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The impact of interruptions on medication errors in hospitals: an observational study of nurses

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The impact of interruptions on medication errors in hospitals: an observational study of nurses

Aim To explore interruptions during medication preparation and administration and their consequences.
Background Although not all interruptions in nursing have a negative impact, interruptions during medication rounds have been associated with medication errors.
Method A non-participant observational study was undertaken of nurses conducting medication rounds.
Results Fifty-six medication events (including 101 interruptions) were observed. Most medication events (99%) were interrupted, resulting in nurses stopping medication preparation or administration to address the interruption (mean 2.5 minutes). The mean number of interruptions was 1.79 (SD 1.04). Thirty-four percent of medication events had at least one procedural failure, while 3.6% resulted in a clinical error.
Conclusions Our study confirmed that interruptions occur frequently during medication preparation and administration, and these interruptions were associated with procedural failures and clinical errors. Nurses were the primary source of interruptions with interruptions often being unrelated to patient care.
Implications for nursing management This study has confirmed that interruptions are frequent and result in clinical errors and procedural failures, compromising patient safety. These interruptions contribute a substantial additional workload to medication tasks. Various interventions should be implemented to reduce non-patient-related interruptions. Medication systems and procedures are advocated, that reduce the need for joint double-checking of medications, indirectly avoiding interruptions.

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Introduction

Interruptions are a normal part of most health professionals' workday and can provide nurses with necessary information for example, a monitor alarm that indicates an abnormal heart rhythm is an important timely alert that can interrupt practice (Rivera-Rodriguez & Karsh 2010). Interruptions have been defined as: 'a break in the performance of a human activity initiated by a source internal or external to the recipient. This break results in the suspension of an initial task to perform an unplanned secondary task which results in a break or termination of the primary task'(Berg *et al.* 2013, p. 658). Not all interruptions during clinical practice should be perceived as negative (Bower *et al.* 2015).

A position paper by Coiera notes that although some interruptions are beneficial to clinical practice, interruptions during medication administration have been associated with patient harm (Coiera 2012). This view is supported by a study of 38 063 medication error reports where the researchers found that distractions (often used synonymously with the term 'interruptions') were the most commonly occurring factor present in 49% of reports (Santell *et al.* 2003). Coiera recommends further research to identify the key affected areas of practice and to seek ways of making them 'interruption proof' (Coiera 2012, p. 358). This study explores and defines types of interruptions and their consequences during medication preparation and administration.

Within Australia, Canada, the United Kingdom (UK) and the United States (US), studies have been conducted to examine the relationship between interruptions and medication errors (Bennett *et al.* 2010, Westbrook *et al.* 2010a, Hopkinson & Jennings 2013). A systematic review of the literature on interruptions occurring in nursing practice sought to define the characteristics of interruptions, data collection methods and the outcomes (Hopkinson & Jennings 2013). Only two studies included potential or observed outcomes in the form of medication errors (Hopkinson & Jennings 2013), with one study demonstrating that the risk and severity of medication errors doubled when the number of interruptions increased from 0 to 4 (Westbrook *et al.* 2010b).

Further close examination of incident data within an Australian hospital identified that a small proportion of self-reported medication incidents (134/1259; 11%) had identified interruptions as a contributing factor. The consequences were that: the error did not reach the patient (68%); the error did reach the patient but did not harm the patient (6%); the error reached the patient and the patient required monitoring (15%); and finally the error reached the patient and required intervention following temporary harm (11%) (Johnson *et al.* in press). This study was limited to self-report data and observational studies are required.

