

TITLE PAGE

Interruptions and distractions associated with medication administration errors: a literature review.

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

ABSTRACT

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 recognizes 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: Utilizing 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 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.

KEYWORDS

Nurses, medication errors, interruptions, disruption, distractions, multitasking.

WHAT DOES THIS PAPER 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 programs 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 non-scheduled medication administrations.

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 United Kingdom (Kohn, Corrigan & Donaldson 2000). An average of 450,000 preventable medication errors are reported each year from the United States (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 healthcare 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 healthcare 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, Moxham & Happell 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 (Roughed & Semple 2009). The primary responsibility for the majority of hospital based medication administrations remains with nursing staff (Palese et al. 2009; Reid-Searl, Moxham & Happell 2010). Combined with the inevitability of interruptions within the clinical environment (Flynn et al. 2012), the way in which 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 in order 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 medication administrations result in error (Reid-Searl & Happell 2012; Runciman et al. 2003). In addition to reported errors, between one and two errors per patient per day remain unreported (Flynn et al. 2012; Reid-Searl, Moxham & Happell 2010). Financial and personal costs attached to these errors include increased lengths of stay, readmissions, patient mortality, post discharge disability, and emotional distress of

the patient, relatives, and administering nurse (Choo, Hutchinson & Bucknall 2010; Flynn et al. 2012; Roughead & Semple 2009).

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

Between 16 and 40% of nurses' time is engaged in MA (Potter et al. 2005; Westbrook et al. 2011). Jennings, Sandelowski and Mark (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 medication administration 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. In order 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 1,854 articles were retrieved. Duplicated articles were excluded (n=126). Title review excluded literature reviews, papers specific to multidisciplinary teams, medical practitioners, or other health care professionals (n=1549). The remaining 179 papers were subject to abstract and/or full text review. Non-primary research, discursive papers 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 papers 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 paper was excluded. As a result 160 papers were excluded, generating 19 studies which met the inclusion criteria (see figure 1). Analysis of the remaining articles was completed by the primary author, and validated by the entire author team.

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 to 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 (Brady, Malone & Fleming 2009, Biron, Loiselle and Lavoie-Tremblay 2009, Raban and 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, McQueen, and Namey (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 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, McQueen, & Namey 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. 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 strategizing 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 (Biron, Lavoie-Tremblay & Loiselle 2009; Deans 2005; Westbrook et al. 2010). In fact 'Setting the scene - interruptions and distractions impacting care' was identified as a theme in 18:19 of reviewed papers. Between 25% and 55% of medication administrations are subject to interruption (Kalisch & Aebbersold 2010; Palese et al. 2009; Westbrook et al. 2010). A recent Australian study conducted in two major teaching hospitals, reported that nearly 85% of interrupted medication administrations resulted in

either clinical error (e.g. wrong dose, timing, or route) or procedural error (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 numbers of interruptions during MA were over-represented compared to other nursing tasks.

In a descriptive observational study, Biron, Lavoie-Tremblay and Loiselle (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 healthcare team 25% - 26.2% (Kalisch & Aebersold 2010; McGillis Hall et al. 2010). 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, Sandelowski and Mark (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 medication administrations 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. Whereas 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, Lavoie-Tremblay & Loiselle 2009; McGillis Hall et al. 2010; 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 1,305 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, Hicks & Serembus 2006).

Effects: Increasing numbers 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 to 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 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 undergraduate 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, Moxham & Happell 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. 2010; Jennings, Sandelowski & Mark 2011). It should be acknowledged however that some interruptions can have positive outcomes for patient care (Jennings, Sandelowski & Mark 2011). McGillis Hall, Pedersen and Fairley (2010) reported that 10.8% (83:1,687) 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% (1,315: 13,025) of observed interruptions were considered to have had a positive impact (McGillis Hall *et al.* 2010). 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, Hurley & Dolan 2007; Jennings, Sandelowski & Mark 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 medication administrations. Unscheduled medications can be either STAT/statim (required immediately) or PRN/pro re nata (as required). Jennings, Sandelowski and Mark (2011) highlighted the distinction between scheduled and unscheduled medication administrations 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 medication administrations.

