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Review
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Review

Educational intervention to improve the safety medication process: a review using the GRADE approach

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Abstract

Objectives Medication errors are frequent and affect patient safety in all the world. This review using the GRADE approach aims to identify the educational intervention which improves nursing medication competences and knowledge.
Methods According to PRISMA statement, a review was conducted.
Key findings In this review of nine studies, we determined that there is a lot of educational intervention aimed to improve nursing knowledge, such as traditional classroom training, simulation, e-learning, slide show presentations and the use of posters and pamphlets or mobile application. All of these can improve the medication process and nursing skills. Only three studies reached moderate, and two studies reached low-quality ratings.
Conclusions Our findings show that all educational interventions can lead to medication without harm. This work will inform regulators, public health initiatives and policy makers considering the nursing educational intervention for increasing patient safety and improve medication competence and knowledge.

Keywords: medication errors; patient safety; education intervention; medication competences; medication knowledge; nursing

Introduction

Medication errors (MEs) are frequent and affect patient safety in all the world. One of the most controversial aspects of medical care is the potential to cause unintended disability and distress. Wherever medical care is provided, the patient runs the risk of being injured as a result of involuntary consequences of treatment.[1]

Often cited reports from the USA, such as *To Err is Human* or *Keeping Patients Safe*[2, 3] and, more recently, in the English National Health Service (NHS) inquiries by Keogh [4] and Francis,[5] showed that medical errors were prevalent and weigh on patient safety.[2] Among adverse events, MEs is one of the most frequent causes of patient injury, disability or in-hospital death.[2] The process of reporting error is encouraged by institutions of all the world.[6–8]

MEs is defined as 'any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient or consumer. Such events may be related to professional practice, health care products, procedures and systems, including prescribing, order communication, product labelling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use'.[9, 10]

It is estimated that any given patient is affected to at least one ME per day and, that MEs account for 100,000 hospitalizations each year.[11] According to Tariq, 'the total cost of looking after patients with medication-associated errors exceeds $40 billion each year, with over 7 million patients affected'.[12] MEs can occur at any stage of the treatment process, from prescription to packaging, storage, administration and monitoring, but numerous studies show, however, that most errors occur during administration phase (medication administration errors) and the nurses are protagonists.[13, 14]

Scientific literature divides the factors that contribute to the occurrence of harmful or potentially harmful events into (i) factors related to the personal and professional characteristics, that is human factors, of the healthcare workers and (ii) factors related to the organization of the drug management process.[15–17] Human factors include personal and professional characteristics of registered nurses, which influence behaviour at work in a way which can affect health and patient safety. These are, for example, knowledge, attitude and behaviour.[16]

The US Food and Drug Administration (FDA) believes that lack of knowledge is one of the human factors could led to MEs. According to Durham,[18] andragogical strategy is valid in the field of medication safety. This strategy could decrease rates of MEs and improve patient outcomes. Indeed, andragogy has been defined as 'the art and science of helping adults to learn and the study of adult education theory, processes and technology to that end'.[19] The advantages of this strategy are well known in nursing science.[20]

Methods

Aim

The aim of this review was to explore the literature regards to educational strategies to improve medication knowledge and skills.

Data sources and search strategy

This systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[21] (see Supplementary File 1).

To identify as many studies as possible, five different nursing and biomedical database were selected: PubMed, Cinahl, Eric, Ovid and Embase. To obtain an exhaustive string search, the following keywords were combined through Boolean operators AND and OR: ME, nurse, educational interventions, teaching method (Table 1). The searches were conducted by analyzing publication between 1 January 2014 and 31 December 2020 and only results in English and Italian were considered.

Study selection

For inclusion in the systematic review, studies had to meet the requirements of the Population, Intervention an Outcome approach.[22] The population included nurses. The exposure was any educational intervention that can induce patient safety or decrease medication-related errors (outcome).

In addition, the reviewers defined the eligibility criteria used to rule in or out the collected studies for this research study.

