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ABSTRACT

Aim: To examine the existing literature relating to the impact that interruptions have during medication administration within the paediatric critical care (PCC) setting.

Background: Medication administration has inherent risks and errors can have enormous impact on the quality and efficiency of patient care, particularly in relation to experience, outcomes and safety. Nurses are pivotal to the medication administration process and therefore must demonstrate safe and reliable practice. However, interruptions can lead to mistakes and omissions.

Search strategy: Key terms identified from background literature were used to search three electronic databases (Medline, CINHAL and BNI). Selected sources were critically appraised using the Critical Appraisal Skills Programme (CASP) Tool.

Findings: There is confusion within the literature concerning the definition of interruption. Moreover, an assumption that all interruptions have a negative impact on patient safety exists. The literature identifies the multi-dimensional nature of interruptions and their impact on medication administration and patient safety. The cumulative effect of interruptions depends on what type of task is being completed, when it occurs, what the interruption is and which method of handling is utilised. A conceptual schema has been developed in order to explicate the themes and concepts that emerged.

Conclusions: This review summarizes debates within the international arena concerning the impact of interruptions to medication administration. However, conclusions drawn appear applicable in relation to practice, education and future research to other critical care settings.

Relevance to clinical practice: Findings infer that no single strategy is likely to improve the negative affect of interruptions without a patient safety-focussed culture. Practice education to improve team building interactions is required that equips nurses with the skills in managing interruptions and delegating high priority secondary tasks.

BACKGROUND

Preventable harm from medicines is a global problem (Dickinson et al, 2012), with huge economic and social burden. In the UK the National Health Service (NHS) spends more than £750 million on the consequences of medication errors (NPSA, 2007). Furthermore, recent high profile reports, such as The Francis Report (2013) and Patients First and Foremost (2013) have explicated the impact that medication errors have on patients and safety. Report recommendations highlight the need for further investigative work to be conducted that provides strategies to minimise the number of medication errors that occur.

The administration of medication is a fundamental nursing role, which carries inherent risks (Gill et al, 2012). Nurses are accountable for the safe administration of medication, therefore they require theoretical knowledge of pharmacology and numerical competence (Nursing and Midwifery Council, 2010; Murphy and While, 2012). Nurses spend a significant part of their working time in medication-related activities. Approximately 7,000 doses of medication per day are administered across each NHS Trust in England and Wales (NPSA, 2007). Even if these were administered with a 99.9% accuracy rate, at least seven medication errors per day would occur.

AIM OF THE LITERATURE REVIEW

This review will examine and synthesise the published literature that has explored the impact of interruptions during medication administration within the paediatric critical care (PCC) setting. Specifically, the review will address the following questions:

- How and why do interruptions occur during medication administration?
- Who contributes to the interruptions and what is their role within the situation?
- Can interruptions be classified to allow prioritisation?
- What strategies can be employed to reduce medication errors during interruptions?

SEARCH STRATEGY

Three electronic databases (Medline, CINHAL and British Nursing Index) were searched from their inception in February - March 2014. Keywords and terms used in single and combined searches included: nurse*; nursing staff; nurse's role; medication; medication administration; drug administration; medication error; interruption*; intervention*; intensive care; paediatric*; pediatric*, and were restricted English language sources only. Thirty-seven papers were identified as relevant to the topic that included systematic reviews, ethnographic studies, and other qualitative designs. Reference lists were reviewed to identify additional relevant literature. In order to support a robust evaluation of the literature included in this review, the critical appraisal of each included paper was undertaken using the relevant CASP tool checklist (Critical Appraisal Skills Programme, 2014) with the source design (such as systematic review, cohort study, qualitative study).

REVIEW FINDINGS AND DISCUSSION

What is a medication safety incident?