The causal relationship between interruption and error has also been examined with a recent study conducted within a simulation laboratory, finding that nurses were more likely to make errors when interrupted compared with when they were not interrupted and that interventions such as the presence of a verification booth, standardised workflow of activities, and speaking aloud, were effective in some forms of error reduction (Prakash *et al.* 2014). Using a pre-post design with comparison units, a recent North American study found reductions in interruptions with one-third of wards being affected and medication errors occurring in two of the three participating critical care units, including the comparison unit (Flynn *et al.* 2016). The interruption limiting strategies included: hourly patient rounds, triage of phone calls, protected medication times, signage reminding staff to limit interruptions, the presence of no interruption zones in medication rooms, nurses wearing visible vests, and the availability of patient and family materials limiting interruptions. Although inconsistent findings were identified, this multifactorial approach does support the view of Bower *et al.* (2015) that one single approach is unlikely to be effective. Also with this approach, there are difficulties in identifying which component of the intervention was the most effective (Hayes *et al.* 2015). Careful examination is needed of the type of task, interruption and handling methods to develop effective and tailored intervention strategies (Bower *et al.* 2015).

Interruptions place a burden on the working and prospective memory of staff and are 'contextually

dependent on ward layout, patient care, trust or ward protocols and the seniority of the nurses undertaking the task' (Bennett *et al.* 2010, p. 22). Further work is needed in understanding how interruptions occur and therefore how workflows could be modified accordingly (Coiera 2012). Key areas identified in past work when examining interruptions during medications include the source of the interruptions, the duration of the interruption, the primary task ('the task being performed when interrupted' (Biron *et al.* 2009, p. 79), secondary tasks ('the requested tasks by the interrupting source' (Biron *et al.* 2009, p. 79), the particular phase within the medication process, and the time taken to address the interruption.

Further, two major studies have provided the definitions, methods and categories to be used in this study relating to the types of interruptions and their outcomes (Biron *et al.* 2009, Westbrook *et al.* 2010b). A Canadian observational study noted that most interruptions were caused by nurse colleagues (29.3%), followed by system failures (22.8%), during the preparation phase. During medication administration, nurses initiated the most interruptions (16.9%) followed by patient interruptions (16%) (Biron *et al.* 2009). In most cases the secondary task was related to a patient need (43.9%). Interruptions were identified as lasting 1 minute and 32 seconds on average (Biron *et al.* 2009). Primary and secondary tasks have previously been studied because the dissimilarity of the content between the primary and secondary tasks is likely to negatively impact decision-making performance (Speier *et al.* 1999).

This present study uses existing definitions relating to errors where possible. Clinical errors are defined as observing administration of the wrong medication including giving the wrong drug or dose, or the wrong route of administration, or to the wrong patient or at the wrong time (Westbrook *et al.* 2010b). Procedural failures refer to neglecting or omitting to follow established practices, standards or policies in any aspect of the medication process. Examples of procedural failure include the failure to check patient identification, failure to record medication administration on the medication chart, failure to read medication label and expiry date, the temporary storage of medication in an unsecured environment, or failure of two nurses to sign the dangerous drug register (Westbrook *et al.* 2010b). Finally, a medication administration event is defined as commencing when a patient's medication order is taken by the nurse with the intention of preparing or administering a medication, to administration of a medication to a patient, and completion of any required documentation. This event begins when the nurse enters the bed unit and concludes when the nurse signs and replaces the medication chart. Nurses would be expected to administer one or more medications to one or more patients.

Aim

We sought to explore the nature of interruptions during medication preparation and administration, including the source of interruptions, time taken away from the primary task (medication administration), the secondary tasks undertaken, and the frequency of clinical errors and procedural failures. Additional papers, examine the use of behavioural strategies to manage interruptions (Johnson *et al.* in press).

Methods

A non-participant prospective observational study was conducted.

Sample and setting

A convenience sample of five medical-surgical and two critical care units (Neonatal Intensive Care Unit and the Emergency Department) was recruited within a large metropolitan teaching hospital in Sydney, Australia. These wards volunteered to participate after the lead author described the study at a forum of unit managers. At the ward/unit level, 25 of 28 nurses (89% agreeable) consented to be observed preparing and administering medications at 56 medication events (from 47 unique patients) resulting in 108 observed interruptions. Nine patients had two medication events observed.