The inclusion criteria were as follows: intervention studies, including randomized controlled trials (RCTs), controlled clinical trials and all observational studies (e.g. cohort analytic studies, cross-sectional studies, case–control studies, etc.); papers reporting the educational intervention to improve nursing competence and knowledge among medication process; peer-reviewed research articles published in English and Italian.

Exclusion criteria were as follows: studies reporting a prevention of MEs; studies reporting the administration of medications by other health professionals or nursing students and studies reporting the prescription and the dispensation of drugs; studies carried out in outpatient centres, assisted living facilities and nursing homes; grey literature, such as dissertations, conference papers, proceedings and so on.

Data extraction and quality assessment

The review process for evaluating study inclusion and data extraction was conducted by two authors who independently analysed the studies to be selected. Thanks to this in-depth reading, they were able to exclude those studies that did not focus on the education intervention.

The results obtained from the research were imported into Endnote database, then, duplicates were eliminated. The first phase of screening of the studies was carried out by reading the title and abstract based on the previously established eligibility criteria. The second phase of eligibility instead provided for the reading of the full text to determine the pertinent papers.

For each selected study, the following information was collected: name of the author(s) and year of publication of the study, title of study, study design, study population, educational methodology, outcome and summary of findings (Table 2). The quality of the evidence was carried out with the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) method [23] using the software GRADEproGDT, and the quality assessment of the relevant studies is reported in Table 3.

Results

Characteristic of the included studies

The database search yielded 1594 records. After the removal of 58 duplicates, 1442 records were excluded on the basis of their title or abstract. Of the remaining 94 potentially relevant full-text articles, 83 did not meet the eligibility criteria (Figure 1). A final nine articles were included in the narrative synthesis of which three are

Table 1 Query in PubMed

Search query
Search: (((((“teaching method”[Title/Abstract]) OR (“education”[Title/Abstract])) OR (“teaching”[Title/Abstract])) OR (“educational intervention”[Title/Abstract])) AND (“medication error*”[Title/Abstract])) AND (“nurs*”[Title/Abstract])

Table 2 Summary of the articles

Authors (year of publication)	Title of study	Type of study	Population	Teaching methodology	Outcome	Results	Notes
Amiri, *et al*., (2018) Iran	The effect of nurse empowerment educational programme on patient safety culture: a RCT	RCT	60 nurses and 20 supervisors (divided into 2 groups: experimental group and control group) of 6 adult ICUs at Namazi Hospital in Shiraz, Iran	Pre-test; 2-day Workshop, posters on display and brochures for the experimental group; post test	Comparison between the two groups before and after the intervention with a questionnaire (which consist of 42 elements and evaluates 12 dimensions)	In the experimental group, the mean post-test score on patient safety (3.46 ± 0.26) was significantly higher than that of the control group (2.84 ± 0.37, $P < 0.001$)	The empowerment programme has improved the culture of patient safety in some dimensions and therefore can be used to promote these dimensions; however, dimensions such as the 'non – punitive' response to error and the frequency of reported errors continue to be weak, therefore, to improve these dimensions, other studies and teaching methods must be carried out.
Simonsen, *et al* (2014) Norway	Improvement of drug dose calculations by classroom teaching or e-learning: a randomized controlled trial in nurses	RCT	183 nurses (from hospitals and primary health care), divided into two groups: experimental and control group	Pre testing of drug dose calculations; the none group was assigned to an interactive and self-directed e-learning course, the other to a classroom course with the same content; post-test after 2–4 weeks	Comparison between the questionnaires of the two groups on the dosages of drugs (conversion units, dilutions, etc.) before and after the courses	No significant differences between the two teaching methods were detected by the overall test score, certainty or risk of error	The study was unable to demonstrate a difference in learning outcome between the two teaching methods; both methods led to an improvement in pharmacological dosage calculations.
Siebert *et al*. (2016) Switzerland	A mobile device App to reduce time to drug delivery and medication errors during simulated paediatric cardiopulmonary resuscitation: a randomized controlled trial	RCT	20 randomized paediatric nurses in two group: an experimental one that will use the PedAMINES mobile device in the simulation, a control one that will not use the device	Simulation of paediatric cardiopulmonary resuscitation in the scenario: after the recovery of the circle, the nurses of the intervention group use the app for the preparation of the continuous infusion of dopamine and noradrenaline, the control group uses the usual table for the calculations and dosages of the infusions	Comparison of two groups in the time of preparation and administration of the drugs and in the possible pharmacological error	During the study period, the drug preparation time using the app compared to the traditional method was 128,1 s (95% CI 102–154) versus 308.1 s (95% CI 216–400), with a reduction of 180 s ($P = 0.002$); medication errors were reduced from 70% to 0% ($P < 0.01$) using PedAMINES.	In this simulation-based study, PedAMINES dramatically reduced the preparation and administration time for amines and related errors.
Daupin *et al*. (2016) Canada	Medication errors room: a simulation to assess the medical, nursing and pharmacy staffs' ability to identify errors related to the medication-use system	Cross-sectional study	207 nurses, doctors, pharmacists and pharmacy technicians, selected on the basis of their ability to complete the grid for the study	A room was created to reproduce the patient's room and the pharmacy to start the simulation: out of 30 scenarios, 24 contained errors that participants had to identify and report in a special grid	Participants had to find out if there were any errors in the simulated scenarios and report them in a response grid	The overall correct answer rate was 67.5% ± 13.3%; most participants wanted to change their practices	Simulation has proven to be an effective and relevant tool for dealing with the critical processes of professionals

