REVIEW

Medication errors in hospitals: a literature review of disruptions to nursing practice during medication administration

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Aims and objectives. The purpose of this review was to explore what is known about interruptions and distractions on medication administration in the context of undergraduate nurse education.

Background. Incidents and errors during the process of medication administration continue to be a substantial patient safety issue in health care settings internationally. Interruptions to the medication administration process have been identified as a leading cause of medication error. Literature recognises that some interruptions are unavoidable; therefore in an effort to reduce errors, it is essential understand how undergraduate nurses learn to manage interruptions to the medication administration process.

Design. Systematic, critical literature review.

Methods. Utilising the electronic databases, of Medline, Scopus, PubMed and CINAHL, and recognised quality assessment guidelines, 19 articles met the inclusion criteria. Search terms included: nurses, medication incidents or errors, interruptions, disruption, distractions and multitasking.

Results. Researchers have responded to the impact of interruptions and distractions on the medication administration by attempting to eliminate them. Despite the introduction of quality improvements, little is known about how nurses manage interruptions and distractions during medication administration or how they learn to do so. A significant gap in the literature exists in relation to innovative sustainable strategies that assist undergraduate nurses to learn how to safely and confidently manage interruptions in the clinical environment.

Conclusions. Study findings highlight the need for further exploration into the way nurses learn to manage interruptions and distractions during medication administration. This is essential given the critical relationship between interruptions and medication error rates.

Relevance to clinical practice. Better preparing nurses to safely fulfil the task of medication administration in the clinical environment, with increased confidence in the face of interruptions, could lead to a reduction in errors and concomitant improvements to patient safety.

What does this study contribute to the wider global clinical community?

- Provides insights into the lack of knowledge regarding how nurses currently manage interruptions during medication administration.
- Identifies the need for the development of sustainable programmes that include high quality learning experiences that teach interruption management techniques to undergraduate nurses in a safe environment.
- Identifies the need for further solution-focussed research into the impacts of interruptions on error interception rates.
- Highlights the need for research into the effects of interruptions on nonscheduled medication administrations.

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Introduction

Medication and intravenous fluid (IV) incidents and errors are the second most reported clinical incident in Australian health care settings. Figures from NSW, Australia, revealed 10,475 medication and IV incidents and errors over a six-month period (Clinical Excellence Commission & Health 2013). Similarly, medication incidents and errors remain a significant problem in North America, Canada and the UK (Kohn *et al.* 2000). An average of 450,000 preventable medication errors are reported each year from the USA (Flanders & Clark 2010). The Australian Commission on Safety and Quality in Health Care developed a set of 10 National Safety and Quality Health Service Standards aimed at improving the quality of care within the health care service (The Australian Commission on Safety and Quality in Health Care 2011). Standard number 4 addresses medication safety and outlines the need for systems to be implemented to ensure that the health care workforce are competent when administering medications, to reduce medication incidents and errors, improve safety and quality care for patients.

Interruptions to the medication administration (MA) process have been identified as one of the leading causes of medication errors (Reid-Searl *et al.* 2010). These errors have the potential to have long-term negative effects on the life of a patient, their relatives and the administering nurse, and result in financial burdens on the health care system (Roughead & Semple 2009). The primary responsibility for the majority of hospital-based MAs remains with the nursing staff (Palese *et al.* 2009, Reid-Searl *et al.* 2010). Combined with the inevitability of interruptions within the clinical environment (Flynn *et al.* 2012), the way in which the nursing staff learn to manage interruptions during MA is a key element in ensuring patient safety. Consequently, a literature review exploring the impact of interruptions and distractions on MA was undertaken in the context of undergraduate nurse education. Literature addressing how nurses currently learn to manage interruptions and distractions during MA was reviewed to identify existing gaps and encourage research into the identification of new strategies that may support this ongoing health care safety issue.

Background

Approximately 20% of all MAs result in error (Runciman *et al.* 2003, Reid-Searl & Happell 2012). In addition to reported errors, between one and two errors per patient per day remain unreported (Reid-Searl *et al.* 2010, Flynn *et al.* 2012). Financial and personal costs attached to these errors include increased lengths of stay, readmissions, patient mortality, postdischarge disability and emotional distress of the patient, relatives and administering nurse (Roughead & Semple 2009, Choo *et al.* 2010, Flynn *et al.* 2012).

There are five identifiable phases within the process of MA in which errors occur: prescription, transcription, dispensing, administering and monitoring patient condition/documenting (Choo *et al.* 2010, Jennings *et al.* 2011). The administration phase is particularly vulnerable to errors (Jennings *et al.* 2011). Simultaneous demands or interruptions during these complex processes, increases the likelihood of errors occurring (Choo *et al.* 2010).

Between 16 and 40% of nurses' time is engaged in MA (Potter *et al.* 2005, Westbrook *et al.* 2011). Jennings *et al.* (2011), p. 1448) highlight the fact that MA does not occur in isolation from other work and found that rather than consuming a set portion of the nurses' day, it was difficult to separate the impacts of MA from other tasks, and therefore concluded that MA in fact 'constitute[s] the day'. With this heavy emphasis on MA, the way interruptions to the process are managed impacts on nurses' ability to deliver safe and effective patient-centred care (Hayes *et al.* 2014).

Aim

The purpose of this review was to explore what is known about interruptions and distractions on MA in the context of undergraduate nurse education.