Single and four-bed patient rooms were used in the study. Medications comprising oral and non-controlled preparations were stored in a dedicated medication trolley, which the nurse took to the patient bed or located it outside the room when the patient was in isolation. When not in use, the medication trolley was stored in the corridor near the nurses' station. Injectable medications and controlled drugs (Australian Government Department of Health Therapeutic Goods Adminstration 2016) were obtained and prepared in a locked preparation room located in the ward. In the Neonatal Intensive Care Unit and Emergency Department, all medications were stored in the preparation room.

Development of the observation tool

A standard observation tool was developed that included the ward details, nurse identifier, patient clinical history, medications administered and data on interruptions during medication events. Features of the interruptions, such as nature of the interruption including a brief description of the interruption, and source of the interruption according to pre-defined categories were recorded. Also recorded were details about whether the medication administration was stopped for the nurse to attend other tasks, place of interruption, time taken away from the primary task and time taken for the secondary task.

In addition, a brief written description of the primary and secondary tasks was detailed, for example, if the interruption was by another nurse asking for the drug keys. The primary task was defined as the medication administration task and the secondary task was defined as talking to the other nurse about where the drug keys were currently located. The time taken to address the secondary task or interruption was recorded using the clock function on a mobile phone. Procedural failure (failure to check patient ID, failure to comply with infection prevention procedures) and clinical errors (the right patient, right drug, right dose, right time, right route and right documentation) were also included. Space for free-text responses was included to allow for identification of other issues.

Preliminary testing of the observation tool included 21 observations during the morning round of medication administration. Modifications to the tool included adding information regarding place of interruption and whether the interruption occurred during the preparation or administration phase, the date of observation, and the definitions for clinical errors and procedural failures (Westbrook & Ampt 2009). The revised version of the observation tool was then used. A copy of the observation tool can be provided on request. All data definitions used have been tested extensively by Westbrook *et al.* (2010b) who reported kappa coefficients of 0.94–0.96.

Procedure

Prior to undertaking the study, ward nurses were informed of the proposed study during regular in-services by the Nurse Unit Manager and/or Clinical Nurse Educator. The research nurse asked nurses if they were willing to be observed. Written consent was obtained before observation commenced.

Data were collected by one registered nurse with research experience who stood at a set distance of 3 m from the patient during regular medication administration times (0800, 1200, 1400 hours), often observing for one hour in a specific unit and time. Observation of the two critical care areas – Neonatal Intensive Care Unit and the Emergency Department – was conducted outside the regular medication times as per specific ward practices. The research nurse was instructed to intervene if a potentially dangerous incident was witnessed; that is if the researcher believed that a patient or nurse could potentially be harmed as a result of the medication preparation or administration procedure.

Analysis

Numeric data were analysed using IBM SPSS Statistics for Windows Version 22.0 (IBM SPSS Statistics 2016). Descriptive statistics and proportions were used to describe the frequency of interruptions and other characteristics.

Written descriptions of the interrupting secondary task were analysed and re-categorised into quantifiable categories using NVivo™ Version 9 (QSR International 2016). For example, issues relating to nurses' discussions of work schedules, or staffing were categorised as administrative issues.

Results

Patient characteristics

Although no demographic data such as patient age or gender were collected, the primary diagnosis was obtained from Nursing Handover Summary documents. Diagnoses comprised gastrointestinal conditions (30%), followed by musculoskeletal, spinal and skin conditions (21%), cardiovascular conditions (15%), endocrine, hepatic, renal and urinary conditions (9%) and other conditions (25%) (n = 47).

Interruptions during medication preparation or administration

Direct observation of nurses during medication administration events resulted in 56 observed medication administration events with 108 interruptions. Seven cases related to the administration of blood products and were later removed, resulting in 101 interruptions.

Most medication events (55/56) were interrupted (99%), which also included self-interruption. As

shown in Table 1 the major source of interruptions was nurse-initiated (40%), followed by patients (13%) and then medical officers (11%). Most interruptions occurred during medication preparation (73.3%), rather than administration (26.7%). Most nurse interruptions were by registered nurses (63.4%), followed by endorsed enrolled nurses who were practice nurses who completed a specific course enabling them to administer medications (14.6%), clinical nurse educators (4.9%), other enrolled nurses (4.9%) and other individuals (12.2%).