Table 2 Contiued

Authors (year of publication)	Title of study	Type of study	Population	Teaching methodology	Outcome	Results	Notes
Johansson-Pajala *et al.* (2014) Sweden	Nurses' self-reported medication competence in relation to their pharmacovigilant activities in clinical practice	Cross-sectional study	296 nurses from different work settings, divided into two groups: 124 nurses had followed a pharmacovigilance course at the university (exposed group), while 172 did not (not exposed)	A 45 item questionnaire was administered on the pharmacological competence of nurses (knowledge, evaluation of adverse reactions, pharmacovigilance, etc.)	Comparison between the group exposed to the university course of pharmacovigilance and the group not exposed to the course in the questionnaire response	Out of 296,75 nurses were exposed and 93 were not exposed to having fully answered the questionnaire. In general, the level of expertise in the field of drugs (with a significant difference between exposed and unexposed: $P = 0.001$) was high, but the content of pharmacovigilance activities was low	Previous training in pharmacovigilance improved drug knowledge but was not sufficient to increase pharmacovigilance activity
Tenhunen ML, Tanner EK e Dahlen R. (2014) Texas	Outcomes of a quality improvement project for educating nurses on medication administration and errors in nursing homes	Descriptive study	72 nurses in two Nursing Homes	Pre-test; 35 minute training presentation on drug administration; post-test after one month	Comparison between pre and post tests and comparison between structures	Tests showed an increase in nursing knowledge in one facility ($P = 0.04$) and no significant increase in knowledge in the second Nursing Home	Factors influencing the knowledge and administration of drugs in Nursing Homes need further study
Tamashiro L.M.C e Peres H.H.C. (2014) Brasile	Development and assessment of learning objects about intramuscular medication administration	Descriptive study	8 nurses and 8 nursing students	Use by samples of a technological educational medium aimed at learning to administer drugs intramuscularly	Evaluation of educational aspects, graphic interface and teaching resources by students and nurses	The learning object was rated excellent and satisfactory by nurses and students, resulting in 97% positive responses, and was therefore considered appropriate for nursing teaching	The use of educational technology on the administration of IM drugs can positively influence nursing education, stimulate knowledge, autonomous and independent learning in line with new vocational training needs
Xu *et al.* (2014) Cina	An intervention to improve inpatient medication management: a before and after study	Almost experimental study	Study carried out in 31 units of a general university hospital in southeast China: 16 medical units, 9 surgical units, 2 obstetrical-gynaecological units, 2 paediatric units an emergency department and intensive care	Intervention strategy with a five-point protocol aimed at improving patient safety and reducing errors	Pre-intervention evaluation conducted for 2 years, introduction of the five-point protocol (1.Conduct of training programmes 2. Optimization of drug policies 3. Management of drug classification 4. Improvement of safety in administration 5. Supervision of the drug administration process)	Pre-intervention and 2 years after intervention: first: correct administration 94.0% $n = 496$ Later: proper administration 96.8% $n = 496$ $P = 0.035$	The five-point intervention strategy has improved the safety of hospitalized patients: therapeutic errors have been reduced, nurses' awareness and hospital satisfaction have improved; however, a RCT is needed to test its effectiveness
Prakash *et al.* (2014) Canada	Mitigating errors caused by interruptions during medication verification and administration: interventions in a simuled ambulatory chemotherapy setting	Prospective study	37 nurses from the oncology clinic	Simulation experiment in an outpatient chemotherapy setting	Verification and determination of error rates related to interruption during drug preparation and administration	Significantly more errors were made when interrupted than when not interrupted, especially in the volume of	Interruptions cause many errors, but interventions and participative discussion have