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, Lavoie-Tremblay & Loiselle 2009; Anthony *et al.* 2010; Relihan *et al.* 2010; Westbrook *et al.* 2010). This was identified as a theme in 5:19 of the papers 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 behavior 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 were 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 interruption rates during MA following the introduction of the interventions, direct links to 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, Sandelowski & Mark 2011). The clinical nursing environment includes frequent interruptions and requires regular multitasking (Kalisch & Aebersold 2010). Indeed, nurses have been described as “multitasking in action and thought” (Eisenhauer, Hurley & Dolan 2007, p. 86). This theme was identified in 5:19 papers.

In a study measuring numbers 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) whilst observing nurses’ cognitive load, they occurred at an average rate of 9/hour or every six-seven minutes; the majority occurring during MA. Jennings, Sandelowski and Mark (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 subject 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.

Strategizing 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, Sandelowski & Mark 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, Lavoie-Tremblay & Loiselle 2009). Limited studies exist in this area and are specific to registered nurses. Elements of this theme were identified in 5:19 papers.

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, Sandelowski and Mark (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 medication administrations were reported as strategies experienced nurses utilise to manage their time and improve work flow in the face of interruptions (Jennings, Sandelowski & Mark 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 paper 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. Whilst 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, Sandelowski & Mark 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.* 2010). The development of sustainable programs 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, Colbert & Smith 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 standalone 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 (Jennings, Sandelowski & Mark 2011; Tucker & Spear 2006). No primary research papers 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' medication administrations. There is a significant gap in the literature pertaining to 'unscheduled' medication administrations. Jennings, Sandelowski and Mark (2011) made the distinction between the numbers 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 to 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 paper 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 (Anthony et al. 2010; Biron, Lavoie-Tremblay & Loiselle 2009; Pape et al. 2005; 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 post controlled 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 was 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 generalizing 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, Hicks & Serembus 2006; Reid-Searl, Moxham & Happell 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, Moxham & Happell 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 papers 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 programs 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 multi-tasking during MA. The critical relationship between these strategies and error rate reduction also requires further examination (Westbrook, Woods, 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 medication administration occurs in a dynamic often chaotic environment. Nurses need to be able to manage more than one task at a time whilst 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 utilizing 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 multi-tasking unavoidable,

may be the key to effectively empowering nurses to manage interruptions and distractions during MA.

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Figure 1 – Retrieved articles