The NPSA (2007) defines a patient safety incident as 'any unintended or unexpected incident which could have or did lead to harm for one or more patients'. Within this broad definition there are three main categories that relate to medication; errors, 'near misses' and adverse drug events. The Canadian Patient Safety Institute (2003) summarises a medication error as 'the failure to complete a planned action as it was intended, or when an incorrect plan is used, at any point in the process of providing medication to patients'. Both of these definitions highlight the multidisciplinary nature of medication incidents and the lengthy nature of the process, both of which increase risk. The impact of medication errors is variable, there may be no harm to the child or there may be catastrophic consequences. Recently the NHS England Patient Safety Domain Team (2013) has published a list of 'never events', medications are involved in eight of the categories listed which highlights their potential for catastrophic harm.

The medication process

The medication process can be split into five broad stages; prescriptions, checking of prescription, preparation of drug, double checking of process and administration to the patient. Kliger (2010) estimates that between 50 and 100 steps occur from the time a prescription is written to the administration of the drug. A systematic review conducted by Simon et al (2012) categorised all clinical tasks into three different types; procedural, problem-solving and decision making. All of these types are evident in the medication administration process. The task is an automatic procedure, there are often multiple calculations involved that require solving and the nurse may have to make a clinical decision regarding whether the drug should be routinely given or advice sought. These three elements contribute to the complexity of the task before factors such as interruptions are considered.

Medication administration errors include incorrect drug calculation (both at prescribing and administration), timings, preparation and administration to the wrong patient (Blair, 2011). Kunac and Reith (2008) highlight that the most common error occurring in paediatric units is dosing error with the prescribing and administering stages being the points at which a mistake is most likely to occur. This is supported by Leape (2005) who identified that one third of errors occurred during the administration phase. Nursing staff are fundamental to this process as they are responsible for four of the five stages in the process, therefore it follows that nurses are more likely to report errors than any other profession involved in medication administration (Dickinson et al, 2010).

The process of medication administration is a multidisciplinary event, with pharmacists advising on drug prescriptions, with nurses double checking the whole process. Leape (1995) found that nurses intercepted 86% of errors made by doctors and pharmacists by double checking the prescription and dispensing process. However, once the process reaches the administration phase there is no other professional involved to double check the process except the nurse. Within paediatric healthcare it is common for nurses to 'double check' the administration process, certainly for intravenous and

complex medications. The double checking process involves two nurses independently checking the prescription and administration of medication. A study conducted in New Zealand examined the understanding of paediatric nurses on the process and procedure of 'double-checking' medications, utilising focus groups. Analysis identified that paediatric nurses supported independent double-checking as best practice, but there was variability in the process and it could be influenced by environment and attitudes (Dickinson et al, 2009). The limitation of this study was sample size, only nineteen nurses were selected; although, representation of grades and experience was achieved.

Are children vulnerable?

Medication errors are common place in the healthcare environment (Gill et al, 2012); they are reported to occur in one of every five medication dosages (Davis et al, 2005). Within the paediatric population, the literature highlights that infants and children may be at three time's greater risk of medication errors than adults (Murphy and While, 2012 and Kaushal et al 2001). The NPSA (2007) note that the proportion of errors involving children under four was higher than expected given the proportion of activity they represent. Medication administration to infants and children require complex calculations, individualised dosing and the use of off-label medication which has limited prescribing information available this contributes to common errors such as incorrect dose or frequency (NPSA, 2007).

Is intensive/critical care different?

The intensive or critical care unit has high medicine workload, utilising complex drugs that if administered incorrectly can result in harm (NHS England, Patient Safety Domain Team, 2013). The National Patient Safety Agency (2007) stated that the two main drugs which caused the most harm to patients were opioids and anti-coagulants which are frequently used in intensive care. Within paediatric critical care medication safety is viewed as a priority due to the volume of medication administration per patient, large variables in drug dosing, ongoing, complex calculations, frequent

titrations and a narrow index of dosing before harmful effects can occur (Dickinson et al, 2012). A review of over 20 000 prescriptions in British critical care units found that 15% had one or more errors, nearly 20% of the errors were significant, serious or life threatening (Ridley et al, 2004).

