Educational interventions to reduce nurse medication interruptions

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Review

Educational interventions to reduce nurse medication interruptions: A scoping review☆

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A R T I C L E   I N F O

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A B S T R A C T

Background: Preventable harm from medicines is a global problem creating huge economic and social burden. Interruptions occur frequently in clinical environments causing medication episodes to take longer and having a cognitive cost on the nurse.

Aim: The aim of this scoping review is to identify and evaluate educational interventions that have been employed to reduce medication interruptions and improve medication safety.

Methods: Six databases were searched for the scoping review (PubMed, Embase, Cochrane Library, CINAHL, Pishin and Medline) along with reference lists and grey literature searches. Articles were included if they were written in English, published between 2010 and 2020 and employed an education intervention (including bundled interventions). Databases were searched using keywords and Boolean operators.

Results: Eight studies met the inclusion criteria. Seven of these studies were conducted in hospital (adults $n = 6$, paediatric $n = 1$) and one study in a university with undergraduate nurses. Four studies used a combined intervention and four exclusively employed an education intervention. Five studies found a significant decrease in the number of interruptions post intervention, but one of the studies that exclusively employed an education intervention found no significant difference. Changes in the nurses' behaviour post intervention were also cited in two studies.

Implications for future research: There was a lack of exclusive education interventions, making it difficult to determine the effectiveness of education at reducing medication interruptions. This review highlights the necessity of some interruptions when performing tasks, for example, to make a nurse aware of a deteriorating patient. However, as the majority of studies used the number of interruptions to determine the effectiveness of the intervention, there is uncertainty as to whether this is the right outcome measure to use. In the future, a focus on outcome measures reflecting change in nurse behaviour may be more effective in determining the strength of an educational intervention.

1. Introduction

Preventable harm from medicines is a global problem which creates a huge economic and social burden (Dickinson et al., 2012). The World Health Organisation (WHO) has recognised the issue and developed a strategy to reduce avoidable medication errors by 50 % by 2022 (Donaldson et al., 2017). Donaldson et al. (2017) estimated that the annual global cost of medication errors is US$42 billion, which represents approximately 1 % of the global expenditure on health. In 2018, Elliott et al. (2018) found that each year in England, an estimated 237 million medication errors occur at some point during the medication process, with 66 million of these being potentially clinically significant errors. The U.S. Food and Drug Administration (2016) found that at least one death a day can be contributed to medication errors, and injuries to around 1.3 million people every year.

The complexity of a Paediatric Intensive Care Unit (PICU) can mean

medication errors or Adverse Drug Reactions (ADRs) are more likely. There are environmental factors that can cause a higher risk of drug errors including the acuity of patients, the frequency of drugs and the complexity of the calculations associated with paediatric drugs (Bower et al., 2015). A single medication error will have several contributing factors, many of which are human in nature. Nurses often work in a busy and stressful environment, where interruptions frequently occur (Myers & Parikh, 2019). Interruptions and distractions are both key contributing factors leading to medication errors globally (Kwon et al., 2021; Davidson et al., 2022). Interruptions can occur frequently in clinical environments. One study found that 99 % of observed medication episodes (55/56) were interrupted (Johnson et al., 2017). Research suggests that there is a cognitive cost of interruptions, such as reducing concentration, causing confusion and reduction in work efficiency (Cole et al., 2016). Research can also delay time critical jobs such as patient assessments and cause a decline in effective communication leading to a deterioration in patient's health (Weigl et al., 2016). Interruptions can include self-distraction, loss of focus, patients, other healthcare providers, phone calls and texts (Hayes et al., 2015). Kalisch and Aebersold (2010) found that nurses spend approximately 30 % of their time at work multi-tasking, which can have both positive and negative effects. It can allow nurses, who often are constrained on time, to use their time more effectively. On the other hand, it can also affect their workload which can impact patient's safety (Kalisch & Aebersold, 2010).

