SYSTEMATIC REVIEW

Nursing students' experience of risk assessment, prevention and management: a systematic review

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Keywords

Clinical risk • Patient safety • Nursing students • Nursing curriculum

Summary

Introduction. *As a fundamental dimension of quality, the patient safety and healthcare workers safety in the healthcare environment depend on the ability of each healthcare workers (whether administrators or technicians) to reduce the probability of error. This review focused on nursing students. The aim was to assess level and determinants of knowledge about risk assessment, risk prevention and risk management of nursing students.*

Methods. *A systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Two reviewers searched the bibliographic databases Pubmed, Scopus and Cinahl to collect all the available articles in English and Italian issued between 2015 and August 2019. To obtain an exhaustive query of search, the following keywords were combined through Boolean operators AND and OR: Clinical Risk Assessment, Nursing Education, Nursing Student*, Patient Safety. The authors assessed the quality of the evidence by using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) method.*

Results. *Twelve papers are included. Although the literature on the nursing student's error is limited, their frequencies are worrying. Some authors have created a model of prevention of clinical error based on three level. However, the majority of nursing students don't feel confident with a patient safety. Many authors shown that patient safety education was delivery by lecture, laboratory or simulation sessions.*

Conclusions. *This review underlines the need to revise the nursing curriculum on patient safety and the need to think what educational methodology is the better for the student to create a safe care.*

Introduction

The continuous search of *the best* for the healthcare workers, associated with the best for the citizens, has determined a strong acceleration towards the continuous improvement of the quality of care. Based on the first definition of quality in health care (by Avedis Donabedian), the U.S. Institute of Medicine identifies a quality service with the one that can increase the probability of the expected health outcome, in accordance with the best medical knowledge available.

As a fundamental dimension of quality, the patient safety and healthcare workers safety in the healthcare environment depend on the ability of professionals (whether administrators or technicians) to reduce the probability of error. If in practice the focus has long been on preventing or containing active errors, today we tend to emphasize the need to control risk factors.

Risk is a mathematical concept related to the possibility of suffering a harm in relation to more or less predictable circumstances. This concept, inherent in every human activity, can be translated into the health sector in terms of clinical, occupational, environmental and insurance risk [1, 2].

Clinical risk is closely linked to the healthcare facilities and the "care" provided by healthcare workers. Based on the general definition of risk, the Institute of Medicine (US) Committee on Quality of Health Care defines *clinical risk* as the probability that a patient is a victim of an adverse event, or suffers "any damage or discomfort attributable, even if involuntarily, to medical care provided during the period of hospitalization, which causes an extension of the period of hospitalization, a worsening of health conditions or death" [3].

All the regional, national and international organizations have as their priority objective the risk prevention in the healthcare settings through risk management programs [4], implementing a security model, capable of increasing the levels of control in the face of the impossibility of *zero risk*. In other words, it is legitimate to speak of a risk management system when strengthening analysis systems inspired by these principles [5]. The risk management process can be divided into four phases:
- risk identification, in which the most frequent risks and their specific components are identified;
- risk analysis, with reactive or proactive approach;

- risk treatment. in this phase, specific preventive measures are identified and applied in order to avoid a repetition of the event;
- monitoring.

In order to prevent and promote quality and safe care, local, regional, national and international health care organizations must identify and analyze all system failures. This literature review aims to examine the knowledge and behavior of the nursing student regarding risk identification, risk prevention and risk management.

Methods

STUDY DESIGN

This systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [6] (Supplementary file). The protocol for this systematic review has not been registered or published.

SEARCH STRATEGY

According to the purpose of this review, the authors drafted a protocol based on the Population, Intervention, Outcome and Setting (PIOS) approach:
- P: nursing students;
- I: nursing knowledge or nursing behaviour;
- O: preventing medical error, preventing adverse drug error, patient safety, quality of care;
- S: hospital setting.

This research aims at answering the following questions:
- what behaviours are implemented by nursing students in order to reduce the risk of error?
- are students sensitized to the issue of clinical risk during their education?
- can lack of knowledge or poor knowledge induce to error?
- do a third-year student of a nursing school show more knowledge and appropriate behaviour of clinical risk prevention versus a first-year student?