Table 2 Continued

Authors (year of publication)	Title of study	Type of study	Population	Teaching methodology	Outcome	Results	Notes
						aspirated drugs and in the programming of electronic pumps, but after simulation error rates decreased (syringe volume control: 89% vs. 58%, $P = 0.038$ and bags: vs. 58%, $P = 0.012$; 94% Ev administration:89% vs. 32%, $P = 0.001$; Pump programming: 39% vs. 5%, $P = 0.017$)	been effective in reducing unforeseen errors

RCT,[24–26] six are observational studies.[27–32] All interventions can led to an improvement of the medication process and to improve nursing skills according to *P*-values. Only three studies reached moderate[24–26] ($n = 3$) and two studies reached low-quality ratings[27, 29] ($n = 2$) (Table 3).

Findings of papers included have been organized into two main areas: ones focused on patient safety, the each one focused on medication competence and knowledge.

Educational intervention on patient safety

Amiri *el al*.,[24] in six Intensive Care Unit (ICU) at Namazi Hospital in Shiraz (Iran), conducted an RCT. The sample is randomized into experimental and control group. The sample size was of 60 nurses and 20 supervisors. Both of them had to respond to a pre-test. The experimental group then attended a 2-day seminar (lecture, group discussion and scenario presentations) on patient safety, danger situations, strategies and tools for improving performance and reducing treatment errors, and information leaflets were distributed and posted for 6 weeks. Subsequently, the two groups were compared with a post-test. While in the pre-tests between the two groups, the scores were not statistically different; in the post-tests, the total mean scores were significantly higher in the experimental group ($P = 0.001$).

Focused on patient safety, Daupin *et al*.[27] conducted a transversal study using a real 'simulation room' that reproduced a patient's room and the hospital pharmacy, involving pharmacists, doctors and nurses ($n = 230$ healthcare workers), a setting of 11 total sessions in which staff had to detected errors inserted in 30 scenarios of daily activities and bring them back on a dedicated grid. The effectiveness of this simulation has allowed the identification of errors and also of some deviations from the expected practices (recognized by the questionnaires) that have made the staff reflect (encouraging them to change certain behaviours).

Prakash *et al*.[28] focused on interruptions during the preparation and administration of chemotherapy in a simulated outpatient setting. The aim was to design and verify the effectiveness of interventions aimed to reduce medication-related errors due to interruption. In the simulation, actors intervened disturbing the activity of preparation and administration of therapy, while trained observers collected data in real time from an observation room, in particular: during the verification of the name of the drug the operator was interrupted by requests from a colleague and patient; during drug dosage verification was interrupted by patients, telephone, request from a doctor, thus continuing until the programming of the infusion pump. The nurses made many therapeutic errors when they were interrupted, decreased after some corrective action: errors in the verifying the volume of drug contained in the syringes (error rate before corrective action: 89%, after corrective action: 58% ($P = 0.038$)); programming of infusion pumps (error rate before corrective action: 94%, after corrective action: 58% ($P = 0.012$)); during administration and programming of the pump (error rate before corrective action: 39%, after corrective action: 5% ($P = 0.017$)). For manual drug administration, visual timers were introduced to facilitate pressure times on the syringe, while reminder were added to the infusion pumps with warning signal that remind us to control the infusion parameters, clamps and the tube connections. The introduction and use of these system (especially the visual reporting of 'areas of no disturbance') has resulted a reduction in the number of errors related to the aspects investigated, while not ensuring a reduction in errors related to 'the person' (such as checking the labels of the drug, the name of the patient, etc.).