Studies have associated interruptions with clinical errors and procedural failures (Eid et al., 2022), however, the link has never been directly proven. A review of 38,063 medication errors identified that interruptions were the most common contributing factor (Santell et al., 2003). Distractions/interruptions were identified in nearly half of the reports into the medication errors. Many of the studies investigating medication interruptions found that the most frequent cause of medication interruptions were nursing colleagues (Alteren et al., 2021; Schroers, 2018). Westbrook et al. (2010) also found that the 85 % of medication episodes that were interrupted during their observations, resulted in either clinical or procedural errors. Some interruptions are unavoidable, necessary and occur for patient safety reasons, for example, important communication about a patient or alerting to a risk. In view of this, it is important that interventions to reduce interruptions can distinguish between those that are avoidable and those that are necessary.

There are currently no standardised guidelines or interventions to reduce medication interruptions (Tomietto et al., 2012). However, the main intervention for tackling this problem in the last decade has been "Do Not Disturb Vests" or "No Interruptions Zone". These interventions have been adapted from the sterile cockpit areas from the aviation industry. However, there is weak evidence to support the effectiveness of these types of interventions (Hall et al., 2010). A recent multicenter cluster randomised controlled trial in France, found that a 'do not interrupt' vest intervention had no impact on administration errors or interruptions (Berdot et al., 2021). Hayes et al. (2014) suggests that these interventions deny the complexity of the healthcare environment, the medication task, and the nurse-patient interaction. Furthermore, another study found, registered nurses characterised the vests as uncomfortable and time consuming, and only 48 % supported the vests becoming hospital policy (Westbrook et al., 2017). A previous literature search into interventions to reduce medication interruptions was conducted by Raban and Westbrook in 2013. They found ten research papers eligible to include in their review. Employed interventions included signage, quiet zones, checklists and more. All interventions had a poor impact on reducing the rate of medication interruptions and there was weak evidence for their effectiveness and no study employed targeted education interventions. Other research has suggested that interventions should focus on addressing the culture of the organisation towards managing interruptions (Machen et al., 2019). In recent years there has been a shift from tackling the phenomenon of interruptions directly towards educational interventions that teach staff to employ techniques

to manage these situations better, with a focus on non-technical skills of situational awareness, task management and coping with stress.

The aim of this scoping review is to identify and evaluate published literature describing employed educational interventions to reduce medication interruptions and improve medication safety.

2. Method

A scoping review was conducted to answer the research question; 'Are educational interventions that are employed to overcome problems associated with medication interruptions, effective?'. The aim was to examine the extent, range and nature of research activity into medication interruptions as suggested by Arskey and O'Malley (2005). A scoping review was more appropriate than a systematic review, as the area under investigation is broad and no specific study design was required to answer the question. Furthermore, as this is part of a larger study, the limited time also made it more appropriate to conduct a scoping review, as stated by Arskey and O'Malley (2005).

Six databases were searched in November 2020, including PubMed, Embase, Cochrane Library, CINAHL, PyschInfo and Medline. Manual searches of reference lists and grey literature were also conducted. The inclusion criteria were created to be able to answer the research question. Articles were included if they were written in English and published between 2010 and 2020. The articles met the inclusion criteria if they employed an education intervention (including bundled interventions) aimed at reducing medication interruptions. Exclusion criteria included: review articles, research that did not specifically focus on medication interruptions. Research focused on medication errors rather than managing or overcoming medication interruptions. Studies were also excluded if they were not written in English or if the full text was not available. The decision was made to include other healthcare professionals that have similar roles to nurses in the medication process. This included healthcare workers and student nurses, as they often participate in the medication process with nurses, in the same environment. They are therefore exposed to the same interruptions and often contribute to these interruptions. Education interventions needs for these healthcare professionals will be the same as for nurses.

Databases were searched using individual keywords identified from background literature and using the OR/AND function to combine keywords such as "medication interruptions" AND "Education" AND "Interventions". A combination of medical subject headings (MeSH) and free text keywords were used alongside keywords identified from other published articles during the initial search (Table 1). The keywords were tested in different combinations before the final strategy was identified for the search. The subject headings were exploded to included narrower related terms, which were added to the search as 'free text'. Data from each article was independently reviewed and extracted into a data extraction table. Descriptive characteristics were collated in a table by the main author, which was reviewed by the co-author. Assessment of risks of bias was undertaken for non-randomised intervention studies using the ROBINS-I tool (Sterne et al., 2016) and the RoB 2 tool for randomised trials (Sterne et al., 2019). Thematic analysis was completed to identify key themes by the main author, which was presented to the co-author for review. The PRISMA extension for scoping reviews was followed during this scoping review (Tricco et al., 2018).