Two reviewers searched the bibliographic databases Pubmed, Scopus and Cinahl to collect all the available articles in English and Italian issued between 2015 and August 2019. To obtain an exhaustive string search, the following keywords were combined through Boolean operators AND and OR: *Clinical Risk Assessment, Nursing Education, Nursing Student*, Patient Safety.*

INCLUSION AND EXCLUSION CRITERIA OF THE STUDY

The reviewers defined the characteristics that made up the eligibility criteria used to rule in or out the collected studies for this research study.

Inclusion criteria
- Studies focusing on nursing students and clinical risk: their knowledge and behaviour.
- Studies focusing on undergraduate program of clinical risk.

- Papers reporting the adverse drug event or medication error by nursing students.
- Intervention studies, including RCTs, Controlled Clinical Trials (CCTs) and all observational studies (e.g. cohort analytic studies, cross-sectional studies, case-control studies…), reviews.
- Peer-reviewed research articles published in English and Italian.

Exclusion criteria
- Studies focusing on nursing staff.
- Studies reporting the knowledge of nursing student on a specific pathology.
- Grey literature, such as dissertations, conference papers, proceedings etc.

STUDY SELECTION

In the very first phase, the results obtained from the research were imported into Endnote® database, then, duplicates were eliminated and only results in English and Italian were considered.

In the second phase, two authors independently reviewed each article loaded in the database. They first screened the records by reading their titles and abstracts, then, according to the eligibility criteria previously set, they excluded the irrelevant articles, while read the full text of the pertinent papers.

Thanks to this in-depth reading, they were able to exclude those studies that did not focus on clinical risk manager and nursing students.

QUALITY ASSESSMENT

The authors assessed the quality of the evidence by using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) method [7].

Table I shows the quality assessment of each study included in the systematic literature review. For each study was reported: title of the article, objective of the study, design of the study, risk of bias, possible lack of reproducibility of the results (inconsistency), possible lack of generalizability (indirectness), imprecision (imprecision), further considerations.

Results

Initially, 336 references were identified, then, after the elimination duplicates, authors selected 12 relevant studies (Fig. 1). The main information concerning the relevant studies has been reported in a data extraction table (Tab. II).

The results obtained from the research of the scientific literature have been organized into three main interest categories, as explained below.

NURSING STUDENT AND CLINICAL ERROR

Although the literature on the nursing student's error is limited, their frequencies are worrying.

Tab. I. Qualitive assessment, grade.

Title of study	Outcome	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Quality
A multi-university assessment of patient safety competence during clinical training among baccalaureate nursing students: a cross-sectional study	Assessing nursing students' perceived competencies during clinical education related to patient safety	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Are clinical instructors preventing or provoking adverse events involving students: a contemporary issue	Understand the adverse event prevention techniques implemented by nursing students in order to assist clinical instructors and graduate programs in addressing this little-known issue	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Self-reported confidence in patient safety knoeledge among Australian undergraduate nursing students: a multi-site cross-sectional survey study	Describe the confidence of Australian first-, second-, and third-year nursing students with respect to patient safety knowledge gained in the classroom and clinical setting during the three academic years	Observational studies	Serious	Not serious	Not serious	Not serious	None	⊕◯◯◯ VERY LOW
Knowledge and competence with patient safety as perceived by nursing students: the findings of a cross-sectional study	Describe nursing students' perceptions of their own knowledge and skills in patient safety and describe any differences between first, second, and third year students	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Preregistration nursing students'perceived confidence in learning about patient safety in selected Kenyan universities	Assess theoretical and practical learning of skills related to patient safety as perceived by nursing students	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Effects of a patient safety course using a flipped classroom approach among undergraduate nursing students: a quasi-experimental study	Examining the effects of a course on patient safety among nursing students in South Korea	Quasi-experimental study	Not serious	Not serious	Not serious	Not serious	None	⊕⊕⊕⊕ HIGH
Patient safety education and baccalaureate Nursing students'patient safety competency: a cross-sectional study	Determine how and the extent to which patient safety education was provided and evaluate the competency of nursing students	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Regulation and current status of patient safety content in preregistration nurse education in 27 countries: findings from the Rationing-Missed nursing care (RANCARE) cost ACTION Project	Establish how patient safety-related teaching is incorporated into undergraduate courses in 27 countries	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Nursing students'interprofessional educational experiences in the clinical context: findings from an Italian cross-sectional study	Explore nursing students' interprofessional educational experiences and explore the factors supporting them	Observational studies	Serious	Not serious	Not serious	Not serious	None	⊕◯◯◯ VERY LOW
The influence of situation awareness training on nurses' confidence about patient safety skills: a prospective cohort study	Understand senior nursing students' confidence in their patient safety skills; examine the impact of training on students' situational awareness	Observational studies	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
Nontechnical skills training and patient safety in undergraduate nursing education: a systematic review	Synthesize available evidence regarding nontechnical skills training to improve patient safety in undergraduate nursing education	Systematic review	Not serious	Not serious	Not serious	Not serious	None	⊕⊕◯◯ LOW
The attitudes of nursing students and clinical instructors towards reporting irregular incidents in the medical clinic	Examine why students and nurses do not report errors and whether they believe internal changes may increase reporting	Observational studies	Serious	Not serious	Not serious	Not serious	None	⊕◯◯◯ VERY LOW