Methods

This review draws together and critically examines dominant and recurring themes existing in the literature in relation to the impact of interruptions and distractions on MA, and strategies used by undergraduate nurses to manage

them. It raises questions as to whether or not current strategies that aim to reduce or eliminate interruptions and distractions are appropriate as standalone measures to reduce interruption related medication errors in the clinical environment. To present a comprehensive background and advance the understanding of this multifaceted yet common problem in nursing, and highlight gaps in current knowledge a critical review approach was taken.

Combining both electronic and hand searching, a total of 1854 articles were retrieved. Duplicated articles were excluded ($n = 126$). Title review excluded literature reviews, studies specific to multidisciplinary teams, medical practitioners or other health care professionals ($n = 1549$). The remaining 179 studies were subject to abstract and/or full text review. Nonprimary research, discursive studies and those that were not specific to registered or undergraduate nurses or not related to interruptions or distractions, medication incidents and/or errors during MA were rejected. Studies considered to be methodologically unsound based on the Critical Appraisal Skills Program (CASP) checklists were also excluded (Critical Appraisal Skills Programme 2013). CASP guidelines were cross-referenced with studies in search of clear aims, appropriate methodology, recruitment strategy, record of ethical considerations and rigorously analysed data with clear findings. If these guidelines were not adequately addressed the study was excluded. As a result 160 studies were excluded, generating 19 studies which met the inclusion criteria (see Fig. 1). Analysis of the remaining articles was completed by the primary author, and validated by the entire author team.
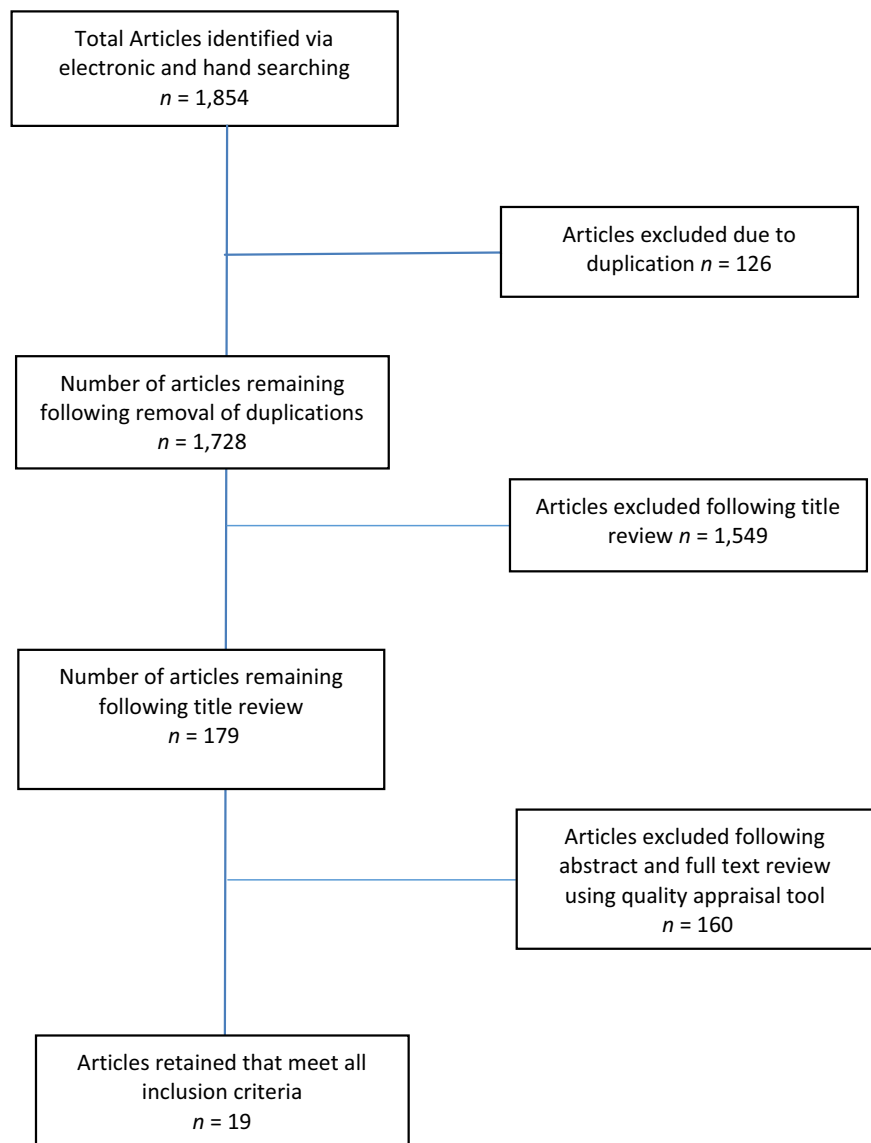

Figure 1 Retrieved articles.

Search strategy

The literature search was conducted utilising the online databases: Medline, Scopus, PubMed, CINAHL and Google scholar. In addition, the reference lists of retrieved articles were hand searched. Keywords included nurses, medication incidents or errors, interruptions, disruption, distractions and multitasking.

Inclusion criteria

Electronic literature searches were limited to English language, humans and articles published from Jan 2005–Dec 2012. Suitability for inclusion in the review was evaluated against clear inclusion and exclusion criteria (see Table 1). Included studies comprised peer-reviewed, research-based articles, where the domain was undergraduate nursing. Due to the scarcity of literature examining undergraduate nurses' responses to interruptions during MA, the search was broadened to include both registered and undergraduate nurses. The main focus of the articles was interruption, distraction, disruption, multitasking and/or MA.

