

## APPLICABILITY OF ASSISTIVE INNOVATIONS AND TECHNOLOGIES FOR PATIENT SAFETY: INTEGRATIVE REVIEW

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**ABSTRACT:** The present study aimed to identify the technologies used by nurses to promote patient safety in hospital settings. Integrative review, with search of articles in databases in the health area, from January to February, 2016. Twenty articles were selected and sorted according to the assistive technologies used. In the promotion of patient safety, nurses use hard technologies – implementation of electronic records, automated drug infusion pumps, sensors and computer-based monitoring systems. They also incorporate good practices in health - construction of instruments targeted to patient safety and identification of risks, and promote/ participate in professional training courses – calculation and administration of medications and intravenous infusions and hand hygiene. It is concluded that nursing professionals are concerned with patient safety, which reinforces the need to conduct further studies on the use of relevant strategies.

**DESCRIPTORS:** Patient safety; Nursing; Biomedical technology; Health care; In-service training.

### APLICABILIDADE DE INOVAÇÕES E TECNOLOGIAS ASSISTENCIAIS PARA A SEGURANÇA DO PACIENTE: REVISÃO INTEGRATIVA

**RESUMO:** Objetivou-se identificar as tecnologias utilizadas pelo enfermeiro para promoção da segurança do paciente no contexto hospitalar. Revisão integrativa, com busca de artigos em bases de dados na área da saúde, no período de janeiro a fevereiro de 2016. Foram selecionados 20 artigos, divididos segundo as tecnologias assistenciais utilizadas. No intuito de promover a segurança do paciente, os enfermeiros utilizam tecnologias duras – implantação de registros eletrônicos, bombas de infusão, sensores e sistemas computadorizados e de alerta; incorporam as boas práticas em saúde – construção de instrumentos voltados para segurança do paciente e identificação de riscos; e realizam/participam de cursos de capacitação profissional – cálculo e administração de medicamentos e infusões intravenosas e higienização das mãos. Conclui-se que o enfermeiro é um profissional que tem se preocupado com a segurança do paciente, o que reforça a necessidade da realização de mais estudos que tenham como foco a utilização de estratégias que promovam tal prática.

**DESCRIPTORIOS:** Segurança do paciente; Enfermagem; Tecnologia biomédica; Assistência à saúde; Capacitação em serviço.

### APLICABILIDAD DE INOVACIONES Y TECNOLOGÍAS DE ASSTENCIA PARA SEGURIDAD DEL PACIENTE: REVISIÓN INTEGRATIVA

**RESUMEN:** Estudio cuyo propósito fue identificar las tecnologías utilizadas por el enfermero para promover la seguridad del paciente en el contexto hospitalar. Revisión integrativa, con búsqueda de artículos en bases de datos en el área de la salud, en periodo de enero a febrero de 2016. Se seleccionaron 20 artículos, organizados de acuerdo a las tecnologías asistenciales utilizadas. Para promover la seguridad del paciente, los enfermeros utilizan tecnologías duras – implantación de registros electrónicos, bombas de infusión, sensores y sistemas computadorizados y de alerta; añaden las buenas prácticas en salud – construcción de instrumentos para dar seguridad al paciente, así como para identificación de riesgos; y realizan/participan de cursos de capacitación profesional – cálculo y administración de medicamentos e infusiones intravenosas, además de higienización de las manos. Se concluye que el enfermero es un profesional que se preocupa con la seguridad del paciente, lo que resalta la necesidad de realización de más estudios cuya énfasis sea el uso de estrategias que promovan esa práctica.

**DESCRIPTORIOS:** Seguridad del paciente; Enfermería; Tecnología biomédica; Asistencia a la salud; Capacitación en servicio.

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## ● INTRODUCTION

Patient safety can be defined as the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the processes of health care. It is a serious global public health issue whose importance has been increasingly recognized worldwide in recent years, because since health care has become more complex, with greater use of technologies, there is a greater probability of occurrence of accidents, errors and/or adverse events (AE) <sup>(1)</sup>.

Literature data reveal that millions of people worldwide suffer disabling injuries and deaths caused by unsafe health practices. This estimate is based on studies conducted in developed countries that count on more efficient health systems than those in developing countries where epidemiological data is still scarce. In 1999 the theme gained prominence after a publication by the United States Research Institute, which revealed that health care errors caused 44 to 98,000 adverse events annually in hospitals in that country. In Europe, 10.8% of hospitalized patients were affected by adverse events, and 46% of these events could have been prevented <sup>(2)</sup>.