Table 1
Keywords used in the literature search.

Medication	Interruption	Education	Intervention
Medicines	Interruption[a]	Training	Programme
Drug		Teaching	Programme[a]
		E-learning[a]	
		Online learning	

[a] 'Free text' headings (non-medical subject headings).

3. Results

A total of 1144 articles were identified from the initial search. Duplicates were removed and articles were then screened by title, abstract and full text to ensure eligibility (Fig. 1). This resulted in eight articles meeting the inclusion criteria. Key information from the eight articles was captured in order to examine each of the interventions and the reported impact of these (Table 2).

3.1. Study demographics

The eight articles were published during a 9-year period of 2010–2019, and in a range of countries including; Australia ($n = 3$), Italy ($n = 2$), Switzerland ($n = 1$), Egypt ($n = 1$) and Ireland ($n = 1$).

Most of the research was conducted in general hospitals, with two studies set in a paediatric hospital and one within a university. The studies were mainly conducted in medical wards ($n = 4$), surgical wards ($n = 2$), and medical-surgical wards ($n = 2$). Most of the participants included were female nurses and the level of nursing experience ranged from less than 6 months to 20 years. Sample sizes for the studies ranged from 14 participants to 536 participants.

Half of the studies identified used a combined intervention ($n = 4$), whilst the others focused exclusively on implementing an education intervention (n = 4). Those that used a combined intervention employed strategies such as no interruption zones, sashes, signs on the wards and red aprons. Most of the studies evaluated the effectiveness of the intervention using a pre and post intervention observational design ($n = 6$), with two studies using reflection and focus groups post-intervention. Only one study used a randomised controlled trial design (Johnson et al., 2019). Various strategies were adopted to implement the

education interventions, including lectures/group sessions ($n = 4$), role play and simulation ($n = 2$) and e-learning modules (n = 2). One study used a combination of both group sessions and simulation/role play. Two of the studies did not provide a working definition for interruptions (Hayes et al., 2017; Johnson et al., 2018) six studies provided a definition, although these were all similar, there were subtle differences between each, for example whether interruptions are purely caused by external factors or both external and internal factors. Despite the fact that research has been conducted in this field for many years, there remains a lack of a standardised definition of interruption. The implications for evaluating the effectiveness of interventions.

Six of the studies used a pre and post intervention design. The other two studies used focus groups and reflection to determine the effectiveness of the interventions. All of the studies collected their data within 6 months of the intervention being implemented, the majority collected data between 1 and 3 months.

All of the non-randomised intervention studies scored a moderate or serious risk of bias using the ROBINS-I tool (Table 3) ($n = 7$). The majority of the bias is due to the lack of controlled interventions resulting in bias due to confounding factors. There was also often little information regarding participant selection, meaning it was difficult to identify if processes were biased. On the other hand, the majority of the randomised controlled trial conducted by Johnson et al. (2019), was deemed low risk. The final result scoring 'some concern' due to a lack of information about participant attrition rates and missing outcome data (Table 4).