Although interruptions and distractions during the MA process has been an issue for nurses for many decades, the recognition within the literature that interruptions are inevitable in the clinical environment is a reasonably new concept (Flynn *et al.* 2012), establishing the need to focus on safe and effective interruption management strategies. Literature reviews have examined characteristics and rates of interruptions, the relationship between interruptions and medication errors, and the effectiveness of interruption minimisation strategies (Biron *et al.* 2009, Brady *et al.* 2009, Raban & Westbrook 2014). However, strategies used by nurses to manage interruptions, and the way in which undergraduate nurses learn them, are yet to be reviewed.

Data analysis

Thematic analysis was chosen as it generates patterns or themes which can be categorised and analysed. The key advantages of thematic analysis for this study included the ability to identify both explicit and implicit themes. The analysis approach and final report involved several key steps as outlined by Guest *et al.* (2012). Broad/common themes and patterns were identified as the literature was read then re-read. This was followed by coding to identify recurring features of the literature. Each study was categorised according to the central themes, allowing deeper analysis and comparison. Themes were identified by the first author and validated through discussion with the writing

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Published in English Language	Not published in English language
Primary research article or thesis	Not considered be primary research
Published Jan 2005 onwards	Published prior to 2005
Specific to registered and undergraduate nurses	Not specific to registered or undergraduate nurses
Specific to interruptions, distractions or disruption	Not specific to interruptions, distractions or disruption
Specific to medication administration	Not specific to medication administration
Specific to medication incidents and/or errors	Not specific to medication incidents and/or errors

team until consensus was reached. Team discussion and consensus was considered to be an essential part of the process to minimise the risk of omitting outlying themes inherent when individual researcher interpretation is used to decide on codes, code application and central themes (Guest *et al.* 2012). The data findings from each article were then transcribed and interwoven.

Findings

Relevant literature included a combination of qualitative, quantitative and mixed methods studies (Table 3). Broad and recurring themes included frequency, types, causes and effects of interruptions, interruption elimination strategies and coping with interruptions. Four central themes were identified across studies: setting the scene – interruptions and distractions impacting care; reducing interruptions – current research responses; shifting focus – multitasking and prioritising and strategising care – managing interruptions.

Setting the scene – interruptions and distractions impacting care

Frequency and causes
Interruption or distraction of the administering nurse during the process of managing the six rights of MA (see Table 2) has been widely acknowledged as a leading cause of error (Deans 2005, Biron *et al.* 2009, Westbrook *et al.* 2010). In fact 'Setting the scene – interruptions and distractions impacting care' was identified as a theme in 18:19 of reviewed studies. Between 25 and 55% of MAs are subject to interruption (Palese *et al.* 2009, Kalisch & Aebersold 2010, Westbrook *et al.* 2010). A recent Australian study conducted in two major teaching hospitals, reported that nearly 85% of interrupted MAs resulted in either clinical error (e.g. wrong dose, timing or route) or procedural error

Table 2 Six rights of medication administration (Woodrow *et al.* 2010)

Right
Patient
Drug
Dose
Time
Route
Documentation

(e.g. not checking patient identification, or inadequate hand hygiene) or both (Westbrook *et al.* 2010). Fry and Dacey (2007), reported that 94% (127:135) of study participants felt distractions during MA had an impact on medication incidents. The impact of interruptions to nurses' work was examined by Westbrook *et al.* (2011). They found that the number of interruptions during MA were over-represented compared to other nursing tasks.

In a descriptive observational study, Biron *et al.* (2009) reported an average frequency of 6·3 interruptions/hour during MA. The preparation phase produced 5·2 interruptions/hour with an increased risk rate of error of 60%. During the administration phase 6·8 interruptions/hour were recorded. Error rates were reported per administration in another study of 56 observed MA rounds, at rate of one interruption for every 3·2 medications administered (Palese *et al.* 2009). Observational data collected over 46 hours in two hospitals, revealed that nurses were interrupted by patients 28% of the time and were initiated by the administering nurse up to 30% of the time (Kalisch & Aebersold 2010). Anthony *et al.* (2010) reported similar self-initiated interruptions rates of 26·4%. Self-initiated interruptions may include occurrences of communication unrelated to the MA, being distracted by events occurring in proximity to the administering nurse, or unexplained loss of focus (Anthony *et al.* 2010). Other nurses have been identified as accounting for 22·3–25% of interruptions, and other members of the health care team 25–26·2% (Kalisch & Aebersold 2010, McGillis Hall *et al.* 2010a). Figures as high as 73·6% of interruptions being initiated by someone other than the administering nurse have been reported (Anthony *et al.* 2010).

The types and causes of medication errors were described by Deans (2005) as resulting from three key factors; environmental, e.g. interruptions and distractions (25·3%); human, e.g. stress (25·3%); and miscommunication, e.g. illegible handwriting (16·5%). Interruptions that stem directly from the MA procedure itself were identified by Jennings *et al.* (2011). These included medications requiring varying routes of administration; unavailable medications

and medications that require patient monitoring. Secondary tasks causing interruption were triggered by a range of causes, the most significant being direct patient care issues. Moreover, 88% (118:134) of participants in a cross-sectional survey of registered nurses stated interruptions by patients were the most challenging, and 87% (116:134) felt phone calls were the next most distracting interruption (Fry & Dacey 2007).

In a study of 945 MAs over a three-month period, interruptions during MA differed in cause and frequency according to time of day (Palese *et al.* 2009). Obtaining medications that were not on the trolley dominated as interruptions to early morning (38·5%) and mid-afternoon (26·4%) administrations. However, patient management issues dominated as interruptions to mid-morning (33·3%) and early evening (34·4%) administrations. Technology such as intravenous pumps and monitors alarming, have also been identified as a source of interruptions during MA (Biron *et al.* 2009, McGillis Hall *et al.* 2010a, Relihan *et al.* 2010).