Educational intervention on medication competence and knowledge

Six studies included focused on medication competence and knowledge of healthcare personnel.[27–32] Simonsen *et al*.[26] in Norway, performed an RCT comparing two teaching methods (classroom frontal lesson with e-learning) and the risk of error after a course on calculating doses of administration and dilution of drugs. The study showed no significant differences between e-learning and classroom learning ($P = 0.77$); however, in both cases, there was an improvement in patient safety and a decrease in medication related errors.

Siebert *et al*.[25] undertook a RCT with two groups of paediatric nurses comparing Pediatric Accurate Medication in Emergency Situations (PedAMINES) with a drugs infusion rate table during the preparation of continuous drug infusion. The authors used a high-fidelity simulation-based paediatric cardiopulmonary resuscitation cardiac arrest scenario in a shock room. The study aimed to show if the use of digital methodology reduce the rate MEs and drug preparation time (TDP) in emergency, compared to the traditional preparation. Findings shown as PedAMINES dramatically reduced TDP (reduction of 180 s, $P = 0.002$) and the rate of MEs (reduced from 70% to 0%, $P = <0.001$).

Another study was conducted by Johansson-Pajala *et al*.[29] The authors have used a questionnaire to evaluate nurses' medication competence. Based on attendance at a university course on pharmacovigilance, the sample was divided into two groups, exposed and not exposed. Findings showed a high medication

Table 3 GRADE assessment

Certainty assessment							№ of patients		Main findings	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention	Control		
Patient safety										
1[24]	Randomized trials	Not serious	Not serious	Not serious	Serious[b]	None	31	33	Educational programme vs. no intervention In the experimental group, the total post-test mean scores of the patient safety culture (3.46 ± 0.26) was significantly higher than that of the control group (2.84 ± 0.37, $P<0.001$). It was also higher than that of the pre-test (2.91 ± 0.4, $P<0.001$).	⨁⨁⨁◯ MODERATE
1[27]	Observational studies	Not serious	Not serious	Not serious	Not serious	None	207/230 (90.0%)	0.0%	Simulation to identify hospital staff's errors The participants' overall rate of correct answers was 67.5% ± 13.3% (4073/6036). Among the least detected errors were situations involving a Y-site infusion incompatibility, an oral syringe preparation and the patient's identification. Participants mainly considered the simulation as effective in identifying incorrect practices (132/136, 97.8%) and relevant to their practice (129/136, 95.6%). Most of them (114/136; 84.4%) intended to change their practices in view of their exposure to the simulation.	⨁⨁◯◯LOW
1[28]	Observational studies	Not serious	Not serious	Not serious	Serious[b]	None	N = 18 Pre-intervention experiment N = 19 Post-intervention experiment		Simulation laboratory experiment Significantly more nurses committed medication errors when interrupted than when uninterrupted. With use of interventions when interrupted, significantly fewer nurses made errors in verifying medication volumes contained in syringes (16/18; 89% pre-intervention error rate vs. 11/19; 58% post-intervention error rate; P = 0.038; Fisher's exact test) and programmed in ambulatory pumps (17/18; 94% pre-intervention vs. 11/19; 58% post-intervention; P = 0.012). The rate of error commission significantly decreased with use of interventions when interrupted during intravenous push (16/18; 89% pre-intervention vs. 6/19; 32% post-intervention; P = 0.017) and pump programming (7/18; 39% pre-intervention vs. 1/19; 5% post-intervention; P = 0.017).	⨁◯◯◯VERY LOW
Medication competence and knowledge										
1[26]	Randomized trials	Not serious	Not serious	Not serious	Serious[b]	None	92	91	e-learning courses vs. classroom teaching There was no difference in risk of error between groups after the course (P = 0.77).	⨁⨁⨁◯ MODERATE
1[25]	Randomized trials	Not serious	Not serious	Not serious	Serious[b]	None	10	10	PedAMINES vs. conventional preparation methods Mean TDP while using PedAMINES and conventional preparation methods was 128.1 s (95% CI 102–154) and 308.1 s (95% CI 216–400), respectively (180 s reduction, P = 0.002). Mean TDD was 214 s (95% CI 171–256) and 391 s (95% CI 298–483), respectively (177.3 s reduction, P = 0.002). Medication errors were reduced from 70% to 0% (P < 0.001) by using PedAMINES when compared with conventional methods.	⨁⨁⨁◯ MODERATE
1[29]	Observational studies	Not serious	Not serious	Not serious	Not serious	None	296 with educational course	172 without edicational course	Courses in pharmacovigilance vs. no intervention Significant ($P \leq 0.001$) differences between groups were observed regarding medication competence. The exposure of completed dedicated courses in pharmacovigilance was the strongest factor for self-reported medication competence when adjusted for age, other education, workplace and experience.	⨁⨁◯◯LOW

