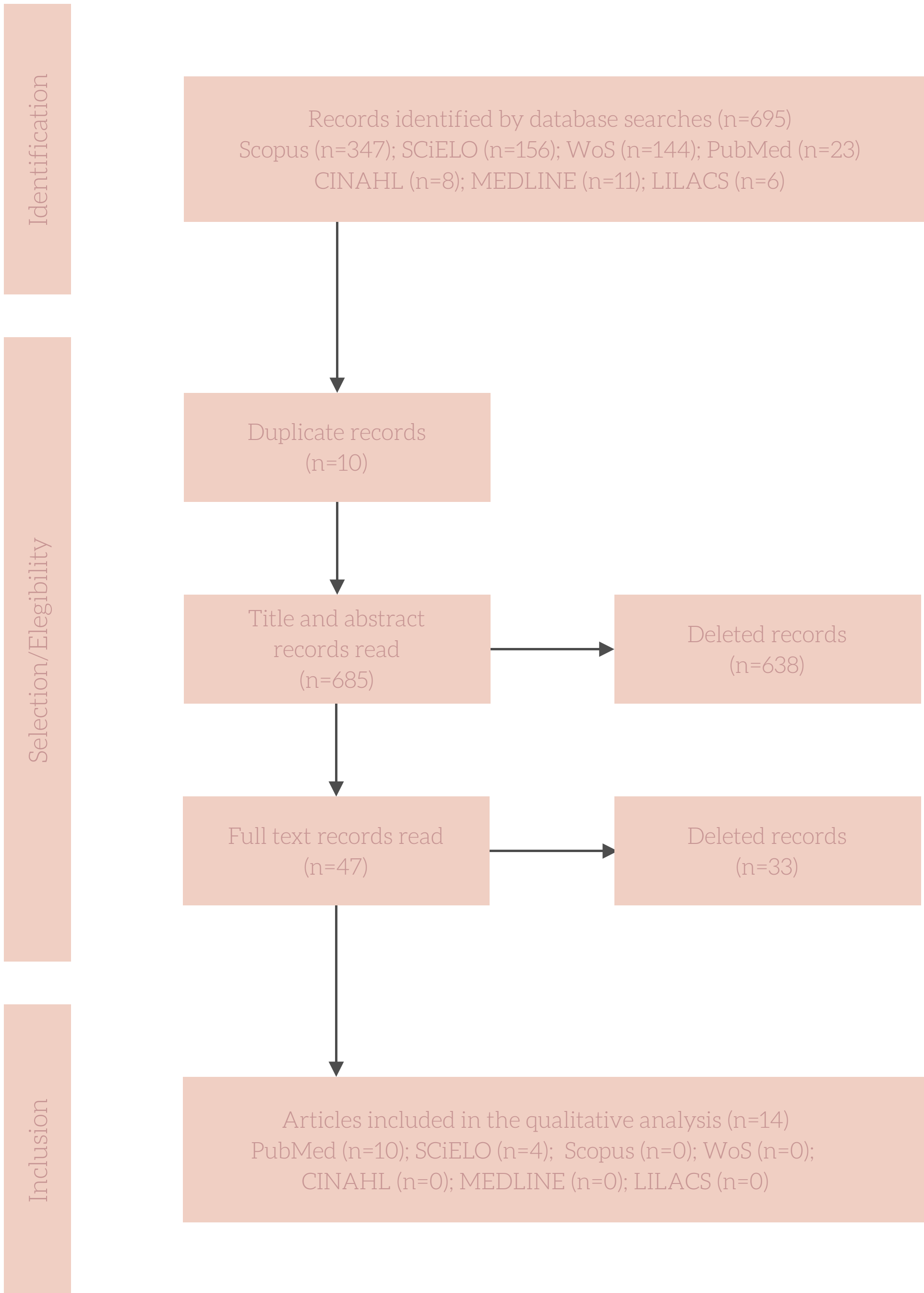

Figure 1 – Study selection process flowchart, adapted from PRISMA, Porto Alegre, Rio Grande do Sul, Brazil, 2022.↖

Chart 1 – Summary of articles and main outcomes – Porto Alegre, Rio Grande do Sul, Brazil, 2022.→↖