Undergraduate nurses are a significant sub-group within the nursing workforce who, under the direct supervision of registered nurses, administer medications in clinical environments. A review of 1305 incidents/errors that had been made by undergraduate nurses during MA over a five-year period revealed the most significant of the contributing factors to be inexperience (77·1%) and distraction (20·5%) (Wolf *et al.* 2006).

Effects

Increasing number of interruptions were linked to increasing error rates in an observational study in two Australian hospitals (Westbrook *et al.* 2010). Of the 4271 administrations observed, only 19·8% were found to be error free. Just over half (53·1%) were subject to interruptions. The observed error rate increased in direct relationship with the number of interruptions experienced. When exposed to one interruption, a procedural error followed in 82·1% of cases and a clinical error in 43·5% of cases. As the number of interruptions increased so did the error percentages. Procedural errors were observed at 100% when there were between two and three interruptions, and when there were between four and five interruptions clinical errors were observed in 70% of the cases. Westbrook *et al.* (2010) also found that as interruption numbers intensified so did the severity of the errors, doubling when the interruption rate reached four or more per administration attempt.

Limited studies are available in relation to the effects of interruptions on medications administrations by undergrad-

uate nurses. However, undergraduate nurse participants (9:28) in one Australian study reported an error or near miss occurring while they or their supervising registered nurse was interrupted or distracted in some way (Reid-Searl *et al.* 2010).

Inevitability, outcomes and limitations

Medication interruptions and distractions appear to be inevitable in the clinical environment (Flynn *et al.* 2012); in fact the very process by which one attempts to control interruptions can become an interruption in and of itself (Tucker & Spear 2006, McGillis Hall *et al.* 2010a, Jennings *et al.* 2011). It should be acknowledged, however, that some interruptions can have positive outcomes for patient care (Jennings *et al.* 2011). McGillis Hall *et al.* (2010b) reported that 10·8% (83:1687) of observed interruptions had the potential to improve patient care, e.g. a patient may question the accuracy of medications being administered, preventing a medication error. These findings were reflected in the parent study where 10% (1315:13,025) of observed interruptions were considered to have had a positive impact (McGillis Hall *et al.* 2010a). It was noted during the course of the review that although discussed these assertions were not elaborated on. Nurses are the largest group of health professionals responsible for administering medications in hospitals, and as such are in a key position to identify, prevent or intercept errors before they occur, irrespective of the cause, through appropriate attention to and prioritisation of interruptions (Eisenhauer *et al.* 2007, Jennings *et al.* 2011, Flynn *et al.* 2012).

The majority of research in this area focuses on scheduled medication rounds. There was a paucity of studies distinguishing between the effects of interruption and distractions on scheduled and unscheduled MAs. Unscheduled medications can be either STAT/satim (required immediately) or PRN/pro re nata (as required). Jennings *et al.* (2011) highlighted the distinction between scheduled and unscheduled MAs in relation to actual administration numbers but did not identify any differences in error rates. They reported an average of 22 to 25 scheduled doses per patient to be administered, with STAT or PRN doses accounting for between 7–14% of the recorded doses.

One key limitation within the reviewed studies for this theme related to the method of data collection. None of the studies collected data on weekends or night duty. It may be possible that the behaviours of nurses during MA vary outside of what is considered 'normal working hours', this represents a significant gap in the literature. Research is needed to address differences in interruption rates, and related error rates, between scheduled and unscheduled MAs.

Reducing interruptions – current research responses

In response to research findings indicating that interruptions and distractions to the MA process are one of the leading causes of error, current research continues to focus on prevention of errors by utilising strategies that aim to reduce or eliminate interruptions and distractions to the administering nurse (Pape *et al.* 2005, Biron *et al.* 2009, Anthony *et al.* 2010, Relihan *et al.* 2010, Westbrook *et al.* 2010). This was identified as a theme in 5:19 of the studies reviewed. Several current strategies such as wearing tabards asserting 'do not disturb', and creating 'no interruption zones' (NIZ) are based on the 'sterile cockpit rule'; an aviation industry innovation to eliminate distractions in the cockpit area during take-off and landing. The premise of adopting this approach is that eradicating interruptions during MA will prevent errors (Anthony *et al.* 2010, Relihan *et al.* 2010).

Anthony *et al.* (2010) reported a 40·9% decrease in overall interruptions following introduction of NIZ. Following the introduction of the intervention 100% of interruptions were reported as being initiated by someone other than the administering nurse. Relihan *et al.* (2010) also noted decreases in interruptions from 26/hour to 11·4/hour following the introduction of a range of interventions. These interventions included checklists, signage, staff education and behaviour modification, as well as discouraging patients, relatives and other health care professionals from interrupting nurses during MA. However, it was not outlined within the study which of the reported interventions specifically affected interruption rates, nor if some where more successful than others. One would need to maintain caution when considering implementing any of the interventions in this study without further research and clarification.

While all of these studies were able to report a decrease in the interruption rates during MA following the introduction of the interventions, direct links to the decreased medication error rates are tenuous. Interruptions though decreased in number, were not eliminated in the reviewed literature. The inevitability of interruptions and the concurrent need for nurses to be taught to manage interruptions effectively is reinforced by these findings. The impact and sustainability of these strategies over the long-term is also an issue for consideration.