3.2. Intervention themes

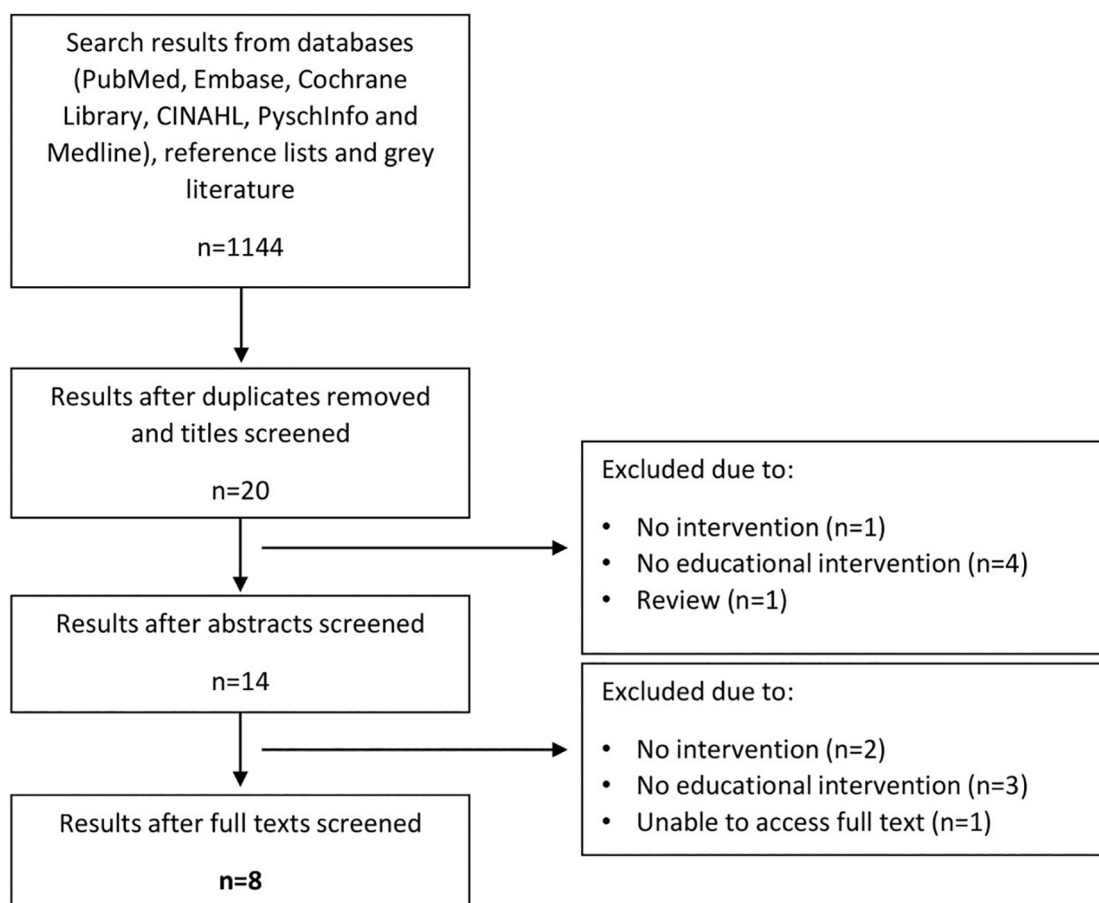Several themes of interventions were identified including general

Fig. 1. Screening the literature for educational Interventions to reduce medication interruptions.

Table 2
Descriptive characteristics of studies included.