Inadequate patient safety measures result in increased health care costs and length of hospital stay, and may lead to complications and deaths, which reduces user confidence in the health system, causes psychological damage and substantial legal liability <sup>(3)</sup>.

Nurses play a key role in the promotion of patient safety during the care process, since they are responsible for coordinating nursing care. Moreover, they are required to provide 24-hour patient care <sup>(4)</sup>. Therefore, they are expected to perform very complex tasks, which require training in the use of new technologies and ethical commitment, through the implementation of actions aimed to prevent and reduce errors and adverse effects, to ensure high quality care <sup>(5)</sup>.

Given the magnitude of the issue, it is necessary to emphasize the technological production of innovations in the health and nursing fields. Technological innovation in health contributes directly to the quality, efficacy and safety of care to patients, and hence to health living <sup>(4)</sup>. Therefore, it is necessary to investigate which technological innovations are used by nurses to ensure patient safety.

In order to contribute to research that gives visibility to the issue, the present study aimed to identify the technologies used by nurses to promote patient safety in the hospital setting.

## ● METHOD

Integrative literature review for selection of studies based on the following research question: which technologies are used by nurses to promote patient safety?

The following databases were selected: Latin American and Caribbean Health Sciences Literature database (LILACS), Nursing Database (BDENF), Spanish Bibliographic Index of the Health Sciences (IBECS), Scientific Electronic Library Online (SciELO), Medical Literature Analysis and Retrieval System online (MEDLINE) and National Library of Medicine (PubMed), using descriptors patient safety, technology and nursing, according to MeSH terminology. The search equation was "patient safety" AND "nursing" OR "patient safety" AND "technology" AND "nursing".

The inclusion criteria for pre-selection of the studies were: articles on patient safety produced by nurses, published in national and international journals over the past six years (2011-2016) that contemplated the proposed objectives, available in full-length in English, Portuguese, Spanish and French, in electronic format. Book chapters, doctoral theses, masters' dissertations, editorials, letters to the editor and reflection, revision and updating articles were excluded.

Twenty (20) studies fulfilled the eligibility criteria and were included in this review. Figure 1 shows the flowchart of the selection of these studies.