Authors (year)	Objective	Type of technology	EL
Bott; Wexler; Drury; Pollak; Wang; Scher; Narducci (2019)[10]	To examine the effect of digital technology interacting with people through conversation (guided by protocol and person) regarding loneliness, depression, delirium, and falls among hospitalized older patients.	Care Coach Platform, digital conversation agent by the bedside, represented by an animated animal avatar in a monitored and controlled tablet, which may help reduce delirium and consequently, fall events.	1B
Potter; Allen; Costantinou; Klinkenberg; Malen; Norris; O'Connor; Roney; Tymkew; Wolf (2017)[17]	To assess a combined system of hospitalized patient bed depth, designed to attributed fall probability and detect patient leaves from bed to prevent falls.	Sensor technology that dynamically identified hospitalized patient falls, detects early leave from bed of high-risk patients and alerts nurses.	1B
Visvanathan; Ranasinghe; Wilson; Lange; Dollard; Boyle; Karnon; Raygan; Maher; Ingram; Pazhvoor; Hoskins; Hill (2019)[18]	To assess the efficacy of the smart geriatric ambient management, based on a wearable sensor (AmbIGeM), to prevent falls in older people in hospitals.	The Ambient Intelligent Geriatric Management (AmbIGeM) system features movement recognition sensors and location tracking in order to activate team alert messages when there are movements with risk of falls.	1B
Timmons; Vezyridis; Sahota (2019)[8]	To analyzed the failure of an intervention utilizing sensors of bed pressure and hospital bedside chair connected to radio pagers in order to prevent falls at the bedside in older hospitalized patients.	Sensors of bed pressure and hospital bedside chair connected to radio pagers in order to prevent falls at the bedside.	2B
Cook; Komansky; Urton (2020)[19]	To report the case of a comprehensive fall prevention initiative, including the following components: fall risk assessments based on screening, applying new monitoring technologies, better post-event analysis, and awareness and acknowledging activities.	Implementation of a multifactor approach utilizing remote video monitoring (RVM), stretcher alarm, and a robust patient safety culture. RVM were no-recording, moving video cameras that were monitored by the hospital team remotely, and they enabled direct communication with the patient or the team through a loudspeaker, as well as sounding a local alarm if needed.	2C
Sampaio; Castilho; Carvalho (2017)[20]	To devise an mobile device application focused balance and fall risk assessment in older individuals.	Mobile devices that use wearable sensors to assess balance and fall risk in older individuals.	2C

* EL – Evidence Level.

Chart 1 – Summary of articles and main outcomes – Porto Alegre, Rio Grande do Sul, Brazil, 2022.

Authors (year)	Objective	Type of technology	EL
Lin; Chen; Lee (2021)[21]	To devise and implement wearable sensors to detect movement in bed and alert when patients incline themselves to leave their beds and prevent patient falls classified as being at a high risk of falling.	Wearable sensors to detect movement in bed and alert when patients incline themselves to leave their beds. They are adequate to prevent falls.	2C
Ayton; Barker; Morello; Brand; Talevski; Landgren; Melhem; Bian; Brauer; Hill; Livingston; Botti (2017)[25]	To identify perceived barriers and facilitators to implement the 6-PACK fall prevention program.	Multifaceted intervention in five stages: supervision to go to the bathroom, helping in walks, hygiene, low bed, and bed/chair alarm.	3B
Strauss; Davoodi; Healy; Metts; Merchant; Banskota; Goldberg (2021)[9]	To examine the viability, acceptability, and usability of Apple Watch Series 4 paired with an iPhone and the search app Rhode Island FitTest (RIFitTest) among older persons who seek attention for falls.	The Apple Watch is a wearable device with sensors integrated with the iPhone that can detect falls and alerts caregivers and doctors that help is needed. It can be used to objectively collect data on gait, physical conditioning, and falls as part of clinical trials.	4
Opsahl; Ebright; Cangany; Lowder; Scott; Shaner (2017)[22]	To analyze the effects of video on "patient engagement and fall rates" in acute hospital care in orthopedics and medical/surgical units.	Educational video for patients on fall prevention.	4
Duckworth; Adelman; Belategui; Feliciano; Jackson; Khasnabish; Lehman; Lindros; Mortimer; Ryan; Scanlan; Spivack; Yu; Bates; Dykes (2019)[26]	To investigate whether the Fall TIPS modality affects patient engagement in the 3-stage fall prevention process, and whether this affects tool efficacy.	A customized electronic tool to assess and guide patients at high risk of falling called Fall TIPS (Tailoring Interventions for Patient Safety). This intervention utilized health information technology to provide support to clinical decision-making by linking fall risk assessment to customized interventions. The three bedside modalities are as follows: (1) Fall TIPS laminated poster; Fall TIPS electronic poster; paperless patient safety headboard display.	4
Campos; Silva; Reis; Góes; Moraes; Aguiar (2021)[16]	To devise and validate educational technology (educational video) for health professionals on fall prevention in hospitalized child.	Educational technology (educational video) for health professionals on fall prevention in hospitalized child.	5

* EL – Evidence Level.

Chart 1 – Summary of articles and main outcomes – Porto Alegre, Rio Grande do Sul, Brazil, 2022.↩

Authors (year)	Objective	Type of technology	EL
Melin (2018)[23]	To assess a process change in order to potentially reduce fall rated at a medical/surgical inpatient unit.	Training on alarm use at the bedside/chair to prevent falls.	5
Sá; Santos; Galindo Neto; Carvalho; Feitosa; Mendes (2020)[24]	To make and validate an educational video for the older people population on fall risks.	Educational video for the older people population on fall risks.	5

* EL – Evidence Level.