Authors, year (country)	Aim	Sample	Setting	Design	Intervention	Outcomes measure	Key findings
Mortaro et al., 2019 (Italy)	To explore main reasons for interruptions on a geriatric ward in an Italian secondary hospital and test the effectiveness of a combined interruption.	24 nurses	geriatric ward ($n = 1$)	Pre and post observation study Qualitative and Quantitative	Combined intervention: Education Intervention (n = 3) Other Intervention (n = 3)	Number of interruptions Reason for interruptions Duration of interruptions Interruption management	Number of interruptions significantly improved Time wasted on interruptions significantly reduced.
Johnson et al., 2019 (Australia)	To conduct a feasibility cluster randomised controlled trial of an educational intervention that taught behavioural strategies to nurses	68 nurses	Medical-surgical wards ($n = 8$) from 4 hospitals	Parallel cluster randomised controlled trial Pre and post observations Qualitative and Quantitative	E-learning module	Number of Interruptions Observed clinical errors/procedural failures Distribution and frequency of nurse-initiated behavioural management strategies	Reduced multi-tasking and increased engaging strategies No statistical differences in number of interruptions and clinical error/procedural failures
Johnson et al., 2018 (Australia)	To describe and evaluate the perceptions of nurses of an authentic e-learning module that demonstrates behavioural management strategies for interruptions	9 healthcare workers ($n = 1$) 9 nurses	Palliative ward ($n = 1$) Acute ward ($n = 1$)	Focus Groups Qualitative	E-learning module	Framework guided thematic analysis *E.g.* questions about the education programme and if it changed their behaviours	Many needed prompting to remember the programme Felt it was definitely important and should be viewed by other staff Felt the content made sense and was effective
Dall'Oglio et al., 2017 (Italy)	To assess the effectiveness of an improvement programme to reduce interruptions during medication preparation and administration in a paediatric hospital	486 medication cycles were observed Number of participants was not stated	Medical surgical wards ($n = 2$) cardiac wards NICU wards ($n = 2$) medical wards ($n = 3$)	Quasi experimental study Pre and post observations Qualitative and Quantitative	Combined Interventions: Education Interventions (n = 2) Other Interventions (n = 3)	Frequency of interruptions Cause of interruptions Medication Administration Distraction Observation Sheet (MADOS)-adapted for Paediatrics Debriefing session after the intervention	Length of medication cycles significantly decreased after intervention Significant decrease in interruptions post-intervention
Huckels-Baumgart et al., 2017 (Switzerland)	To evaluate the impact of staff training and safety vests on interruptions during medication preparation and double checking	26 nurses	medical ward ($n = 1$)	Pre and post observation study Quantitative	Combined Interventions: Education Intervention (n = 1) Other Intervention (n = 2)	Frequency of interruptions Cause of interruptions Duration of interruptions Medication Administration Distraction Observation Sheet (MADOS)	Decreased interruptions by 23 % After combined intervention time taken for medication preparation and double checking reduced by 52 %
Hayes et al., 2017 (Australia)	To describe undergraduate student nurse responses to a simulated role-play experience focussing on managing interruptions during medication administration	528 2nd year nursing students 8 academic teaching staff	2 campuses within a large Australian University	Thematic analysis of reflective responses Qualitative	Simulation role-play	Structured reflective responses	Learning experience improved their confidence, taught them how to prioritise and plan care and time management Improved awareness of management strategies.
Zakiria & Mohamed, 2017 (Egypt)	To assess the effectiveness of interventions to limit errors and interruptions during medication administration in medical and surgical units	48 nurses	General medical wards ($n = 2$) Surgical wards ($n = 2$)	Quasi-experimental study Questionnaires Pre and post observations Quantitative	Education programme	Postintervention test to assess nurses' knowledge Frequency of errors Frequency of interruptions Cause of interruptions	Statistically significant improvement on knowledge of interruptions and medication safety Statistically significant decrease in errors and interruptions post intervention
Relihan et al., 2010	To assess the impact of a set of interventions in reducing the interruption/distraction rate during medication administration	31 nurses	Acute Medical Admissions Unit (AMAU) ($n = 1$)	Pre and post intervention observational study Quantitative	Combined interventions: Education Interventions (n = 2) Other	Frequency of interruptions/distractions Sources of interruptions/distractions	Interruption/distraction rate significantly decreased post intervention Substantial

(continued on next page)

Table 2 (*continued*)

Authors, year (country)	Aim	Sample	Setting	Design	Intervention	Outcomes measure	Key findings
					Interventions (n = 3)	Medication Administration Distraction Observation Sheet (MADOS)	behavioural changes were observed in staff, patients and visitors post-intervention

Table 3
Risk assessment of bias for the non-randomised interventional studies using the ROBINS-I tool.

Author, year	Pre-intervention		At intervention	Post-intervention				
	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Risk of bias judgment
Mortaro et al., 2019	Low	No information	Moderate	No information	No information	Moderate	Low	Moderate
Johnson et al., 2018	Low	No information	Low	Low	Low	Moderate	Low	Moderate
Dall'Oglio et al., 2017	Serious	Low	Low	Low	No information	Low	Low	Serious
Huckels-Baumgart et al., 2017	Serious	No information	Low	No information	No information	Low	Low	Serious
Hayes et al., 2017	Low	Low	Low	Serious	Low	Low	Low	Serious
Zakiria & Mohamed, 2017	Low	No information	Moderate	Low	Low	Low	Low	Moderate
Relihan et al., 2010	Serious	No information	Low	Low	Serious	Low	Low	Serious