Interruptions have been discussed within the literature with regard to critical care units. McGillis Hall et al (2010) found that nurses identified noise as a frequent distraction during their working day; the critical care unit has a high use of alarms that are vital in alerting staff in changes in patient condition but can also be viewed as a distraction. Health care provided within critical care units commonly involves multiple teams. Communication and collaboration is vital for patient safety, however, team members must be aware of the impact of interruptions during medication administration. McGillis et al, (2010) found that the main source of interruptions was attributed to health care providers within the unit.

Defining an interruption?

Within the literature surrounding interruptions to the medication administration process, three different types are identified. These can be classed as interruptions mid task, between tasks and breaking off to collect equipment and supplies (Bennett et al, 2010). There is also discussion about interruptions which completely halt an activity plus distractions which may be ignored or processed concurrently with the primary task (Biron et al, 2009).

When reading literature regarding interruptions it is difficult to establish clear definitions for the term interruption, Biron et al, (2009) recommend for any future research definitions should be identified. When analysing multiple studies they found that different definitions were being used interchangeably and these differences affected the rate of interruptions observed. This was clarified by Potter et al (2005) where two researchers used two different definitions and the rate of observations was markedly different. A systematic review of the literature by Hopkinson and

Jennings (2012) noted that the terms interruption, distraction and disruption all had different definitions.

In their study McGillis Hall et al (2010) utilised definitions used in management and organisational science, designed by Jett and George (2003). They identify four different types of interruptions; intrusions are unexpected encounters by someone else that affect the flow and continuity of the task, causing a temporary halt. Distractions are classed as psychological reactions triggered by external stimuli which interrupt the nurses' focus. Breaks are described as planned or spontaneous recesses from task that affect flow and continuity. Discrepancies were described as the inconsistencies that nurses perceive between their own knowledge and expectations and the observations they make that are relevant to the work they are performing. The analysis of the data revealed that 52% of interruptions observed were distractions and 35% were intrusions. The focus groups identified that the majority of distractions were due to noise and intrusions were primarily attributed to consultations. There were significantly less breaks and discrepancies observed.

The source of interruption can be broadly split into two groups, the individual and the technical. Individual sources are classed as healthcare professionals, patients and family members. Several studies document that nurses are the largest source of interruptions and they are most likely to be communicated face-to-face (Hedberg and Larsson, 2004 and Lyons et al, 2007). Technical sources are defined as interruptions from alarms or operational failure such as missing equipment (Biron et al, 2009).

McGillis Hall et al (2012) performed a mixed methodology study which included studying the source of the interruption. They found the primary source of interruptions came from other health care providers. A quarter of interruptions were caused by medical staff and allied health professionals, nursing staff provided another 20% of interruptions and the individual nurse caused another 20% of interruptions. Families and patients were found to cause 13% of interruptions. This study was performed across thirty six medical and surgical adult units in Canada. Differences between the two

types of unit were also noted, with health care professional interruptions being higher in the medical units and self-interruptions higher in the surgical. This quantitative data was triangulated by qualitative data from focus groups, which was found to be consistent and supported the findings. There was a limitation due to the large number of data collectors as they may offer a different interpretation of the interruptions they are observing. However, inter-rata reliability was tested weekly to ensure reliability and accuracy. This study looked at interruptions across the whole of the nursing workload; interruptions to medication administration were identified with nurses being involved in preparing and administering medication a substantial amount of the time when interrupted.