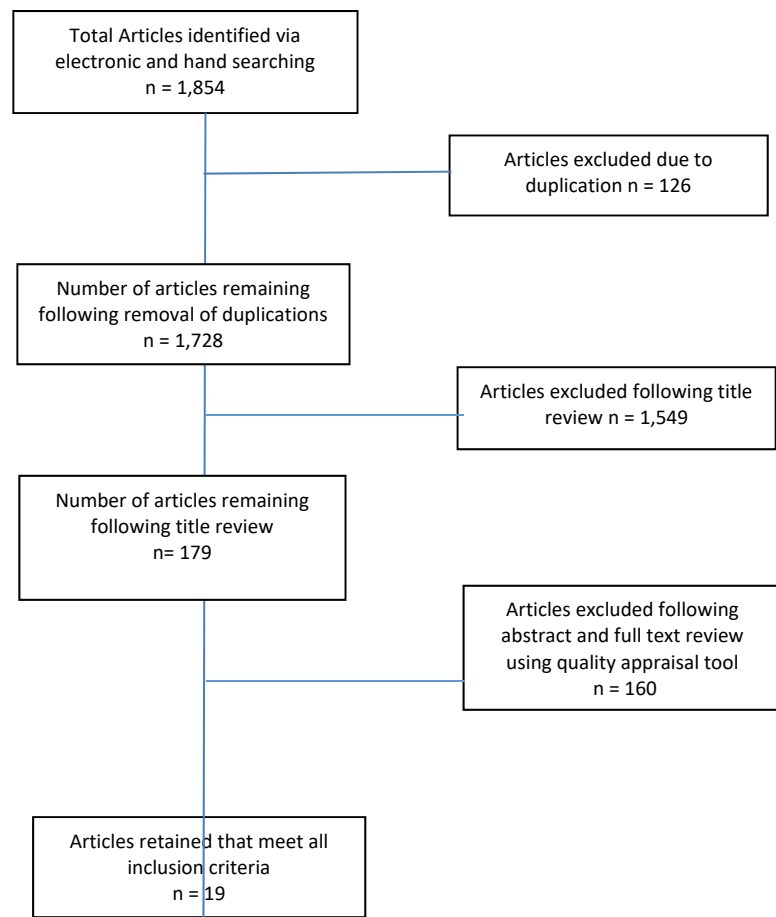


Table 1: Inclusion and exclusion criteria

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

Table 2 – Six rights of medication administration

(Woodrow, Colbert & Smith 2010)

RIGHT
Patient
Drug
Dose
Time
Route
Documentation

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

Author, Title and Journal	Purpose of Study	Sample and Setting	Design and methods	Key Findings	Limitations	Themes captured in this paper
Anthony, K., Wiencek, C., Bauer, C., Dal, B. and Anthony, M.K. 2010, United States.	Evaluated the impact of no interruption zones during MA.	2 x 20 bed intensive care units.	Quasi experimental pilot study. 3 phase study.	Post intervention 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 medication administration 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.	1 hospital 1 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. 3 surgical, 2 medical and 1 palliative care wards.	Self-reporting survey: qualitative and quantitative responses	Identified types and 3 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 post intervention, retrospective semi structured interviews and	Behaviour changes noted following introduction of bar coding. Participants thinking processes unchanged.	Sample included only experienced nurses.	Setting the scene- interruptions and distractions impacting care.

			real time recorded thought processes.	Identified 10 characteristics of thinking.		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.	Non experimental 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.
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 licensed practicing nurses. 1 surgical and 1 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. Strategizing 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 2 hospitals, 7 wards.	Direct observational field design. 136 hours of observation.	Total of 3,441 events, 1,354 interruptions, 46 hours of multitasking and 200 observed errors. 10 interruptions observed/hour (1 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	6 medical and surgical wards in 3 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 1,687. 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 9 hospitals	Mixed methods using 2,880 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.
Palese, A., Sartor, A. Costaperaria, G. and Bresadola, V. 2009, Italy.	Examined interruption frequency during medication rounds	56 medication rounds; 8 rounds in each of 7 surgical wards.	Observational study	945 MA's observed, 1 interruption/ 3.2 administrations. Interruption frequency and causes dependent on numbers 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. Strategizing 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	78 nurses, 5 wards, 1 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.	7 registered nurses in a large tertiary hospital	Mixed methods (43 hours field observation and summative interviews), ethnographic study	16% of nurses time involved in medication administration. Overall average of 9 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 1 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	31 nurses in 59 bed medical unit in an	Pre and post intervention observational	Identified 10 sources of interruption and that the source of interruption impacted the	Conducted in 1 high dependency ward. Hawthorne effect.	Setting the scene- interruptions and

	decrease as a result of the introduction of a set of interventions.	acute teaching hospital.	study over 30.5 hours.	effectiveness of the interventions. The overall most significant source of interruptions was nurses themselves. Overall decrease in interruptions post intervention.	No control group. Individual impact of each intervention unclear.	distractions impacting care. Reducing interruptions - current research responses
Tucker, A.L. and Spear, S.J. 2006, United States.	Examined nurse productivity related to hospital work systems	Three phases: 11 nurses, 6 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. Strategizing 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 6 wards in 2 major teaching hospitals. 4,271 medication administrations	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.	57 nurses, 2 wards in 1 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 1,305 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 was voluntarily reported.	Setting the scene- interruptions and distractions impacting care. Strategizing care - managing interruptions