medicine safety, education for other staff, patient and visitors, role play and simulation, behaviour management strategies and generic techniques. General medicine safety was highlighted to staff in several studies (Mortaro et al., 2019, Dall'Oglio et al., 2017, Huckels-Baumgart et al., 2017, Hayes et al., 2017, Zakiria & Mohamed, 2017). Some studies used the education intervention to discuss medication safety and to reiterate the importance and discuss the five rights of medication administration (right patient, right drug, right dose, right route and right time). Education about general medication safety was always implemented in conjunction with other areas of education. Many studies utilised previous study findings to demonstrate to staff, or students, the epidemiology of interruptions (Huckels-Baumgart et al., 2017; Johnson et al., 2018; Johnson et al., 2019; Zakiria & Mohamed, 2017). Data on the frequency, types and causes of interruptions were portrayed to staff to highlight the severity of the problem. Strategies to reduce interruptions were also common in many of the education interventions. Different strategies were identified in all eight of the studies. Some studies focused on behavioural management strategies, employing techniques such as engaging, multi-tasking, mediating and blocking (Johnson et al., 2018; Johnson et al., 2019). Whilst others adopted more generic techniques such as ensuring the medication trolley was fully stocked (Mortaro et al., 2019; Relihan et al., 2010), alerting colleagues that you are conducting the medicines administration round so others can be on hand to answer phones and patient/staff queries (Dall'Oglio et al., 2017, Relihan et al., 2010). Some studies also included education for other staff, patients and visitors (Dall'Oglio et al., 2017; Mortaro et al., 2019; Relihan et al., 2010; Zakiria & Mohamed, 2017). One study utilised role play to help undergraduate students appreciate the negative impact of interruptions and learn how to navigate them successfully (Hayes et al., 2017). Students were given case studies to prepare, for which they had to administer medication or cause interruptions dependent on the role they were playing. They would also have a student in the observer role to identify interruption management strategies utilised. They then facilitated reflection to help the students identify both good and bad practices.

3.3. Study outcomes

3.3.1. Number of interruptions
Most of the studies found a significant improvement in the number of interruptions post-intervention (n = 5) (Dall'Oglio et al., 2017; Huckels-Baumgart et al., 2017; Mortaro et al., 2019; Relihan et al., 2010; Zakiria & Mohamed, 2017). However, one of the larger studies with an exclusive education intervention did not find a significant difference between the control and intervention group, and the control group's baseline and follow up data (Johnson et al., 2019). However, they did find that more nurses engaged with the intervention at follow up and fewer attempted to multi-task. The intervention was an e-learning module and nurses reported finding it difficult to have the time to complete all the learning. During the focus group session, it also became apparent that the nurses struggled to recall the e-learning programme. This could explain the contrasting finding for this study with the lack of improvement post-intervention. However, the nurses also commented on the importance of the e-learning programme during the focus groups (Johnson et al., 2018; Johnson et al., 2019). They stated that the content made sense and was effective. They also felt that other healthcare staff should view it. The only change they wanted to make to the programme was to add consequences of medication interruptions, for example, show medication errors caused by interruptions.

3.3.2. Duration of interruptions
Many studies not only reported on the number of interruptions post-intervention, but also looked at the duration of the interruptions post-intervention (Dall'Oglio et al., 2017; Huckels-Baumgart et al., 2017; Mortaro et al., 2019; Zakiria & Mohamed, 2017). Significant reductions were found in the studies that looked at the duration of interruptions, and these were also perceived by the participants.

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Table 4

Risk assessment of bias for the randomised trials using the RoB 2 tool.