Fig. 1. PRISMA 2009 flow diagram (from: Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement. PLoS Med 2009;6:e1000097, mod. For more information: www.prisma-statement. org).
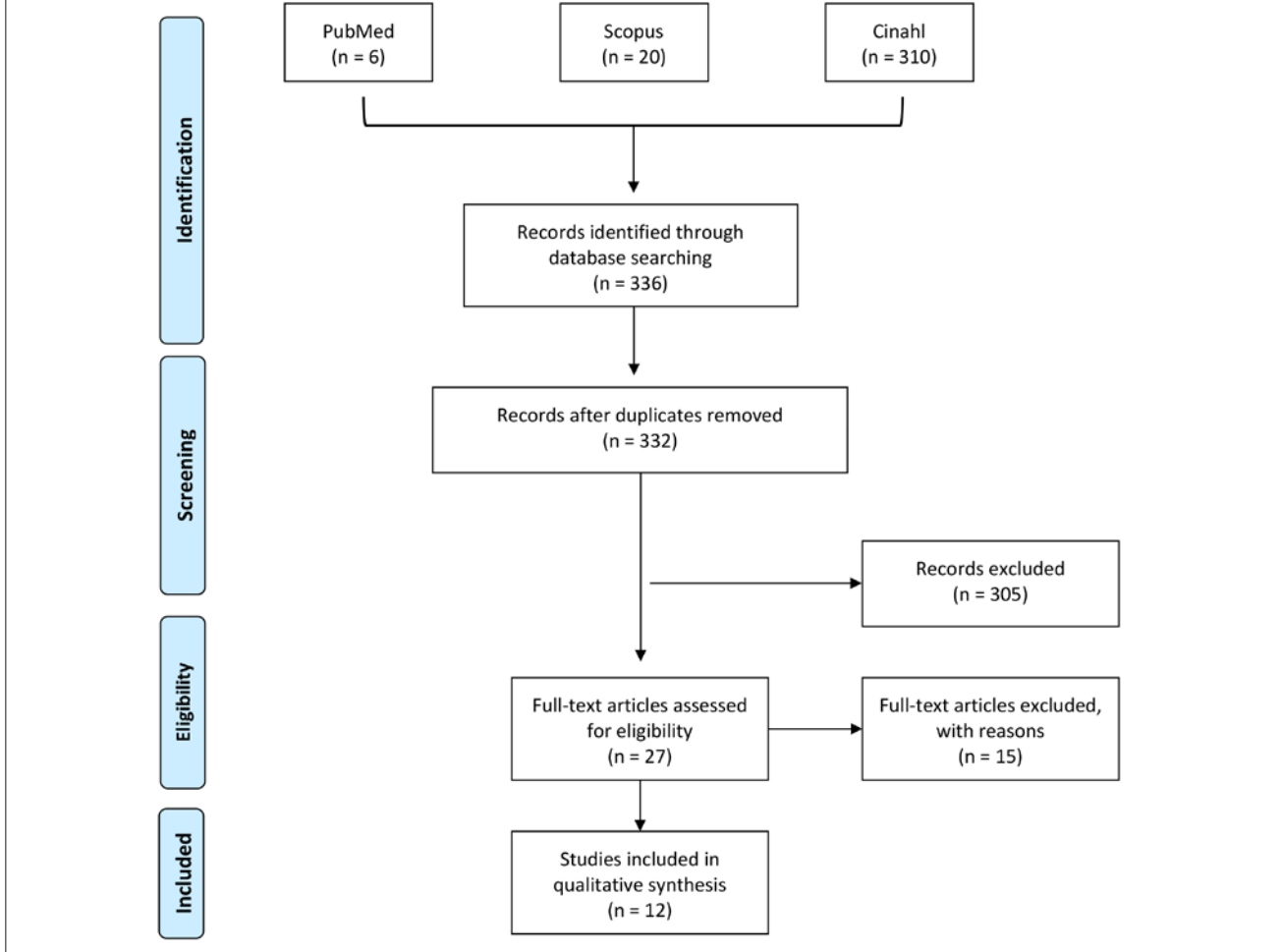
In Turkey, about 39% of the students surveyed reported that they made an error during their nursing student internship, without harming the patient. In Italy, 29% of the students interviewed participated in or witnessed an adverse event, with a risk of harm to the patient in 85% of cases [8, 9].