Interruptions occurred in the corridor (47%), at the patients' bedside or room (36%), the preparation room (16%) and the nurses' station (1%). In all but one interruption, the nurse stopped the medication task to respond to the interruption (98%; 100/101) and later returned to the medication task (97%). The mean time away from the medication task was 2.5 minutes (SD 4.53 minutes) although there was wide variation of this time interval (range: 0.6–28.94 minutes). On average, medication events were interrupted two or more times per event, with a maximum of six interruptions reported for a medication event (see Table 1). The mean number of interruptions per medication event varied slightly between critical care (M 1.57, SD 0.852) and general medical/surgical ward settings (M 1.86, SD 1.10, $t = -0.889$, $P = 0.378$) although this was not statistically significant. The mean number of interruptions per medication event was 1.79 (SD 1.039), or 2.13 interruptions per patient.

Sources of interruptions

One-third of the interruptions were by other nurses seeking to exchange information about patients and workflow, including asking questions, giving instructions, reporting information and requesting assistance (Table 2).

Secondary tasks attended following an interruption

It was also relevant to identify the importance of the tasks that stopped nurses from attending to medication administration. Table 3 details the nature of the secondary tasks, noting the high proportion of social interactions occurring (28%), followed by attending

Table 1
Characteristics of interruptions

	No. (%)	*Mean (SD)*
Number of interruptions per patient ($n = 47$)		
One	17 (36.2)	2.13 (1.21)
Two	16 (34.0)	
Three	9 (19.1)	
Four	2 (4.3)	
Five	2 (4.3)	
Six	1 (2.1)	
Number of interruptions per medication event ($n = 56$)		
One	29 (51.8)	1.79 (1.039)
Two	16 (28.6)	
Three	7 (12.5)	
Four	2 (3.6)	
Five or more	2 (3.6)	
Phase of interruption ($n = 101$)		
Preparation	74 (73.3)	
Administration	27 (26.7)	
Interrupted by ...		
Nurse	40 (39.6)	
Patient (own)	13 (12.9)	
Medical officer	11 (10.9)	
Self	9 (8.9)	
Second RN (waiting to check, etc)	7 (6.9)	
Patient (other)	6 (5.9)	
Other health professional	4 (4.0)	
Equipment unavailability	4 (4.0)	
Family member	3 (3.0)	
Medication unavailability	2 (2.0)	
Other	2 (2.0)	
Phone	0 (0.0)	

Table 2
Sources of interruptions during medication administration events and their definitions

Source	*Description*	*No. (%)*
Alarms	Attending buzzer or alarm	4 (3.4)
Equipment	Equipment not available or not working, looking for equipment	11 (9.3)
Doctor	Requesting tests, attending patient, asking questions, discussing patients and plan of care, looking for patient's charts	13 (11.0)
Nurse (other than self)	Asking questions about patients and workflow, asking questions and giving instructions, reporting, requesting assistance	39 (33.1)
Organising medications	Organising medications from pharmacy, looking for missing or unavailable medications	2 (1.7)
Other health member	Talking about patient, coordinating and planning care, giving instructions	4 (3.4)
Patient	Requesting help or assistance, asking questions, making comments	18 (15.3)
Relatives	Asking questions, requesting assistance for their relative	5 (4.2)
Self-initiated	Initiating conversation, updating information in the computer	10 (8.5)
Waiting	Medication chart used by others, keys or controlled substance cupboard not available, for second nurse to check and administer medications	12 (10.2)
Total		118* (100.0)

*Two or more attendances occurring at the same time.

Table 3
Secondary tasks being undertaken when interrupted during medication administration events

Secondary task	*Description*	*n* (%)
Administrative issues	To discuss work schedule, staffing, administration	7 (19.4)
Attending to patient's needs	Responding to questions, updating information, patient care	5 (13.9)
Coordination of care	To discuss care of patient(s), tasks to attend, new patient	3 (8.3)
Informing doctor	To inform doctor about requirement for cannula	1 (2.8)
More than one role	Nurse in charge of ward with patient load	2 (5.6)
Organising assistance	Getting second nurse to obtain or check medication	3 (8.3)
Patient unavailable	Patient absent during medication administration	4 (11.1)
Resolving errors	Correcting wrong information in the patient's notes	1 (2.8)
Social interaction	Social conversation with nurses, patients and others	10 (27.8)
Total		36 (100.0)

to administrative issues (19%), attending to patient needs (14%) and looking for patients who were not in their bed or their room (11%).