Shifting focus – multitasking and prioritisation

Multitasking involves the performance of concurrent thoughts or tasks (Jennings *et al.* 2011). The clinical nursing environment includes frequent interruptions and requires regular multitasking (Kalisch & Aebersold 2010).

Table 3 Summary of articles meeting inclusion criteria – as several studies incorporated multiple themes articles are presented alphabetically

Author, year, country	Purpose of study	Sample and setting	Design and methods	Key findings	Limitations	Themes captured in this study
Anthony, K., Wiencek, C., Bauer, C., Dal, B. and Anthony, M.K. 2010, United States	Evaluated the impact of no interruption zones during MA (medication administration)	2 × 20 bed intensive care units	Quasi experimental pilot study. Three phase study	Postintervention decrease in interruption rates of 40·9%	Conducted only in intensive care units. Short period of data collection. Data collected by member of team being observed. Observation periods allocated by unit manager. Hawthorne effect	Setting the scene- interruptions and distractions impacting care. Reducing interruptions – current research responses
Biron, A.D., Lavoie-Temblay, M. & Loiselle, C.G. 2009, Canada	Identified characteristics and frequency of interruptions during MA	18 Registered nurses from a medical ward in a tertiary teaching hospital, with minimum 6 months experience	Descriptive direct observational study. 102 MA rounds over 59·5 hours	Identifies MA as one of the most often interrupted nursing activities and links this to a 60% increased risk rate of error. Overall interruption rate of 6·3/hour. Acknowledges that nurses need to learn to identify, prioritise and learn to manage interruptions at the undergraduate level and that little is known about management strategies used by nurses	One hospital one ward. Convenience sampling. Hawthorne effect	Setting the scene- interruptions and distractions impacting care. Reducing interruptions – current research responses Strategizing care – managing interruptions
Deans, C. 2005, Australia	Identified and described the incidence, type and causes of medication errors	79:154 registered nurses. Three surgical, two medical and one palliative care wards	Self-reporting survey: qualitative and quantitative responses	Identified types and three leading causes of errors: miscommunication, human factors and environmental factors. Also identified error reporting behaviours	Single regional hospital. Self-reporting surveys. Unreported errors were not considered	Setting the scene- interruptions and distractions impacting care
Eisenhauer, L.A., Hurley, A.C. and Dolan, N. 2007, United States	Explored thinking processes of nurses during MA and impacts of point of care technology	40 registered nurses' within a variety of wards in a tertiary teaching hospital	Pre- and postintervention, retrospective semi-structured interviews and real time recorded thought processes	Behaviour changes noted following introduction of bar coding. Participants thinking processes unchanged. Identified 10 characteristics of thinking	Sample included only experienced nurses	Setting the scene- interruptions and distractions impacting care. Shifting focus – multitasking and prioritising
Flynn, L., Liang, Y., Dickson, G.L., Xie, M. and Suh, D.C. 2012, United States	Explored the effects of staffing levels, environment and medication error interception rates	686 nurses from 82 medical/surgical units in 14 hospitals	Nonexperimental mixed methods study over an 8 month period	Nurse interception rates impacted error rates	Out of hour's administrations not captured. Hawthorne effect	Setting the scene- interruptions and distractions impacting care

Table 3 (continued)

Author, year, country	Purpose of study	Sample and setting	Design and methods	Key findings	Limitations	Themes captured in this study
Fry, M.M. and Dacey, C. 2007, England	Explored reporting habits and causes of medication incidents and errors	139 of 240 registered nurses in 15 medical wards in a teaching hospital	Quantitative cross-sectional survey	33% reported involvement in medication incidents. 94% of participants stated distractions impacted on incidents/errors	The experience level of the pilot study participants was not equivalent to that of the actual study participants	Setting the scene- interruptions and distractions impacting care
Jennings, B.M. Sandelowski, M. & Mark, B. 2011, United States	Explored complexities involved in MA	143 registered nurses and 18 licenced practicing nurses. one surgical and one medical ward	Ethnographic observational study. 267 hours of field observations, 29, 1-hour interviews	Both MA and other 'nursing work' can interrupt each other and do not occur in isolation. Describes management techniques by registered nurses	Hawthorne effect. Limitations of the study were not reported by the authors	Setting the scene- interruptions and distractions impacting care. Strategising care – managing interruptions Shifting focus – multitasking and prioritising
Kalisch, B.J. and Aebersold, M. 2010, United States	Explores the extent of interruptions, measured multitasking and links with errors	36 RN's in two hospitals, seven wards	Direct observational field design. 136 hours of observation	Total of 3441 events, 1354 hours of multitasking and 200 observed errors. 10 interruptions observed/hour (one every 6 mins). 28% of interruptions by patients; 25% by other nurses. Errors associated with interruptions and multitasking observed 34% of the time. Overall error rate of 1·5/hour	No night duty observations recorded. Hawthorne effect. Observer error possible	Setting the scene- interruptions and distractions impacting care. Shifting focus – multitasking and prioritising
McGillis Hall, L., Pedersen, C., and Fairley, L. 2010, Canada.	Explored interruptions to nurses' work	Six medical and surgical wards in three acute care teaching hospitals. 30 nurses observed, 29 attended focus groups	Mixed methods study using observations and focus groups	Total number of interruptions observed over 2 week period was 1687. Leading causes: other nurses, and other health care professionals. 10·8% of the interruptions noted to have the potential to improve patient safety outcomes	Constitutes part of a larger study. Limitations were not reported by the authors	Setting the scene- interruptions and distractions impacting care
McGillis Hall, L., Feguson-Pare, M., Peter, E., White, D., et al. 2010, Canada	Observed interruptions to nurses work and related outcomes	360 nurses, 113 attending focus groups. 36 medical and surgical wards over nine hospitals	Mixed methods using 2880 hours of observation over a 2 week period, and focus groups	13,025 interruption observed. Causes: administering nurse, other nurses and other members of the health care team. 10% of interruptions resulted in positive outcomes	Hawthorne effect	Setting the scene- interruptions and distractions impacting care