Domain 1a: Risk of bias arising from the randomization process			
Signalling questions	Lower risk of bias	Higher risk of bias	Other
1.1 Was the allocation sequence random?	Y		
1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?	PY		
1.3 Did baseline differences between intervention groups at the start of the first period suggest a problem with the randomization process?	PN		
Risk-of-bias judgment (*low/high/some concerns*)	Low		
Bias due to deviations from intended interventions			
2.1 Were participants aware of their assigned intervention during the trial?		Y	
2.2 Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?		Y	
2.3 If Y/PY/NI to 2.1 or 2.2: Were there deviations from the intended intervention that arose because of the trial context?	PN		
2.4 If Y/PY/NI to 2.3: Were these deviations likely to have affected the outcome?			
2.5 If Y/PY to 2.4: Were these deviations from intended intervention balanced between groups?			
2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention?	Y		
2.7 If N/PN/NI to 2.6: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomised?			
Risk-of-bias judgment (low/high/some concerns)	Low		
Bias due to missing outcome data			
3.1 Were data for this outcome available for all, or nearly all, participants randomised?			NI
3.2 If N/PN/NI to 3.1: Is there evidence that the result was not biased by missing outcome data?	PY		
3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?			NI
3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?			NI
Risk-of-bias judgment (low/high/some concerns)			Some concern
Bias in measurement of the outcome			
4.1 Was the method of measuring the outcome inappropriate?	N		
4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?	N		
4.3 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants?	PN		
4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?			
4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?			

Table 4 (*continued*)

Domain 1a: Risk of bias arising from the randomization process			
Signalling questions	Lower risk of bias	Higher risk of bias	Other
Risk-of-bias judgment (low/high/some concerns)	Low		
Bias in selection of the reported result			
5.1 Were the data that produced this result analysed in accordance with a prespecified analysis plan that was finalised before unblinded outcome data were available for analysis?	PY		
Is the numerical result being assessed likely to have been selected, on the basis of the results, from:			
5.2 … multiple eligible outcome measurements (eg, scales, definitions, time points) within the outcome domain?	N		
5.3 … multiple eligible analyses of the data?	N		
Risk-of-bias judgment (low/high/some concerns)	Low		
Overall bias			
Risk-of-bias judgment (low/high/some concerns)			Some concern

3.4. Other changes

Two of the studies observed changes in the nurses' behaviour (Johnson et al., 2019; Relihan et al., 2010). One study observed behavioural changes in all groups; nurses, other healthcare staff, patients and visitors (Relihan et al., 2010). However, it was unclear whether this change was due to the education intervention or other interventions. For example, one of the changes described was visitors walking towards the medication trolley to interrupt the nurse, but then being discouraged away by signs and posters. One study worked with the nurses to create the interventions, which they found resulted in a greater uptake of the intervention (Zakiria & Mohamed, 2017). A study that employed role play and simulations with students, found that after the intervention students demonstrated an understanding of how medication interruptions affect clinical decision making (Hayes et al., 2017). The simulation improved their confidence and increased their ability in time management and prioritising and planning their care. The students reported that for the role play to be effective and successful, the students need to feel they are in a safe and supported environment where they are able to make mistakes freely. Several studies reported that nurses were the most common cause of interruptions (Dall'Oglio et al., 2017; Huckels-Baumgart et al., 2017; Johnson et al., 2018; Relihan et al., 2010). This is similar to previous research into medication interruptions colleagues (Biron et al., 2009; Johnson et al., 2017), however, the staff still reported surprise that nursing colleagues created the most interruptions.

4. Implications for research

Colligan and Bass (2012) stated that an education and a cultural change are needed with a specific focus on nurses, as nurses showed a willingness to engage in interruptions, and Westbrook et al. (2010) also highlighted the importance of using simulations within education interventions. Raban and Westbrook (2014) state that the lack of studies that implement a control group makes it difficult to assess whether any other factors affected the change in interruptions seen. During their literature review Raban and Westbrook (2014) criticised the lack of randomised controlled trials and stated for research to provide evidence

of the effectiveness of the intervention, more studies with these designs need to be conducted. Considering this scoping review was completed nearly 10 years later, it highlights the lack of progress in this area and how imperative these designs are, to allow us to better understand and manage the complex relationship between medication and interruptions. As the majority of the studies included in this scoping review were feasibility studies and therefore had small sample sizes, more research needs to be conducted on a larger scale. Most of the studies did not control for bias, which brings the quality of the research conducted to date into question. Furthermore, most of the studies took place in general medical or surgical wards. More research needs to be conducted to assess the appropriateness of an educational intervention for medication interruptions in more specialised wards such as intensive care (Bower et al., 2018).