Clinical errors and procedural failures associated with medication administration events

Using the definitions of clinical errors and procedural failures provided by Westbrook and Ampt (2009),

Table 4
Types of clinical errors and procedural failures per medication event ($n = 56$)

	n (%)
Clinical errors	
No clinical error occurred	54 (96.4)
Wrong drug	0 (0.0)
Wrong dose	0 (0.0)
Wrong route	0 (0.0)
Wrong patient	0 (0.0)
Wrong time (≥1 hour before or after prescribed time)	2 (3.6)
Wrong method of administration	0 (0.0)
Procedural failures (unique per medication event) ($n = 63$)*	
No procedural failure occurred	37 (58.7%)
Failure to check patient ID	0 (0.0)
Failure to recognise wrong medication order	0 (0.0)
Failure to document administration/incorrect documentation	7 (11.1)
Failure to check vital signs/blood glucose level, neurological observation, prior to administration where appropriate	0 (0.0)
Failure of two nurses to check where appropriate	9 (14.3)
Failure of two nurses to sign where appropriate	3 (4.8)
Failure to comply with infection control procedures	7 (11.1)
Failure to comply with aseptic or non-touch procedures where appropriate	0 (0.0)

*Some events had multiple procedural failures.

Table 5
Rate of clinical errors and procedural failures per medication event ($n = 56$)

	n (%)
Clinical errors	2 (3.6)
Procedural failures*	19 (33.9%)

*One procedural failure = 13 (23.2%), two failures = 5 (8.9%), three failures = 1 (1.8%).

Table 4 details the observed clinical and procedural failures within medication administration events. From Tables 4 and 5, it can be seen that 34% of observed medication events were found to have procedural failures, most notably failure to check with two nurses when required. There were very few observations comprising clinical errors (3.6%), all of which involved administering medications at the wrong time.

Discussion

This study provides important information about the frequency of interruptions in relation to clinical errors and procedural failures, and the complexity surrounding the types of interruptions that occurred. The methods used in this study provide a framework for nurse managers to examine and audit medication administration practices using an observational approach. Clinicians were willing to participate in finding solutions to the problem of interruptions during medication administration, and these approaches could form a local quality improvement strategy, which is transferable to any setting.

We compared our data collection methods and findings with the work of Biron *et al.* (2009) and Westbrook *et al.* (2010b). In our study, a hardcopy form was completed by one research nurse, while a personal digital assistant was used by multiple data collectors (Westbrook & Ampt 2009). This study also included a small sample of 56 medication events from 25 nurses with 47 unique patients compared with the Westbrook *et al.*'s (2010b) of 3177 administrations (4271 medications) from 98 nurses and 720 patients. The clinical units chosen for the study included two critical care areas and five medical-surgical units, while Westbrook *et al.*'s study used general medical/surgical units. There were fewer interruptions in critical care areas (M = 2) compared with medical/surgical units (M = 3.76), although the difference was not statistically significant.

Most medication events were interrupted, suggesting that interruptions of any kind are a predominant

feature of the working lives of nurses (Hopkinson & Jennings 2013). There were considerably more interruptions in this study than identified in Westbrook *et al.*'s (2010b) study where only 53% of medication administrations were interrupted. An average rate of 1.79 interruptions per medication event (a maximum of 6 per event) was found, which is less than another Australian study reporting 3.4 interruptions (Popescu *et al.* 2011), although these authors noted issues of design and location of medication stores, as having a key role in the number of interruptions. Biron *et al.* (2009) reported 6.3 interruptions per hour, and other researchers reported 5.6 interruptions per hour although this latter rate also included other tasks (Dante *et al.* 2016). The rate of interruptions in our study would exceed these figures. This increase may reflect the high level of activity and acuity of patients admitted to acute hospitals in Australian settings today, compared with previous studies where data were collected in 2007–09.