The impact of interruptions on the medication administration process

There is a continuing debate concerning the impact of interruptions on medication administration. Hall et al, (2010) highlight multiple studies that argue that interruptions and distractions are the key cause for medication error (Wakefield et al, 1998, and Gladstone, 1995). They also argue that there is a range of evidence that supports the theory that where staff are constantly interrupted or asked to switch tasks, there is a greater risk of adverse events and a lack of patient safety. However, Hopkinson and Jennings (2013) state that these studies are based on nursing staff perceptions of the causes of error and there is limited empirical research to support this theory. They highlight that much of this argument is based on findings from experiments based outside the clinical environment that are then translated into nursing care. They note that there is a very persistent argument that interruptions always lead to negative outcomes, but limited data are available that measures interruptions and outcomes. McGillis Hall et al (2010) did relate their study on interruptions to outcome, 13,025 outcomes were observed and they judged that 90% of them resulted in negative consequences, for example delays in treatment, and loss of concentration. The remaining 10% were judged to have a positive outcome but it does not identify what this outcome was.

Interruptions can have a negative effect on nursing staff, by causing them to lack focus, interfere with memory and invoke feelings of frustration and stress (Bennett et al, 2010). Colligan and Bass (2012) believe that there is a cognitive cost of interruptions; the effect of diverting attention can lead to forgetfulness and omissions. In the field of management and organisational science, Hall et al (2010) note that interruptions are intrusive by nature and have a detrimental effect on performance and can affect the quality of decision making (Jett and George, 2003 and Speier et al, 1999). However, certain interruptions have been identified as vital for both patient safety and effective communication. Anthony et al (2010) analysed the implementation of a 'no interruption zone', this study demonstrated a significant decrease in the number of interruptions, but one of the key findings of the study noted a negative consequence of reducing the number of interruptions; communication and coordination was also reduced which was required for effective teamwork and education.

The impact of the interruption may also depend on the level of skill that is required at the time, if the nurse is performing a routine skill, an interruption may have minimum effect. However, if deep thinking and analysis are required an interruption may negatively affect the task (Biron et al, 2009). This links to the study performed by Colligan and Bass (2012) where they found that tasks are not equal and nurses utilise strategies that take account of this. The context of the interruption is important in its handling strategy; an assessment is made by nurses regarding the clinical and situational workload factors (Colligan and Bass, 2012). They noted that nurses prioritise tasks and this prioritisation and handling is affected by personal experience.

Simon et al (2012) discuss three theoretical frameworks that are relevant to understanding interruption effects; the activation goal memory model, the prospective memory model and multiple resource theory. Activation goal memory model relates to procedural type process where one step automatically leads to another. If an interruption occurs during the procedural part of administration, the routine actions may trigger a re-focus after an interruption. Prospective memory

relates to the ability to remember to complete a task in the future, it is created intrinsically with no explicit prompt. Multiple resource theory is concerned with the multi-tasking action, when two tasks compete for attention performance is hampered and eventually one will be abandoned.

It is impossible to definitively state the effect of interruptions on medication administration as no researcher could predict whether the error would have occurred anyway without an interruption, after all, to err is human (Cambridge University Press, 2014). Biron et al, (2009) reviewed the evidence available to review rates of interruptions, characteristics and contribution to medication errors. Out of 23 studies included, 14 measured the frequency of work interruptions and time, from this information they state that there are 6.7 work interruptions per hour. The authors state that the validity of this statistic is increased because they applied strict quality criteria, however, this could be questioned due to the fact that all studies use different definitions and descriptions of the term interruption. All studies used direct observation and measured multiple interruptions but, it is not known, whether the multiple interruptions were consistent across all studies. These data state that an interruption occurs once every ten minutes; in an area where there is a high medication workload this is significant. In an observational study Scott-Cawiezell et al (2007) found a positive relationship between work interruptions and the rate of administration errors.