Table 3 Continued

Certainty assessment							№ of patients		Main findings	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention	Control		
1[31]	Observational studies	Serious[a]	Not serious	Not serious	Serious[b]	None	72/124 (58.0%)	-	Educational courses vs. no intervention Paired t tests demonstrated an increase in nursing knowledge in one facility ($P = 0.04$) and no significant increase in nursing knowledge in the second.	⨁◯◯◯VERY LOW
1[30]	Observational studies	Serious[a]	Not serious	Not serious	Serious[b]	None	16/156 (10.25%)	-	E-learning object The use of educational technology on the administration of IM drugs can positively influence nursing education, stimulate knowledge, autonomous and independent learning in line with new vocational training needs	⨁◯◯◯VERY LOW
1[32]	Observational studies	Serious[a]	Not serious	Not serious	Serious[b]	None	-	--	Five-point management intervention strategy The success rate of medication administration procedures increased from 94.0% (466/496 doses observed) to 96.8% (480/496). Nurse-initiated medication error reports/total medication error reports increased from 77.1% (101/131) to 95.1% (58/61). Rate of inpatient satisfaction with medication increased from 92.1% (3427/3720) to 98.3% (3656/3720). Complaints related to nursing medication administration decreased from 23 to 6 (73.9% reduction).	⨁◯◯◯VERY LOW

[a]Inadequate control for confounders.
[b]Total numbers < 100 patients.