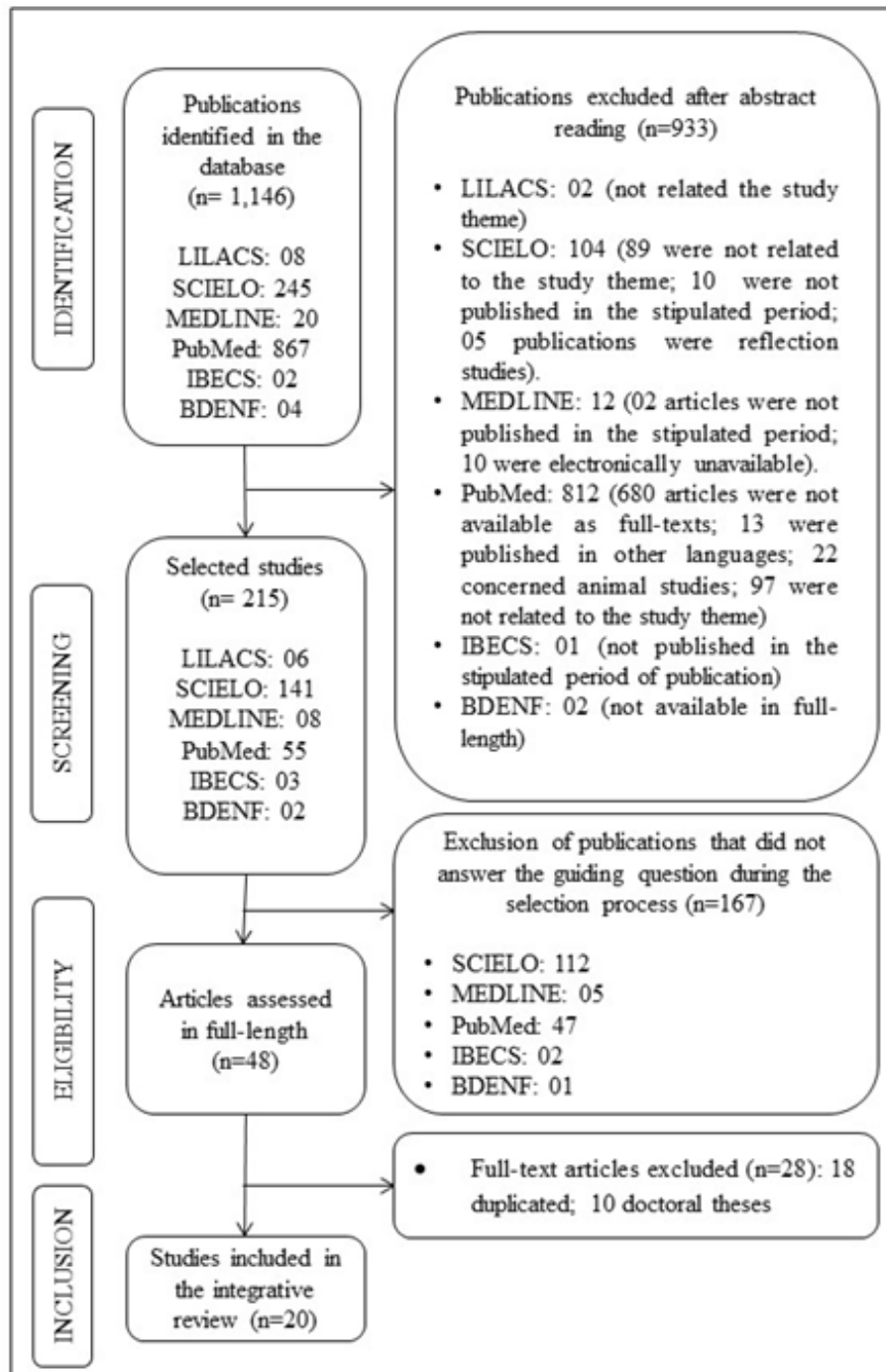


Figure 1 - Flowchart of the selection of studies according to PRISMA. Fortaleza, CE, Brazil, 2016

The studies were pre-selected through careful title and abstract reading. The final sample composed of the studies that met the abovementioned inclusion criteria was obtained through critical and detailed analysis by two independent reviewers. Disagreements were resolved by consultation with a third reviewer.

The following data was collected from the selected studies: country, journal and year of publication, methodological design, level of evidence (LE), target population (adult, pediatric or nursing professionals), study scale (unicenter or multicenter trial) and study theme. Data was entered into Microsoft Excel<sup>®</sup> 2010, submitted to descriptive analysis, and a synthesis of the results was presented in tables.

## ● RESULTS

Most studies were published in 2014: ten articles (50%). Twelve (12) studies were conducted and published in Brazil. Therefore, Portuguese was the most frequent language of the publications (Table 1). Most studies on the theme were conducted in the Southeastern region (five, 25%), followed by the Southern (four; 20%), the Northeastern (two, 10%) and the Central-Western (one, 5%) regions.

Table 1 – Characterization of the selected studies. Fortaleza, CE, Brazil, 2016

Study	Country	Journal/year of publication	Methodological design	LE	Study scale
A1 <sup>(6)</sup>	United States	Journal of Nurse Administration/2011	Cross-sectional	III	Multicenter
A2 <sup>(7)</sup>	Brazil	Revista Latino-Americana de Enfermagem/2012	Descriptive	V	Unicenter
A3 <sup>(8)</sup>	Canada	Ontario Health Technology Assessment Series/2012	Cross-sectional	III	Multicenter
A4 <sup>(9)</sup>	United States	Nursing for Women's Health/2012	Cross-sectional	III	Multicenter
A5 <sup>(10)</sup>	Brazil	Cadernos de Saúde Pública/2012	Methodological	V	Unicenter
A6 <sup>(11)</sup>	Japan	Methods of Information in Medicine/2013	Cross-sectional	V	Unicenter
A7 <sup>(12)</sup>	Brazil	Revista Latino-Americana de Enfermagem/2013	Methodological	V	Unicenter
A8 <sup>(13)</sup>	Brazil	Revista Gaúcha de Enfermagem/2013	Analytical study	III	Unicenter
A9 <sup>(14)</sup>	Brazil	Revista Latino-Americana de Enfermagem/2013	Methodological	V	Unicenter
A10 <sup>(15)</sup>	Brazil	Escola Anna Nery/2014	Descriptive	V	Unicenter
A11 <sup>(16)</sup>	Nigeria	The Brazilian Journal of Infectious Diseases/2014	Cross-sectional	III	Unicenter
A12 <sup>(17)</sup>	Norway	BMJ Open/2014	Randomized clinical trial	I	Unicenter
A13 <sup>(18)</sup>	Brazil	Revista Escola de Enfermagem da USP/2014	Cross-sectional	III	Unicenter
A14 <sup>(19)</sup>	Brazil	Acta Paulista de Enfermagem/2014	Cross-sectional	III	Unicenter
A15 <sup>(20)</sup>	Brazil	Revista Escola de Enfermagem da USP/2014	Mixed: technological production and methodological research	V	Unicenter
A16 <sup>(21)</sup>	Brazil	Acta Paulista de Enfermagem/2014	Longitudinal	IV	Multicenter
A17 <sup>(22)</sup>	United States	Journal for Healthcare Quality/2014	Cross-sectional	III	Unicenter
A18 <sup>(23)</sup>	Saudi Arabia	International Journal of Electronic Healthcare/2014	Cross-sectional	III	Unicenter
A19 <sup>(24)</sup>	Minas Gerais	Texto e Contexto Enfermagem/2015	Descriptive	V	Unicenter
A20 <sup>(25)</sup>	Brazil	Revista Escola de Enfermagem da USP/2015	Descriptive	V	Unicenter