Table 3 (continued)

Author, year, country	Purpose of study	Sample and setting	Design and methods	Key findings	Limitations	Themes captured in this study
Palese, A., Sartor, A. Costeraria, G. and Bresadola, V. 2009, Italy	Examined interruption frequency during medication rounds	56 medication rounds; eight rounds in each of seven surgical wards	Observational study	945 MA's observed, one interruption/3·2 administrations. Interruption frequency and causes dependent on number of drugs administered and time of day. 96% were managed immediately by administering nurse, 3·6% managed on completion of medication round and 0·3% delegated to other staff	Conducted only in surgical wards. No documented training of data collectors. No night duty observations collected	Setting the scene- interruptions and distractions impacting care. Strategising care – managing interruptions
Pape, T.M., Guerra, D.M., Muzquiz, M., Bryant, J.B., Ingram, M., et al. 2005, United States	Explored the impact of signage, checklists and set protocols on distractions during MA	Seventy-eight nurses, five wards, one hospital	Process improvement study using a self-reporting distraction instrument. Also included observations of randomly selected nurses	81% nurses avoided distractions and interruptions when using the set protocols. Medical practioners continued to cause interruption or distraction regardless of interventions	Individual impact of each intervention unclear. Hawthorne effect. No night duty or weekend observations collected	Reducing interruptions – current research responses
Potter, P., Wolf, L., Boxerman, S., Grayson, D., Sledge, J., Dungan, C. and Evanoff, B. 2005, United States	Analysed the characteristics of nurses' cognitive load and environmental factors causing disruption and increased risks of errors	Seven registered nurses in a large tertiary hospital	Mixed methods (43 hours field observation and summative interviews), ethnographic study	16% of nurses time involved in MA. Overall average of nine cognitive shifts/hour or every 6–7 mins, majority occurring during MA	Small nonrandomised sample observed over short period of time. Primary researcher was the lead observer in the field	Setting the scene- interruptions and distractions impacting care. Shifting focus – multitasking and prioritising
Reid-Searle, K., Moxham, L. and Happell, B. 2010, Australia	Explored factors influencing MA practices by nursing students	28 final year undergraduate nursing students in one university	Qualitative in-depth semi-structured interviews	9.28 reported either making a medication error or being involved in a near miss. In most cases the errors occurred as a result of inadequate RN supervision	Participants from single university	Setting the scene- interruptions and distractions impacting care. Strategizing care – managing interruptions
Relihan, E., O'Brien, V., O'Hara, S. and Silke, B. 2010, Ireland	Assessed if interruptions and distractions during MA decrease as a result of the introduction of a set of interventions	31 nurses in 59 bed medical unit in an acute teaching hospital	Pre- and postintervention observational study over 30·5 hours	Identified 10 sources of interruption and that the source of interruption impacted the effectiveness of the interventions. The overall most significant source of interruptions was nurses themselves. Overall decrease in interruptions postintervention	Conducted in one high dependency ward. Hawthorne effect. No control group. Individual impact of each intervention unclear	Setting the scene- interruptions and distractions impacting care. Reducing interruptions – current research responses

Table 3 (continued)

Author, year, country	Purpose of study	Sample and setting	Design and methods	Key findings	Limitations	Themes captured in this study
Tucker, A.L. and Spear, S.J. 2006, United States	Examined nurse productivity related to hospital work systems	Three phases: 11 nurses, six hospitals observed for average of 9 hours; 6 of those 11 nurses interviewed; 520 nurses from 21 hospitals surveyed	Mixed methods – direct observation, interview and survey	95% of interruptions caused by patient care issues and family members. On average nurses were observed to experience 8·4 operational failures/8 hour shift, most frequently during MA	Purposeful sampling of both observed and interviewed nurses by unit manager. Hawthorne effect	Setting the scene- interruptions and distractions impacting care. Strategising care – managing interruptions
Westbrook, J.I., Woods, A., Dunsmuir, W.T.M. and Day, R.O. 2010, Australia	Explored the impact of interruptions during MA on error rates	98 of 120 nurses from six wards in two major teaching hospitals. 4271 MAs	Observational study conducted over 520 hours	53% of administrations interrupted. Overall error rates: 1/pt/day. 74·4% procedural errors; 25% clinical errors. Overall interruptions increased procedural errors by 12·1% and clinical errors by 12·7%	Hawthorne effect. No night duty or weekend observations collected	Setting the scene- interruptions and distractions impacting care. Reducing interruptions – current research responses
Westbrook, J.I., Duffield, C., Ling, L. and Creswick, N. J. 2011, Australia	Reviewed how nurses distribute time across tasks	Fifty-seven nurses, two wards in one hospital	Prospective observational study over 191 hours	Nurses spent 19% of their time on medication related tasks yet attracted 27% of interruptions. Multitasking was reported in 25% of medication tasks	Single hospital. Hawthorne effect. No night duty or weekend observations collected	Setting the scene- interruptions and distractions impacting care. Shifting focus – multitasking and prioritising
Wolf, Z.R., Hicks, R. and Serembus, J.F. 2008, United States	Reviewed the characteristics of medication errors made by nursing students during MA	Analysis of 1305 incidents or errors made by student nurses	Descriptive retrospective study over a 5 year period	Leading factors contributing to errors: inexperience of staff, and distraction. 70·57% of errors reached patient with in harmful effects. 25–59% of errors required extra care to be provided to patients. 3·83% of errors prevented prior to reaching the patient	Data were voluntarily reported	Setting the scene- interruptions and distractions impacting care. Strategising care – managing interruptions

Indeed, nurses have been described as 'multitasking in action and thought' (Eisenhauer *et al.* 2007, p. 86). This theme was identified in 5:19 studies.