Previous interventions have been heavily criticised for a lack of nurse buy in (Bower et al., 2015; Federwisch et al., 2014; Hayes et al., 2014). Previously, many nurses found the interventions added work, increased the time it took to complete the medication episodes and were not successful. Only two of the studies sought nurses' opinions and experiences after the implementation of the intervention. Therefore, we are unsure as to whether nurses are more accepting of educational interventions than those previously implemented such as no interruption zones or safety vests. Furthermore, one study conducted previously, found that when the intervention decreased the number of interruptions, a reduction in communication and co-ordination was observed, which was essential for effective teamwork (Anthony et al., 2010). This emphasises the need to understand the implications of these interventions on both the number of interruptions but also the healthcare staff and workflow. The studies that used focus groups and reflection to allow nurses to evaluate the interventions, found that the nurses believed the education was important and would be useful for other members of staff (Hayes et al., 2017; Johnson et al., 2018). The simulation/role play was found to increase nurses' confidence and taught them how to prioritise and plan patient care (Hayes et al., 2017). Nurses found it difficult to have the time to complete the e-learning module, and the study did not investigate whether participants completed the whole of the online module (Johnson et al., 2018; Johnson et al., 2019). The largest study that solely employed an education intervention did not find a significant difference in interruptions which could potentially cast doubt as to whether employing exclusive education interventions is the way to go. However, this was the study that implemented the e-learning module and as stated, although they had positive qualitative data from their research, the engagement in the whole of the programme was lacking. Future research could explore the effect if both role play and simulations were implemented simultaneously with an e-learning programme, to allow both the benefits of the easy to access and quick e-learning module with the increased confidence and management skills from the role play.

None of the studies identified in this scoping review, attempted to identify the long-term effects of the interventions. The majority of the studies identified the Hawthorne effect as a limitation to their research, which has also been identified as a limitation in previous research (Prakash et al., 2014). With the limited time between the implementation of the intervention and the post-intervention observations, it increases the likelihood of the Hawthorne effect impacting the participants' behaviour. Furthermore, considering we are unsure on the nurses' level of acceptance of the intervention, it is difficult to determine whether the improvement seen is due to the Hawthorne effect or whether the intervention has triggered a culture change towards interruptions. Similarly, other studies found that participants struggled to recall aspects of the intervention, potentially meaning that there is a 'ceiling effect' to the effectiveness of interventions (Prakash et al., 2014). More longitudinal research is needed to explore whether the initial improvements observed in most studies were sustained over time.

A question raised from this review, is whether researchers were using the correct outcome measures to evaluate the educational interventions. The study that exclusively focused on an education intervention did not find a significant difference in reduction of interruptions between baseline and follow up, and control and the intervention groups. However, the education was aimed at teaching nurses how to effectively manage interruptions, and not to stop interruptions altogether. They did find more nurses used the engaging strategy at follow up more than the multi-tasking strategy. There is a question over whether the aim of the interventions is to eliminate all interruptions, despite being aware that some interruptions are needed, or whether it is to eliminate the risk that is associated with engaging in interruptions during medication administration. If the latter, duration of interruptions or management strategies may be a more effective outcome measure to evaluate the impact of the interventions.

5. Conclusion

The scoping review conducted, found a limited number of studies looking at educational interventions for medication interruptions. The majority of the studies lacked independent interventions and quality. Robust research designs should be employed to provide significant evidence of the effectiveness of interventions. More longitudinal studies are needed to see if any impact is sustained over time. Research in the future should examine whether 'number of interruptions' is the right outcome measure, or whether other measures such as duration of interruption and interruption management behaviour used, would be more insightful. Research identifies that interruptions are necessary, and further research exploring nurses' experience and acceptance of the learning and impact on their work should be conducted to identify any unintended effects that could impact on communication and coordination of care, which can ultimately impact on patient safety.

CRediT authorship contribution statement

Samantha Owen: Conceptualization, Methodology, Validation, Formal analysis, Writing – original draft, Visualization. **Julie Menzies:** Writing – review & editing. **Sarah Pontefract:** Conceptualization, Methodology, Validation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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