Only a percentage between 25 and 40% of errors committed by students are appropriately reported; the rest remain silent due to a strongly punitive culture [8, 10].

A study conducted in 2019 estimates that the 11 and 27% of nurses would not report error or near misses because of the circumstances in which they occurred or because of lack of awareness, such as "reporting is not necessary because no harm has been caused". A percentage between 22 and 33% of nurses, however, would not report them because of fear of consequences, such as "I cannot report anonymously" or "I am afraid of disciplinary action" [10]. The risk of error is increased by the students' perception of "unsafe" clinical environment: high workloads, lack of nursing staff, frequent interruptions are described as the main causes of insecurity by the students [9]. The most reported events are represented by adverse events related to the administration of drugs, accidental falls, errors during blood samples.

Based on these observations and on the conceptual model of prevention developed by the WHO, Christensen [11] has developed a three-level model of error prevention:

* *primary prevention*: constant and in-depth training and education, creation of a culture of patient safety and quality of care; creation of a culture of safe learning is one that treats students fairly, observes mistakes, has accessible and acceptable leadership, involves students in decisions, promotes teamwork and trust, encourages questions;
* *secondary prevention*: replaces the "failure" of the first level. Where the error occurs, the tutors are responsible for guiding the student. A debriefing between the tutor and the student is useful, during which the latter can discuss his/her emotions, his/her reaction to the error; then, together, one can consider the changes that could be made to avoid the error;
* *tertiary prevention*: that includes first a rethinking of the didactic systems and an orientation of the didactic programs to the safety of the treatments and to the management of the error. Educational methodologies such as simulation are encouraged.

Tab. II. Data extraction table.