In a study measuring the number and types of interruptions in the nurses' working day, the extent of multitasking and the errors that resulted, registered nurses were observed to be involved in multitasking 34% of the time; 13% of the time during MA with an average error rate of 1·5 errors/hour (Kalisch & Aebersold 2010). Westbrook *et al.* (2011) found that nurses were engaged in multitasking 25% of the time they spent in medication related tasks. Cognitive shifts, or shifts in focus, were reported by Potter *et al.* (2005) while observing nurses' cognitive load, they occurred at an average rate of nine/hour or every six to seven minutes; the majority occurring during MA. Jennings *et al.* (2011) support these findings, reinforcing that nurses have to manage a variety of competing tasks simultaneously rather than consecutively. It has been suggested that to work effectively as a nurse, requires the ability to engage in multiple tasks and cognitive shifts during the course of the day, while being subjected to interruptions that may mean rapid shifts in focus from one patient to another (Potter *et al.* 2005, Kalisch & Aebersold 2010).

Despite the recognition that prioritising care and multitasking skills are essential in providing safe care during MA, literature specifically addressing how nurses learn these skills during MA remains unavailable. There is a clear need for targeted approaches that further unpack the effects of multitasking and managing interruptions on the cognitive thought process occurring of both registered and undergraduate nurses during MA.

Strategising care – managing interruptions

Nurses encounter multiple interruptions in the course of their day, and are expected to manage these to function effectively, while making sound clinical judgments and performing MA (Kalisch & Aebersold 2010, Jennings *et al.* 2011). It has been recognised that little is known about strategies used by nurses to manage interruptions and that nurses need to learn to identify, prioritise and then manage interruptions at the undergraduate level (Tucker & Spear 2006, Biron *et al.* 2009). Limited studies exist in this area and are specific to registered nurses. Elements of this theme were identified in 5:19 studies.

In an observational study of registered nurses in Italy, the frequency, causes and risk of interruptions leading to errors, along with nurses' management techniques during MA, were examined (Palese *et al.* 2009). Interruption management techniques observed in the study showed that:

96% were managed immediately by the administering nurse, 0·3% were delegated to other staff members and 3·7% were managed at completion of the medication round. Although the study outlined when and by whom, the interruptions were managed, specific management techniques were described on only one occasion. This involved delegation to another staff member, limiting the readers understanding of the interruption management techniques and thought processes used by the nurses.

An ethnographic observational study by Jennings *et al.* (2011) identified techniques used by registered nurses to manage what are described as temporal and physical demands that occur in tandem with MA. Prioritisation and re-prioritisation, multitasking, grouping of tasks and task sequences, and working around systems to expedite MAs were reported as strategies experienced nurses use to manage their time and improve work flow in the face of interruptions (Jennings *et al.* 2011). Reprioritisation was also observed by Tucker and Spear (2006) as a method nurses used to adapt to changing patient needs within any given shift. They also described 'interweaving' which involved moving between multiple patients to administer care (p. 5). How and when the nurses learnt these skills was not reported in the study.

Discussion

The literature reviewed in this study explores the impact of interruptions and distractions on MA, current research responses to those impacts and techniques used by nurses to manage those interruptions and distractions. Due to the nature of nursing, interruptions and distractions to the MA process are part of the nurses' everyday work. While designing, implementing and evaluating strategies to reduce and eliminate interruptions may appear to be efficacious, current approaches have neglected to acknowledge the complexity of the health care system or the dynamic nature of the interaction that occurs between nurse and patient (Jennings *et al.* 2011, Hayes *et al.* 2014).

The complexities of nursing practice require that nurses are available to their patients, rather than undisturbed and consequently isolated from them. Strategies that work successfully to eliminate interruptions for other professional groups, such as the sterile cockpit for pilots, are not necessarily appropriate or directly transferrable to the nursing environment (Hayes *et al.* 2014). It is not possible, or in some cases in the patients best interest, to eliminate all interruptions and distractions from the task of MA (Tucker & Spear 2006, McGillis Hall *et al.* 2010a). The development of sustainable programmes that include high quality learning

experiences teaching interruption management strategies in a safe environment is required.

Attempting to reduce medication errors that occur as a result of interruptions or distractions requires that the theory behind MA be considered. Current theory related to MA, commonly known as the six rights of MA (Woodrow *et al.* 2010) assumes through omission, that nurses will be left to administer medications in a calm, uninterrupted environment. Undergraduate nurses are currently taught the related mathematics and pharmacology, along with how to administer the six rights of MA in a clinical laboratory. Although it is each nurse's responsibility to ensure patient safety by following the six rights, it is not a stand-alone skill. Of significance is the dynamic context in which nurses actually work. This includes the nurses' ability to appropriately manage interruptions *when* they occur, and recognise and intercept potential errors *before* they occur.