Colligan and Bass (2012) examined interruption handling strategies, the results identified a four level taxonomy; three strategies that allow the interruption to occur and one that blocks it. The first strategy is described as engaging; the primary task is interrupted by a high priority secondary task. The second, multi-tasking; the priority of both tasks is similar, attention is divided between both tasks and they are performed synchronously, although as previously noted, performance will be hampered and eventually one task will be abandoned (Simon et al, 2012). The third, mediation; a high priority task is generated before the suspension of primary task, for example the secondary task is delegated. The final strategy, blocking; the primary task is high priority and the secondary task is blocked. This study design was complex with three methodologies used to ensure the results were

valid. The tools utilised were semi-structured interviews, case studies and observations. The sample size within this study was small therefore limiting the generalizability of the results. There was also limited discussion about the experience of the nurse and the impact of this on these strategies, however, they note that the choice of interruption handling is affected by personal experience. Figure 1 represents the interplay between the factors (behavioural and cognitive) and strategies of the interruption of medication administration process.

Strategies to reduce interruptions

Hopkinson and Jennings (2012) discussed the impact of interventions in reducing errors; two studies (Pape, 2003 and Relihan et al, 2010) were highlighted that used checklists and the wearing of visual symbols and both studies demonstrated statistically significant effects in reducing interruptions. The introduction of a 'no interruption zone' in Anthony et al, (2010) also demonstrated a 41% decrease in interruptions in a four week period. As previously noted this decrease was not viewed in a positive light. These studies highlight that the number of interruptions can be reduced but, what is not evident in the literature is whether these reductions have an impact on patient safety. Federwisch et al (2014) attempted to introduce a sterile cockpit environment by implementing two strategies; signs that said 'stop medication administration in process' and a medication quiet time. Evaluation of these strategies by questionnaire, before and after implementation found limited benefit from either strategy because staff would not comply or the strategies were ignored by the interrupters. This study was performed on a large ward with typical medication times which allow strategies to be introduced. Within a PCC Unit medications can be prescribed at any point in the day and many of them are on the critical drugs list so need to be administered on time.

Federwisch et al (2014) also discussed a pilot project that utilised the wearing of yellow vests, a ban on answering the phone and call bells during medication administration and a limited number of staff in the drug room. This pilot was withdrawn after 4 days despite having a 52% reduction in interruptions due to staff resistance. It is indicated that forcing nursing staff to concentrate solely on

one task conflicts with a culture that values flexibility and the ability to respond to full clinical responsibilities. Within paediatric critical care it is vital that nurses do not ignore alarms or critical communication as this could be detrimental to patient safety.

McGillis Hall et al (2010) highlight practical strategies for reducing interruptions; reducing noise levels, specific times when families can telephone the unit and education to new members of multi-disciplinary team. These are strategies which may reduce some of the interruptions that provide a negative outcome; however, to date they have not been evaluated or had sustainability assessed.

CONCLUSION

This review has summarised the debates within the current literature concerning the impact of interruptions to medication administration. International evidence has been drawn from a range of disciplines including patient safety, psychology, human factors, organisation, industry and education. Collectively this review has provided novel insights into the existing evidence base through summarising and synthesising the literature.

Review findings have illuminated conflicts within the existing body of evidence in relation to the definitions, impact and the ultimate consequences of interruptions during medication administration. Current evidence suggests there is greater risk for adverse events, and subsequently reduced patient safety, in environments where staff are regularly interrupted (McGillis Hall et al, 2010). However, there is a lack of empirical studies that demonstrate that minimising interruptions reduces medication errors (Raban and Westbrook, 2012; Hopkinson and Jennings, 2012). Therefore more empirical research is warranted. Bennett et al (2010), note that many studies focus on the secondary analysis of administrative databases which is restricted due to the researcher having no influence over the original study design, data collection tool, or data set. Furthermore, Biron et al, (2009) highlight the need for studies to focus on direct structured observations to help understand the context of interruptions. In order to address these limitations, future research needs to explore

interruptions without the use of standardised instruments based on preconceived notions that are not currently supported by empirical research (Hopkinson and Jennings, 2012). As some interruptions occur in context (such as some interruptions are required to improve patient safety, for example the quick response to a deteriorating patient) future empirical research needs to utilise research approaches that comprehend the context.

REFERENCES

Anthony, K. Weincek, C. Bauer, C. Daley, B. and Anthony, M (2010) No interruptions please, Impact of a no interruption zone on medication safety in intensive care units. *Critical Care Nurse;* 3(3): 21-29.