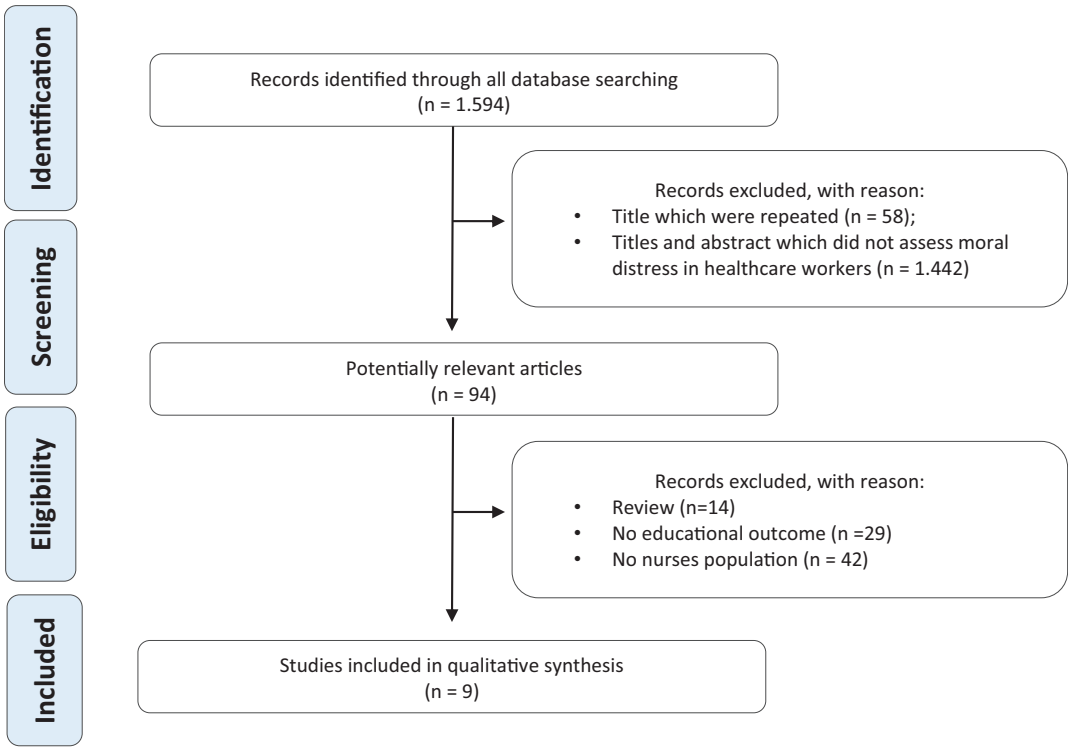

Figure 1 Article selection process.

competence in all nursing sample ($P \leq 0.001$) and low competences in pharmacovigilant activities. The attendance at a university course on pharmavigilance was the strongest factor for self-reported medication competence.

More controversial is the outcome of a descriptive pre–post-test study conducted by Tenhunen *et al.*[31] Seventy-two nurses watched a 35-min education presentation in drug administration. One month later, nursing knowledge have increased in the sample who have watched the educational presentation ($P = 0.04$).

Tamashiro[30] conducted a descriptive study aimed to develop a new educational intervention to improve intramuscular medication administration for nursing undergraduates and nurses. The learning object was made up of a programme and tools with interactive resources that allow the students to build engaging content such as simulations, drag-and-drop interactions, tests, evaluations and more. A random sample of nurses and nursing students tested the tool and evaluated own educational aspects (relevance, objectives, texts), interface (navigation, accessibility and screen design) and didactic resources. The educational intervention was evaluated as excellent and satisfactory, and adequate to the nursing learning process.

At the end, in China, Xu *et al.*[32] conducted a quasi-experimental study aimed to increase patient safety and decrease MEs. The authors created a five-point management intervention strategy: (i) Learning and training programmes to improve nursing knowledge and skill in drug management and medication errors prevention; (ii) optimize of procedures and implementation of the computerized drug management system; (iii) Organization of the classification for drug record, highlighting of analgesics, anaesthetics, emergency drugs and high-risk drugs (storage and organization); (iv) improve safety in the management of intravenous drugs (standardization of nursing behaviour in the administration of drugs); (v) supervision in the administration processes of therapies to ensure greater safety (report on MEs, analysis systems, quality control activities, etc.). Findings of pre-intervention and post-intervention have shown that the rate of medication policies and procedures compliance increased from 86.7% (645/744 doses observed) to 97.5% (725/744). From 94.0% (466/496 doses observed) to 96.8% (480/496), the rate of an adequate medication administration procedures was increased. Nurse-initiated ME reports/total ME reports increased from 77.1% (101/131) to 95.1% (58/61). From 92.1% (3427/3720) to 98.3% (3656/3720), the rate of inpatient satisfaction was increased.

Quality of evidence

On GRADE evaluation, all endpoints were rated as moderate, low or very low quality of evidence. The authors consistently downgraded by 1 point each for study design limitations (as all studies in this review were non-randomized) and inconsistency (Table 2).