There was a prevalence of cross-sectional studies, nine (45%); of quantitative approach, 17 (85%); unicenter, 16 (80%); and in 13 (65%) studies the target population was mostly composed of adults. Classification based on experimental design was used for level of evidence<sup>(26)</sup> with equivalence between the number of published studies with LE III (evidence obtained from non-randomized controlled, cohort or follow-up studies) and V (evidence originating from descriptive studies), with nine (45%) each.

Regarding the themes, 12 (60%) addressed the incorporation of good practices in health to promote patient safety; five (20%) addressed the use of hard technologies, and three (15%) addressed nurse training (Table 2).

Table 2 – Distribution of studies according to the themes addressed. Fortaleza, CE, Brasil, 2016

Study theme	Strategies used by nurses
Use of hard technologies	Implementation of electronic health records (A1);
	Intelligent infusion pumps (A4);
	Vital Signal Collection Sensor Systems (A7);
	Alert systems (A15);
	Computer-based systems for monitoring patient entry (A18).
Incorporation of good health practices to promote patient safety	Construction/validation/adaptation of instruments aimed at patient safety (A2, A5, A7, A8, A9, A16, A19);
	Identification of safety hazards (A10);
	Identification of drugs (A14, A17, A20).
Nursing training	Administration of intravenous infusions (A3);
	Promotion of hand hygiene (A11);
	Calculation of medications (A12).

## ● DISCUSSION

### Use of hard technologies

Regarding care technologies, hard technologies (opposed to soft technologies that involve the human factor, relations) are all the tools and devices used in treatments, tests equipment and in information organization<sup>(11,23)</sup>.

The implementation of electronic health records is a tool aimed to improve the quality of care and ensure patient safety. It details transfer reports, evaluations by managers, allows costs saving as a result of less medication errors, reduces the amount of time spent on documentation, improves nursing records and communicating with the team<sup>(6)</sup>. One study<sup>(6)</sup> conducted in 316 hospitals of the United States revealed that only 21 (7%) had implemented a system of electronic records in all patient care units, and the nursing staff of these hospitals were less likely to report unfavorable outcomes compared to nurses in hospitals that did not use this technology.

Hard technologies have also been widely used in the medication process. Errors in drug administration are very frequent in health facilities, especially those associated with drug dosing and the administration of substances that are harmful to the human body. Smart infusion pumps were designed to promote patient safety and simplify medication administration, preventing wrong doses, wrong rates and wrong times, and ensure that drug doses are fixed depending on patients' weight. The new technology reduced medication errors from 3.1 to 0.8 errors per 1000 doses<sup>(9)</sup>.

Another technology aimed to promote patient safety is the Computerized Nursing Process (CNP), based on the International Classification of Nursing Practices (ICNP) for ICUs. The proposal was based on the recommendation of Nursing Diagnoses (ND), identification of possible clinical and appropriate interventions for each case, through safety alerts<sup>(20)</sup>. The authors confirmed the efficacy of this program and suggested the inclusion of other potential warnings for hospital-acquired pneumonia, secondary infections in intensive care, postoperative wound dehiscence of patients who underwent abdominal or pelvic surgery, loss of vascular access and endotracheal extubation.

Therefore, with the formulation of warning signs and guidelines, health professionals are prepared to handle challenging situations associated to patient safety, adhering to processes based on scientific evidence, minimizing and preventing AEs.

### Incorporation of good health practices

Good health practices involve actions adopted by health institutions and their employees aimed to facilitate the identification and resolution of problems, safely and fast, in order to provide better care<sup>(21)</sup>.

Adverse events (AEs) are the result of several unfavorable factors, such as the physical structure of the workplace; unavailability of material resources; excess working hours; very high nurse-to-patient ratio; lack of permanent education; lack of stimuli to adverse event reporting, among others<sup>(14,25)</sup>. Therefore, the construction and validation of scales of predisposition to the occurrence of AE is justified by the need to improve care<sup>(7)</sup>.