Bennett, J., Dawoud, D. and Maben, J. (2010) Effects of interruptions to nurses during medication administration *Nursing Management;* 16(9): 22-23.

Biron, A., Loiselle, C. and Lavoie-Tremblay, M. (2009) Work Interruptions and Their Contribution to Medication Administration Errors: An Evidence Review. *Worldviews on Evidence-Based Nursing;* Second Quarter: 70-86.

Blair, K. (2011) *Medicines Management in children's nursing*. Transforming Nursing Practice. Exeter: Learning Matters Ltd.

Bryman, A. (2012) *Social Research Methods*. 4th Edition. Oxford: Oxford University Press.

Canadian Patient Safety Institute (2003) *The Canadian Patient Safety Dictionary.* Canadian Patient Safety Institute Ottawa Canada. http://www.royalcollege.ca/portal/page/portal/rc/common/documents/publications/patient_safety_dictionary_e.pdf [accessed 20 November 2013].

Cambridge University Press (2014) *Cambridge Advanced Learner's Dictionary & Thesaurus*. Cambridge Dictionaries Online. www.dictionary.cambridge.org [accessed 25 February 2014].

Colligan, L. and Bass, T. (2012) Interruption handling strategies during paediatric medication administration. *BMJ Quality and Safety;* 21: 912-917.

Critical Appraisal Skills Programme (CASP) (2014) *CASP Checklists.* Oxford, CASP. www.casp-uk.net [accessed 14 June 2014].

Davis, L., Keogh, S., Watson, K., and McCann, D. (2005) Dishing the drugs: A qualitative study to explore paediatric nurses' attitudes and practice related to medication administration. *Collegian*; 12(4): 15-20.

Department of Health (2013) *Patients First and Foremost* (online) London, Department of Health. https://www.gov.uk/government/PatientsFirstand Foremost.pdf [accessed 30 April 2014].

Dickinson, A., McCall, E., Twomey, B. and James, N. (2009*)* Paediatric nurses' understanding of the process and procedure of double-checking medications. *Journal of Clinical Nursing;* 19: 728-735.

Dickinson, C. Wagner, D. Shaw, B. Owens, T. Pasko, D. and Niedner, M. (2012) A Systematic Approach to Improving Medication Safety in a Paediatric Intensive Care Unit*. Critical Care Nursing Quarterly;* 35(1): 15-26.

Federwisch, M., Ramos, H. and Adams S. (2014) The Sterile Cockpit: An Effective Approach to Reducing Medication Errors? *American Journal of Nursing;* 114(2): 47-55.

Francis, R. (2013) *The Mid Staffordshire NHS Foundation Trust Public Enquiry* (online). www.midstaffspublicenquiry.com [accessed 30 April 2014].

Gill, F., Corkish, V., Robertson, J., Samson, J., Simmons, B. and Stewart D. (2012) An exploration of pediatric nurses' compliance with a medication and administration protocol. *Journal for Specialists in Pediatric Nursing;* 17: 136-146.

Gladstone, (1995) Drug administration errors: a study into the factors underlying the occurrence and reporting of drug errors in and district general hospital*. Journal of Advanced Nursing;* 22(4): 628-637.

Hedberg, B. and Larsson, U. (2004) Environmental elements affecting the decision-making process in nursing practice. *Journal of Clinical Nursing;* 13(3): *316-324.*

Hopkinson, S. and Jennings, B. (2012) Interruptions During Nurses' Work: A State-of-the-Science Review. *Research in Nursing and Health;* 36(1): 3638-3653.

Jett, Q. and George, J. (2003) Work interrupted: a closer look at the role of interruptions in organizational life. *Academy of Management Review;* 28(3): 494-507.