Author(s) and year of pubblication	Title	Materials and methods	Main findings	Conclusions
Alquwez, et al. (2019)	A multi-university assessment of patient safety competence during clinical training among baccalaureate nursing students: a cross-sectional study	Descriptive, cross-sectional, multi-university study	The percentage of agreement on the items of the health professional education in patient safety survey ranged from 61.5-76.5%. The dimension "understanding human and environmental factors" received the highest perceived competence, whereas the dimension "working in teams" received the lowest competence. Significant differences in students' patient safety competence from different universities were reported. Male students perceived their competence in "working in teams" higher than the female students. Students in their internship year had significantly higher levels of competence in all the six dimensions of the health professional education in patient safety survey than students in the third- and fourth-year levels	Saudi nursing students have positive perceptions towards their patient safety competencies. Significant differences were found in the patient safety competence of nursing students between universities, gender and year of study
Christensen (2018)	Are clinical instructors preventing or provoking adverse events involving students: a contemporary issue	Contemporary issues	This article proposes a framework to begin to understand nursing student error prevention, with the aim to assist clinical instructors, nursing faculty, and nursing leaders in addressing an unrecognized aspect of adverse events. If the three levels of disease prevention (primary, secondary, and tertiary) are adapted to understand nursing student error prevention, then the following framework emerges: a) primary prevention: creating a safe learning culture; b) secondary prevention: reducing the negative impact of errors on students; c) tertiary prevention: participating in systemic efforts to reduce the established probelm	Clinical instructors have the capacity to create a safe learning culture, guide their students through the experience of making an error, and participate in processes that reduce them in the future
Usher, et al. (2017)	Self-reported confidence in patient safety knowledge among Australian undergraduate nursing students: a multi-site cross-sectional survey study	Multi-site, cross-sectional study used a web-based survey	Participants were most confident in their learning of clinical safety skills and least confident in learning about the sociocultural dimensions of working in teams with other health professionals, managing safety risks and understanding human and environmental factors. Only 59% of students felt confident they could approach someone engaging in unsafe practice, 75% of students agreed it was difficult to question the decisions or actions of those with more authority, and 78% were concerned they would face disciplinary action if they made a serious error	Patient safety voice develops and strengthens over nursing students' course of study and clinical placements, however it is concerning that a large proportion of students express difficulty in questioning the decisions or actions of those in authority positions and concerns about disciplinary action if errors are made. The integration of patient safety into nursing curricula and resulting teaching and learning strategies to facilitate student knowledge and competence is still in its infancy

Continues

Follows

Tab. II. Data extraction table.

Author(s) and year of pubblication	Title	Materials and methods	Main findings	Conclusions
Stevanin, et al. (2015)	Knowledge and competence with patient safety as perceived by nursing students: the findings of a cross-sectional study	Cross-sectional study	A total of 573 students (response rate 92.4%) participated. Around a quarter (28.8%) of students reported having experienced an adverse event or close call during their clinical experience. The settings where they learn were perceived as unsafe by 46.9% of students. PS knowledge and competence as perceived by students, was high (median = 4) in all factors and dimensions of the H-PEPSSIta tool. High PS knowledge and competence was reported by first-year students, moderate by second-year students and higher at the end of the third-year	Faculties and health-care institutions offering clinical placements have to share the responsibility of well-prepared future nurses, working together to improve PS through dialogue when issues are identified by students
Mbuthia, et al. (2019)	Preregistration nursing students' perceived confidence in learning about patient safety in selected Kenyan universities	Cross-sectional descriptive study	The students reported higher confidence about learning on the clinical aspects than on the sociocultural issues of patient safety with the lowest mean scores recorded in "Understanding human and environmental factors" and "Recognising, responding and disclosing adverse events". They reported significantly higher confidence scores in the classroom setting than the clinical setting with no significant difference in reported confidence across the years of study. They were less confident in speaking up about patient safety issues in the clinical areas with 52.2% feeling that reporting a patient safety problem will result in negative repercussions	The patient safety culture in the clinical placements sites needs to be conducive to enable, and not hinder, the acquisition of these competences
Kim, et al. (2019)	Effects of a patient safety course using a flipped classroom approach among undergraduate nursing students: a quasi-experimental study	Pre- and post-test quasi-experimental design with a non-equivalent control group	Pre- and post-test results demonstrated a significant increase in students' patient safety competency including attitude, skills, and knowledge. Mean scores of patient safety competency in the experimental group were significantly higher than in the control group	The flipped-classroom patient safety course was shown to be effective in improving patient safety competency in terms of attitude, skills, and knowledge among undergraduate nursing students
Lee, et al. (2016)	Patient safety education and baccalaureate nursing students' patient safety competency: a cross-sectional study	Cross-sectional study	The majority of students (81.6%) reported that they had received patient safety education during coursework. Patient safety education was delivered primarily by lecture rather than during laboratory or simulation sessions. The degree of coverage of QSEN competency and the students' self-reported competency in total and attitude scores showed statistical differences among nursing schools. Students' attitude score was significantly higher than skill and knowledge	This study confirm the need to revise the nursing curriculum and to use various teaching methods to deliver patient safety education more comprehensively and effectively. Furthermore, there is a need to develop an integrated approach to ensuring students' balanced competency

NURSING CURRICULUM AND PATIENT SAFETY

Patient safety and healthcare workers safety in the healthcare facilities is struggling to enter in educational programs despite its obvious importance [12].