Limited studies provided insights into understanding how registered nurses respond to or manage interruptions during MA, and where interruption management strategies were identified, how and when nurses learnt them was not (Tucker & Spear 2006, Jennings *et al.* 2011). No primary research articles were located specific to undergraduate nurses. The scarce number of studies unpacking concepts such as prioritisation, re-prioritisation and multitasking, in relation to MA for either registered or undergraduate nurses provides a clear gap in the research literature.

Of further concern is the sole focus on reducing or eliminating interruptions during 'scheduled' MAs. There is a significant gap in the literature pertaining to 'unscheduled' MAs. Jennings *et al.* (2011) made the distinction between the number of MA occurrences in scheduled and unscheduled administrations. However, they did not discuss the differences between scheduled and unscheduled administrations in relation to the impacts of interruptions and distractions or the relationship with error rates. Further research would verify if differences exist, and whether or not nurses require different skills to manage them.

Clinical competence related to MA requires the ability to make 'independent, quick and correct decisions' and to be able to 'act out of the box' (Schmalenberg *et al.* 2008, p. 57). This involves being able to listen, think and act simultaneously, all within a rapidly changing environment, and to be able to multitask when faced with interruptions. These concepts were identified in a study reporting on the findings from three linked studies reviewing structures for best practice. It found that of all the educational opportunities afforded to registered nurses at all eight institutions involved in the study, prioritising care and multitasking

were the only areas lacking adequate educational input (Schmalenberg *et al.* 2008). To be able to successfully accomplish the possible multiple cognitive shifts of focus that are at times required, and to be considered clinically competent, nurses need to be taught these skills at an undergraduate level.

Interruption reduction rates resulting from various intervention strategies were noted in several studies (Pape *et al.* 2005, Biron *et al.* 2009, Anthony *et al.* 2010, Relihan *et al.* 2010). However, conclusive evidence of individual strategies being responsible for decreased rates of interruption or error were difficult to establish. This was due to the clustering of interventions, along with a lack of pre- and postcontrolled design studies. As such further research is required where individual strategies are comprehensively examined. Findings of these studies, and as a result the efficacy of each strategy, would be further enhanced if data were available directly linking the introduction of the intervention to medication error rate reduction.

Thirteen of the included studies incorporated observational data. The Hawthorne effect must be taken into consideration when interpreting and generalising these results (Polit & Tatano Beck 2014). Further to this, the majority of data collected includes week day and evening shifts. This is an important confounder as behaviours around MA may vary on weekends and night duty leaving a gap for further research potential.

The leading causes of medication incidents and errors within the undergraduate nursing cohort have been identified. They include inexperience, combined with insufficient time spent in the clinical environment, and inadequate supervision (Wolf *et al.* 2006, Reid-Searl *et al.* 2010). Effective carefully supervised education during undergraduate study would offer nurses the opportunity to develop skills that better enable them to fulfil the task of MA confidently and safely. Practical and sustainable interventions that take into consideration the inevitability of interruptions during MA, require consideration within the broader health care environment (Hayes *et al.* 2014). This includes skills that focus on learning to navigate deviations such as interruptions, distractions and multitasking; and encourage transfer of the knowledge and skills gained to the clinical setting (Reid-Searl *et al.* 2010).

Limitations

MA errors in the hospital environment have been a long-standing issue for nurses and as such there are a multitude of studies discussing and researching this topic dating back for many years. This review only included studies dating

from 2005 and, therefore, may have omitted some relevant older research. The inclusion of studies published in English language only may have further limited the number of studies examined. As the focus of this study was registered and undergraduate nurses, literature related to enrolled nurses, endorsed enrolled nurses and those in other nursing roles who also administer medication within hospital environments was not included and is an area for further study.

Recommendations

A combination of strategies, involving interruption reduction techniques along with well-designed programmes teaching nurses strategies to manage, and appropriately prioritise, in the face of interruptions is necessary to improve patient safety around MA. However, there is a paucity of research combining these concepts. The limited studies that are available are specific to registered nurses. There is a significant gap in the literature pertaining to undergraduate nursing students.

The issue of how we adequately educate nurses to manage interruptions, and prioritise according to individual patient needs, through critical thinking, analysis and assessment of each individual situation, needs further exploration (Hayes *et al.* 2014). It is incumbent on nurse educators to equip nurses to take human factors such as distraction and interruption into consideration, and understand the role these factors play in the risk of medication error.

There is a need for studies that explore the impact of innovative educational experiences that enhance nurses' ability to manage interruptions, distractions and multitasking during MA. The critical relationship between these strategies and error rate reduction also requires further examination (Westbrook *et al.* 2010).

Relevance to clinical practice

Acknowledging that interruptions and distractions are not only one of the leading causes of medication errors, but are also inevitable during MA, is vital to patient safety. This literature review has revealed that a significant gap in the literature exists in relation to innovative sustainable solutions that aim to teach undergraduate nurses how to safely and confidently manage interruptions in the clinical environment.

Conclusion

Administering medications involves processes that require multiple clinical judgments, professional vigilance and critical thinking. The task of MA occurs in a dynamic often chaotic environment. Nurses need to be able to manage more than one task at a time while maintaining clinical competence and patient safety, including during the process of MA.

Understanding the responsibility to manage human factors such as interruptions that may impact the safe delivery of medications and patient care is an integral part of the MA process. Adapting and utilising interruption and distraction reduction strategies, along with existing and emerging teaching methods to enhance the nurses' ability to navigate their way through situations where interruptions and distractions are inevitable, and multitasking unavoidable, may be the key to effectively empowering nurses to manage interruptions and distractions during MA.

Contributions

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Conflict of interest

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