As Hopkinson and Jennings (2013) note in their systematic review, inconsistencies in counting and calculating interruptions are evident, with some studies reporting the number per hour, or per medication activity, or per communication event. We believe that the number of interruptions per event was an appropriate focus for this study.

Most interruptions occurred during the medication preparation phase (73%), which has previously been identified as a period of high risk for error (Berg *et al.* 2013). This finding is consistent with Biron *et al.*'s (2009). In our study, the main reason that nurses were interrupted during preparation of medications was to discuss 'personal matters' (36%) and to a lesser extent to discuss patient related issues or 'break coverage' (22%) (Biron *et al.* 2009, p. 333). This phase of the medication process could form a key focus in educational programmes developed to reduce interruptions, relating to nurses avoiding discussions about non-urgent and non-patient related issues when a nurse is preparing medications (Flynn *et al.* 2016).

The ward corridor was the most frequent site for interruptions (47.6%) followed by the patient's room (35.9%). Popescu *et al.* (2011) noted in their work that distractions varied with the medication dispensing system; satellite stations (M = 2.1 distractions) *vs.* central impressed systems (M = 6.1 distractions) (away from patient bedside). Medications stored in close proximity to the patient resulted in reduced distractions (Popescu *et al.* 2011). Our data appear to support this assertion.

The main source of interruptions was nurses themselves or other nurses (40%) a finding similar to contemporary studies (Dante *et al.* 2016). Reducing nurse-to-nurse social interaction should be a key aspect of any educational intervention. Most interruptions were from either registered nurses or other enrolled nurses who were endorsed to administer medications. Although the secondary tasks attended would suggest that a large proportion of these interactions are social in nature (28%), social interactions with patients could be understood to be therapeutic where patient education relating to medications is being undertaken (Popescu *et al.* 2011). Self-initiated interruptions were relatively low (10%) compared with Biron *et al.*'s (2009) study (16.9%). Interruptions such as pump alarms and providing other supportive patient care were fewer in this study – 4% *vs.* 22% in Biron *et al.*'s (2009).

Patients were the next most frequent source of interruptions (13%) and these interruptions were related to patients requesting help, asking questions, making comments or requesting assistance with activities of daily living. This figure is lower than that reported by other researchers of 44% (Biron *et al.* 2009). Medical officers were the next most frequent source of interruptions (11%) and included requesting tests, attending patients, asking questions, discussing patients and plan of care, and looking for patients' charts. In 98% of cases, nurses stopped the medication task to attend to the interruption. In a study of physicians in the emergency department, researchers noted that although 60% of interruptions were initiated by another health professional, this 'rarely resulted in the physician changing tasks before completion' (Jeanmonod *et al.* 2010, p. 376).

'Waiting' was an unexpected major source of interruption and perhaps delay. Waiting occurred when the medication chart was being used by other staff (including medical officers), the controlled substances cupboard keys were being used, or a second nurse was needed to check and administer medications. The need to check medications with another nurse is a vexing problem. In this study, some nurses chose to address these issues by undertaking medication rounds with another nurse present, a strategy identified by clinicians (Johnson *et al.* in press). Given that waiting for someone to check medications is so frequent and is associated with significant delays, careful assessment of the efficacy of double checking is warranted (Kellett & Gottwald 2015).

A recent systematic review of interventions to reduce errors (Lapkin *et al.* 2016) found that while

there is a duty of care to undertake double checking for all high-risk medications or high-risk patients (Bullock & Manias 2013), the number and type of medications that require double checking may need to be reviewed or reconsidered in terms of its risk as well as the regulatory requirements. Similar approaches that use electronic checking approaches where the staff member is checking with a computer may provide some relief if used within the regulatory requirements of the health services. Further, a recent study of double checking practices of oncology nurses has highlighted that there is evidence of jointly double-checking medications rather than independent checking of medications diminishing the benefits to patient safety (Schwappach *et al.* 2016). The high frequency of interruptions during this joint double-checking process was particularly problematic in our study (Schwappach *et al.* 2016).