Kaushal, R., Bates, D., Landrigan, C., McKenna, K., Clapp, M., Federico, F., and Goldmann D. (2001) Medication errors and adverse drug events in pediatric inpatients. *The Journal of the American Medical Association;* 285(16): 2114-2120.

Kliger, J., Blegen, M., Gootee, D., (2009) Empowering frontline nurses: a structured intervention enable nurses to improve medication administration accuracy. *Joint Commission Journal on Quality and Patient Safety;* 35(12): 604-612.

Kunac, D. and Reith, D. (2008) Preventable medication-related events in hospitalised children in New Zealand. *The New Zealand Medical Journal;* 18:121(1272): 17-32.

Leape, L., Bates, D., Cullen, D., Cooper, J., Demonaco, H., Gallivan, T., Hallisey, R., Ives, J., Laird, N., Laffel, G., et al (1995) Systems analysis of adverse drug events. *ADE Prevention Study Group Journal of American Medical Association;* 274(1): 35-43.

Lyons M., Brown R. and Wears R. (2007) Factors that affect the flow of patients through triage. *Emergency Medicine Journal*; 24(2): 78–85.

McGillis Hall, L., Ferguson-Pare, M., Peter, E., White, D., Besner, J., Chisolm, A., Ferris, E., Pederson, C. and Hemingway, A. (2010) Going blank: factors contributing to interruptions to nurses' work and related outcomes. *Journal of Nursing Management;* 18(8): 1040-1047.

Murphy, M. and While, A. (2012) Medication administration practices among children's nurses: a survey. *British Journal of Nursing;* 21(15): 928-933.

National Patient Safety Agency (NPSA) (2007) *Safety In Doses.* National Patient Safety Agency. www.nrls.npsa.nhs.uk [accessed 24 November 2013].

NHS England Patient Safety Domain Team (2013) *The Never Events List; 2013/14 update.* www.acta.org.uk [accessed 26 June 2014].

Nursing and Midwifery Council (2010) *Standards for Medicines Management* www.nmc.org [accessed 27 March 2014].

Pape, T. (2003) Applying airline safety practices to medication administration. *Medsurg Nursing;* 12(2): 77-93.

Potter, P., Wolf, L., Boxerman, S., Grayson, D., Sledge, J., Dunagan, C. and Evanoff, B. (2005) Understanding the cognitive work of nursing in the acute care environment. *Journal of Nursing Administration;* 35(7/8): 327-335.

Raban, M. and Westbrook, J. (2013) Are interventions to reduce interruptions and errors during medication administration effective? : a systematic review. *BMJ Quality and Safety,* Published Online First: [26 August 2013] doi:10.1136/bmjqs-2013-002118. http://qualitysafety.bmj.com/content/early/2013/08/26/bmjqs-2013-002118.full.pdf+html [accessed 23 March 2014].

Relihan, E., O'Brien, v., O'Hara, S. and Silke, B. (2010) The impact of a set of interventions to reduce interruptions and distractions to nurses during medication administration. *BMJ Quality and Safety;* 19(5): 1-6.

Ridley, S., Booth, S. and Thompson, C. (2004) Prescription errors in UK critical care units. *Anaesthesia;* 59(12): 1193-1200.

Scott-Cawiezell, J., Pepper, G., Madsen R., Petroski, G., Vogelsmeier, A. and Zellmer, D. (2007) Nursing home error and level of staff credentials. *Clinical Nursing Research;* 16(1): 22-78.

Simons, Y., Magrabi, F. and Coiera, E. (2012) A systematic review of the psychological literature on interruption and its patient safety implications. *Journal of the American Medical Informatics Association;* 19(1): 6-12.

Speier, C., Valacich, J. and Vessey, I. (1999) The influence of task interruption on individual decision making: an information overload perspective. *Decision Sciences*; 30(2): 337-360.

Wakefield, B., Wakefield, D., Uden-Holman, T. and Blegan, M. (1998) Nurses' perceptions of why medication administration errors occur. *Medsurg Nursing;* 7(1): 39-44.