This is confirmed by a survey conducted in Australia, according to which while on the one hand the general concepts of clinical safety and effective communication were well rooted in nursing students, on the other hand they suffered from a knowledge gap on issues such as teamwork, risk management, knowledge of factors that increase clinical safety [13]. In addition, 78% of the respondents highlight the difficulty of reporting due to a punitive culture of error [14].

In summary, clinical safety competencies include safety during drug preparation and administration; infection prevention and control; surgical patient safety; and safety in invasive procedures. In addition, socio-cultural patient safety competencies must be implemented, including patient-centered care, teamwork, collaboration, evidence-based practice, improvement of quality, safety and information technology [15].

Nevertheless, the literature is unclear about duration, content, teacher qualification and teaching methods, as they vary for each study; it is therefore difficult to determine which is the best option to implement a safety course.

Through a further study conducted in South Korea in 2016 [16], nursing students from various universities were interviewed. More than 80% of the sample said they had experience in the field of patient safety. 85% of the students received knowledge about this topic through simple lessons, while 76% received it in clinical practice. The courses that dealt most with patient safety both in lessons and in practice were nursing, adult nursing, and management. Nevertheless, the topic was treated differently in different universities, showing statistically significant differences. Students were then asked to determine which subjects related to the skills needed to ensure patient safety had been covered in the curriculum. They stated that patient-centered care was the highest competence in the programs, with 97%; followed by evidence-based practice (90%), information technology (90%), teamwork and collaboration (84%), safety (84%), quality implementation (80%). These competences were mainly dealt with during the lessons, and little through simulations or workshops. 20% of the students stated that these competences were not treated during the of study.

The same conclusion was reached by the study conducted in Kenya in 2019 [15]: students learned more about patient safety in education than in clinical practice. This shows that there is a problem with the application of theoretical aspects in the practical context. In addition, the students were more confident with the clinical aspects of safety and less confident with the socio-cultural elements, which are key skills. Finally, the sample interviewed reported that patient safety aspects were not sufficiently covered in their study plan and do not feel confident about patient safety in clinical settings.

A study carried out in 2019 aims to establish how teaching related to patient safety is incorporated into university courses in 27 countries [8]. This was done by examining how much and how each key topic identified by WHO is integrated into academic nursing education. Most of the respondents agreed that the topics were present at various levels in the training. Key topics such as safety in therapy management, infection control, or even introductory topics such as "what is patient safety" are integrated into programs of various subjects and are not treated as stand-alone topics in specific safety modules. For example, on the topic "infection prevention and control", 98% of respondents indicated that it is present in academic programs, however only 16 universities treat it as an autonomous subject, while 51 reported that the topic is integrated throughout the university curriculum.

Similar results can be observed with the topic "safety in the management of drug therapy" [17].

NON-TECHNICAL SKILLS

An area that receives little attention is represented by non-technical skills (e.g. situation awareness), which relate to the way healthcare workers communicate and cooperate with each other. Emphasizing the importance of these skills is crucial, as estimates suggest that 70-80% of errors are the result of a lack of non-technical skills [18].

Through a literature review conducted in 2018 [19], it was possible to identify which non-technical skills were most frequently evaluated to improve patient safety:

* *communication*: the elements of communication skills are: sending and receiving information; clear and concise presentation of information, including therapeutic communication, listening, empathy, verbal and nonverbal communication; identification and elimination of barriers to effective communication;
* *awareness of the situation*: the elements required are: collection, recognition and understanding of information; anticipation of future events; awareness of patient safety;
* *decision-making process*: the elements of decision-making capacity are defined as: identification of various possible options, risk assessment and selection of options, re-evaluation/revision of results, definition of problems, process for reaching a decision;
* *leadership*: the main elements are: establishing and maintaining standards, supporting other team members, using strategies to cope with stress and pressure;
* *teamwork*: the main elements are: support to other workers, exchange of information and accurate reporting of news, coordination of team activities; assessment of roles and capabilities, conflict resolution. It has been documented that the collaboration of other professionals and the use of care models based on teamwork improve the quality and safety of care. Opportunities for interprofessional experience are not included in university programs, so student nurses reported only a few opportunities to have meaningful contacts with other health professionals during their education. As a result of this, students show little competence in teamwork. Among the factors that threaten the integration of interprofessional experiences in clinical training were: the organizational level, the management level, the practical level such as lack of time the cultural level such as a different perception of teamwork or a potential risk of superiority of one profession over the others. 40% of Italian students interviewed reported that "never" or "just a little" had the opportunity to learn from other professionals during their last clinical traineeship.

Discussion and conclusions

The picture provided by the literature is very clear: in the clinical practice, most students do not know what to

do to deal with the clinical risk, in order to ensure the safety and quality of care. The students are divided on the aspects concerning the presence of topics related to clinical risk in the university teaching modules. Even if they come from the same university and even from the same course, the opinions of the students appear to be in contrast. This could be because the subjects are not treated as autonomous subjects in the university career, but as many small teachings that integrate with each other over the academic years. So, it is up to the student to join these pieces and "create a module" on the clinical risk itself.

From here it is normal if the students of the same course do not show the same knowledge, the same attitudes and the same behaviours related to clinical risk and patient safety. The situation is made worse by the absence of practical simulations that provide for dealing with an error, a near miss, an adverse event. This obviously translates into the inability, in clinical practice, to identify an error, to report it in an appropriate way, and to implement behaviours aimed at its resolution.

From the studies analysed, it is doubtful whether the implementation of courses, seminars or, more generally, any educational intervention in addition to the basic university preparation is effective. Research shows an increase in knowledge and a greater awareness of clinical risk between pre and post educational interventions, and between control groups and experimental groups. But this occurs in the immediate post-operative period. Studies do not assess whether this knowledge is retained by the students in time. Therefore, it is not possible to conclude whether educational interventions are valid or not.

Indeed, some studies evaluate the Theory of planned behaviour related to patient safety among nursing students [20]. "For many students reporting an error would lead to a loss of trust in the nursing profession and this could prevent the report. Nevertheless, some of them affirmed to be positively judged when they did it. It was then observed that a better education on safety raised the level of self-confidence and the sense of responsibility of the students, making them more inclined to the drug therapy management" [20].

This review has limitations. One limit is the methodology with which the studies were conducted. Most of them are observational studies in which the survey of knowledge and skills was carried out through a written questionnaire given to the students, so it is not possible to assess the truthfulness of the answers given. Consequently, even the results derived from it do not allow to create with certainty, but with probability, the scenario described.

Although wandering is human, the analysis of global university contexts suggests increasing the knowledge about clinical risk and safety of care. Studies agree to implement these notions especially in nurses, because it is those health professionals who are closest to the patient, both in terms of physical proximity and in terms of time. Nurses also approach the patient holistically, so that care is expressed not only in the physical field, but also psychically and socially. Therefore, the complexity of care is very high, and this requires extensive, solid knowledge, supported by scientific evidence, which will result in appropriate behaviour not only to prevent any risk, but also to deal with it once it has occurred [21].

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Conflicts of interest statement

The authors declare no conflict of interest.

Authors' contributions

Conceptualization: MDM; Visualization: NG; Data curation: GBO, EDS, SD, GN; Funding acquisition: none; Methodology: MDM, NG, CN; Project administration: MDM; Visualization: GBO, MDM; Writing original draft: MDM, EDS ; Writing review & editing: NG, SD, CN.

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Supplementary file: PRISMA 2009 checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	E1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	E1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	E1-E2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	E1-E2
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	E2
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	E2
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Available upon request
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	E2
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	E2
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	E2
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	E2
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	E2
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	E2
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	E2
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	E2-E7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	E2-E7
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	E2-E7
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	E2-E7
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	E2-E7
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	E2-E7
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	E2-E7
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	E7-E8
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	E7-E8
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	E7-E8
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	E8

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