The average time required to attend to an interruption was 2.50 minutes (SD 4.53 minutes) with a maximum of 28.94 minutes, which is slightly more than that reported by other researchers (1 minute 32 seconds) (Biron *et al.* 2009). Given that the normal medication round within the study hospital takes approximately 40 minutes to complete, this is an illuminating finding. This study did not use complex interpretations of interruption timings as presented by other researchers (Trafton *et al.* 2003, Li *et al.* 2012). These authors suggest that interruptions should be considered as consisting of the total task time, including the start of the primary task, the point of the alert for the secondary task, the start point of the interrupting task, the interruption time, the end interrupting task and the resuming of the primary task followed by the end of the primary task. Further studies focused specifically on the time costs associated with interruptions could be strengthened by considering all of these different time points in order to get a more accurate measure. Interruptions may potentially add 20 minutes to every medication round for nurses (calculated with 2.5 minutes per medication event × 8 patients), which represents a substantial workload issue (Myny *et al.* 2012).

Only 3.6% of medication events were found to have a clinical error and these errors were related to the timing of the administration of medications. The use of the greater than 1 hour timing as a benchmark has been challenged by other researchers in the area who use a timing of before the next medication is due (Latif *et al.* 2013). It could be argued that delays in the administration of medications reduce the therapeutic benefit of the medication or in some cases may increase the patient's length of stay (Santell *et al.* 2003). This number of clinical errors is less than another study, which reported 25% of medication administrations with at least one clinical error (Westbrook *et al.* 2010b).

Procedural failures were frequent (34%) and included predominantly a failure to check a medication with two nurses where required. Given the delays noted earlier in this discussion, it is possible that nurses were actively considering the risk of not double-checking medications while trying to prioritise their workload. The proportion of procedural failures reported here was less than the proportion found in Westbrook *et al.*'s (2010b), which demonstrated that 74% of administrations had at least one procedural failure. Non-compliance with infection control procedures (handwashing between patients) was frequent (9%) in this study. Although hand gels are placed in many cases at the foot of the patient beds there are issues of non-compliance with hand hygiene that warrant further education.

Limitations

We sought to examine the current context of interruptions during medication administration as the basis for designing an educational intervention for several large acute hospitals. These data should be understood as being related to periods of a high volume of interruptions that may or may not be experienced similarly in evening or night shifts for nurses. This study represents a small study within a large metropolitan Australian hospital, which may not be generalisable to other countries. Similarly, the medication practices may reflect local site-specific practices that may or may not have applicability to other settings.

Conclusions

We have confirmed that interruptions occur frequently and are associated with procedural failures and clinical errors. Educational interventions are urgently required that focus on the importance of interruptions, their association with procedural failure and clinical error, their implications in the time required to complete medication rounds. Reducing non-patient related interruptions may lessen medication errors while reducing the time required to complete medication rounds. Engaging in non-patient related social interactions during medication administration procedures should be regarded as high risk behaviour, which should be eliminated. Medication administration systems or policies that reduce the need for double-

checking could reduce the waiting time to complete medication administration. Further research into independent double-checking approaches and their impact is required.

Implications for nursing management

Interruptions occurring during medication preparation and administration, contribute substantial workload for clinicians. Medication administration systems that limit opportunities – in close patient proximity, with a facility for double-checking – for interruptions may reduce delays and interruptions and require further study. Given the time lost per medication round related to interruptions, the potential exists for nurse managers to increase available nursing hours per patient by reducing nurse-to-nurse socialisation or non-patient related interruptions. A method of working with clinicians to identify sources and volume of interruptions has been defined and could be used as a quality improvement strategy in any setting. Although the focus of this study was on designing an educational intervention, other innovative systems or processes, or other effective interventions, could be considered in consultation with clinicians, to develop local responses to reduce interruptions.

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Ethical approval

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