Involving patient and family in their own safety is one strategy of prevention of AE, particularly when children are involved. In this regard, a methodological study<sup>(12)</sup> aimed to develop and validate a checklist with preoperative interventions related to patient safety, to be completed by children and their families. The use of the tool resulted in some gaps of communication between health professionals, patients and families, such as difficulties created by the use of technical terminologies, lack of data in medical records, problems faced by health professionals in their interaction with children or their families, and lack of information. Therefore, improvements in the preoperative guidelines and adaptations of the language used are necessary.

The implementation of the checklist is a low-cost endeavor that takes between two to three minutes to complete. The difficulty lies in the surgical team<sup>(10)</sup>. One individual is responsible for implementing the checklist, and a nurse is supposed to guide this process; the nursing professional must have full control over the surgical process and be prepared to stop the procedure if any of the steps is unsatisfactory<sup>(13)</sup>.

The construction and implementation of guidelines have also proven to be effective in ensuring patient safety. A study<sup>(24)</sup> conducted in Minas Gerais aimed to develop guidelines to identify the main incidents in intra-hospital transport of ICU patients. The authors found that the incidents were related to breakdowns and malfunction in equipment and devices that posed frequent risks, such as blood pressure changes, agitation, peripheral arterial saturation decrease and tachycardia.

Another study<sup>(21)</sup> conducted in three intensive care units (ICUs) in São Paulo aimed to assess the best practices in health. Comparison of the ICUs revealed significant differences related to change of decubitus position; prevention of falls; prevention of hospital infection, among others. The items with more than 90% use of effective measures in the three health institutions were: egg crater mattress; sitting patient and high side bedrails to prevent falls; bed identification; head of bed at or above 30 degrees; three-way taps protected with "luer-cone" and drainage bag below the level of the bladder. Therefore, health institutions should maintain and improve a risk management policy to prevent errors and improve care.

A study<sup>(15)</sup> conducted in Ceará found that the biggest concern of the nursing staff was related to the risk of falls, of transmission of infections and adverse events related to the surgical procedure. Nurses are primarily responsible for implementing safe practices in health services, and the quality of care provided. The professionals in the referred study met international standards, as well as safe surgery protocols, performing checklists and incorporating scientific evidence.

In addition to safety strategies, nurses may implement safety in the Nursing Process (NP), a systematic and scientific method of planning and providing individualized nursing care. Tools like NANDA International Nursing Diagnoses (ND), for identification of a given problem, and the Nursing Interventions Classification (NIC), that lists the priority interventions for a given ND are used to standardize the nursing process<sup>(18)</sup>.

Regarding medication administration, health professionals responsible for medication prescription must ensure legibility of prescription, as well as of all pertinent information, signature, etc. In addition, the professional must communicate any changes in medication prescription to the other health staff members to minimize communication gaps<sup>(19,25)</sup>.

## Nurse training

Hand washing (HW) is a simple patient safety strategy for preventing transmission of infections among hospital patients and health care personnel. One study<sup>(16)</sup> carried out in Nigeria was aimed to train 202 health workers on proper hand hygiene. After the training, the authors reported 75.3% adherence to HW, mainly after contact with body fluids (75.3%) and after physical contact with patients (73.6%). The rate of adherence was higher in nurses (72.9%) than in physicians (59.7%) and midwives (65%).

Another concern perceived in the selected studies was the occurrence of errors in the calculation of drug doses. One randomized study<sup>(17)</sup> conducted in Norway with 183 participants found that half of doctors surveyed were unable to calculate drug doses. The referred study also revealed that the ability to calculate drug doses correctly is a requirement of the nursing profession. The implementation of a course on drug dosage calculation improved the nursing practice, and 37 (20.2%) of those who participated in the course obtained an excellent grade.

The training also proved effective in a study<sup>(8)</sup> developed in Ontario aimed to identify the difficulties faced by nurses in the management of patients with intravenous access. Following the identification of the difficulties, educational interventions were made through telephone calls.

Health professionals need continuing educational support, which includes the new guidelines on the handling of modern equipment, on ways to administer new drugs, and strategies for improving care, and working as a team.

## ● FINAL CONSIDERATIONS

Patient safety is a key concern for nursing. It represents a major challenge as it requires work in multidisciplinary teams. It is expected that nurses' decision-making will always aim at patient safety and that their professional practice will be based on research and evidence.

Among the nurses' contributions to patient safety, it is worth mentioning hand hygiene, care in medication management and administration, identification of risks to patient safety, use of information systems and applicability of instruments and scales to assess patient safety.

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