Discussion

This systematic review aimed to explore educational intervention to improve medication skills among nursing population. Based on our knowledge, this study is the first systematic review to use an evaluation based on GRADE approach in order to obtain an evidence-based discussion of educational intervention in nursing medication safety. Indeed, the magnitude of MEs in healthcare setting is well known, but the percentage of errors related to knowledge deficits is however not clear. Medication errors are caused by several factors.[33–36] Some studies [37, 38] showed that about half of the therapeutic errors in ICU are the result of knowledge and/or performance deficits, while Rothschild [39] estimate a percentage of only 25% of these. Based on a Italian questionnaire,[40] some studies show statistically significant differences between knowledge and attitudes.[16, 41] An accurate knowledge is so related to a positive attitude. Also, a positive attitude is fundamental to an accurate knowledge and to

improve medication behaviour. Moreover, one study shows that the 85.6% of nursing sample considered the teaching about the use of IV medications inadequate and it will be increased during the degree course; 30.3% agreed that postgraduate courses on the use of IV drugs should be designed.[42] Indeed, educational interventions supporting nursing medication competences and knowledge show improvements in patient outcomes and reductions in MEs.[43] However, there are not clear differences between educational interventions studied, although it was shown that simulation, especially high fidelity, has a very strong educational effect in the implementation of nursing skills. The result of frontal lessons, e-learning, digital applications and simulations is therefore always relevant in the reduction of MEs, their effect should perhaps be re-evaluated and repeated over time to maintain a constant and updated level of effectiveness. The analysis of findings of included studies did not specify a rigorous pedagogical methodology. However, andragogy, as Knowles[44] explains, how adult learning is different from the education in child (centred more on the learner's need to know, on his or her concept or self, on his or her previous experience, on his or her willingness to learn, on orientation and motivation to learn), in a context of individual and situational particularities. Educational intervention and didactic methodologies, therefore, must also take into account these peculiar aspects of the learner and certainly require a targeted preparation of the formators themselves. From this review, it emerges that training always produces a positive result, in the short term, on the performance and reduction of MEs, but in the long term (for example, after a few years), the results have not been evaluated. Recalling the 'learning cone' of the American pedagogist Edgar Dale[45] active learning is the most effective method in improving the duration of memories because our memory is influenced by experiences (the more they are new, particular and full of emotions and the more easily they will be remembered), therefore the direct impact of the simulation of real experience should allow us to learn and remember more easily in the long term. At the basis of these reflections it would be necessary to evaluate the outcomes of the educational interventions at a distance of time and possibly prepare retraining to maintain and update knowledge.

This review has several limitations. The main limitation of this review is the non-randomized design of the majority of the included studies that has reflected in the quality of evidence by GRADE classification. Another limitation is that the review is focused only in the latest 5 years. Secondly, the aim of this systematic review was to evaluate the best evidence on the educational intervention to improve medication safety among nursing population, and therefore, we did not include physician or pharmacist in our search strategy.

Conclusion

The current review suggests that there are several education interventions to improve patient safety and medication competence and knowledge. However, there are no clear differences between educational interventions studied, although it was shown that simulation, especially high fidelity, has a very strong educational effect in the implementation of nursing skills. The result of frontal lessons, e-learning, digital applications and simulations is therefore always relevant in the reduction of MEs; their effect should perhaps be re-evaluated and repeated over time to maintain a constant and updated level of effectiveness. This work will inform regulators, public health initiatives and policy makers considering the nursing educational interventions for increase patient safety and improve medication competence and knowledge. Our findings show that all educational interventions seem to have a positive effect. In the future, we can do a meta-analysis of these studies or we can compare educational intervention studies that sharing similar content. Furthermore, it might be interesting to analyse ME phenomenon among nurses who are affecting by specific learning disorders. The analysis of the included studies does not reveal this topic.

Author Contributions

Substantial contributions to the conception and design of the work: SD, MDM, EDS, NG. Acquisition, analysis of data: MDM, NG, EDS, SD. Interpretation of data: MDM, NG, EDS, SD. Drafting the work and revising it critically for important intellectual content: NG, MDM, SD, EDS. Final approval of the version to be published: SD, MDM, NG, EDS, MT, RC.
Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: NG, EDS, SD, MT, RC, MDM.

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Conflict of Interest

None declared.

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