

Review Article

Medication Safety Practices in Clinical Nursing: Nurses' Characteristics, Skills, Competencies, Clinical Processes, and Environment

Efstratios Athanasakis, BScN (Hons), RN, MA (Research Methods)

Senior Clinical Research Nurse, NIHR Clinical Research Facility, Wythenshawe Hospital, Manchester University NHS Foundation Trust, Manchester, UK

Correspondence: Efstratios Athanasakis, NIHR Clinical Research Facility, Wythenshawe Hospital, Manchester University Hospitals NHS Foundation Trust, Southmoor Road, Wythenshawe, Manchester, M23 9QZ, UK. E-mail: efstratios.athanasakis@mft.nhs.uk

Abstract

Background: An important aspect of patient safety is the safe medication administration to patients. Although preventive measures have been integrated in practice, deviations from medication safety still exist. To minimise medication errors' occurrence, organisations and nurses continuously develop the clinical field with practices and interventions to ensure maintenance of safety.

Aim: To discuss the original research evidence about nursing medication safety practices which are related to (a) nurses' characteristics, skills and competencies, (b) clinical processes and (c) clinical environment.

Design and methods: This is a discussion article that draws on original research evidence about medication safety practices in clinical nursing practice. Literature retrieved from searches in databases: PUBMED, BNI, CINAHL, Wiley Online library and ScienceDirect. Specific inclusion and exclusion criteria were set.

Results and Discussion: The medication safety practices concerned nurses' characteristics (knowledge, experience), skills and competencies (e.g. self-awareness and vigilance), clinical processes (e.g. additional 'Rights' to the traditional '5 Rights'), and clinical environment (e.g. ward design).

Conclusion and Implications: Each of the safety practices is significant and contributes to patient safety in a unique way. The heart of all medicine safety practices is their practicality, simplicity, effectiveness, positive contribution to improve the safety culture and the learning outcomes for all clinical teams. Any of the mentioned practices can be used as initiative or resource for either the frontline or senior management nurses to integrate them in their own practice on a ward level, hospital policies, clinical environments and shape the future of medication safety culture.

Keywords: Registered nurses, nursing, medication errors, medication administration, medicine safety, clinical nursing practice, preventive measures, prevention

Introduction and Background

Over the last 20 years there have been various reports by national and international healthcare organisations and bodies discussing issues about the severity of errors in healthcare in general including medication errors (MEs) (USA National Coordinating Council for Medication Error Reporting and Prevention, 2001; World Health Organization, 2017; The Medicines Safety Improvement Programme by NHS England, 2019). Important reports about features of MEs were published by individual groups of healthcare researchers, like Taxis and Barber (2003); Tang et al. (2007); Sheu et al. (2009); Kim et al. (2011); Westbrook et al. (2011) with the report by Kohn et al. (1999) remaining benchmark in patient safety in healthcare. Progressively and throughout the last decades the research portfolio about

medication safety and errors in nursing have been developed extensively.

Registered nurses play important role in patient safety, and especially in medicine safety, prevention of MEs and ME management, as one of their core skills is patients' medication management (Nursing & Midwifery Council, 2010). The nurses participate in the late stages of the medication administration (MA) process: medication preparation, MA, documentation of the MA and monitoring of medication response (Leape et al., 1998). All these activities and other medication-related occupy around 25-40% of the nursing working time (Armitage & Knapman, 2003; Keohane et al., 2008).

Nurses perform medication rounds for the administration of medications. Medication rounds are known as drug rounds or medication cycle, as well. A medication round: (a) *'is the process of the*

nurse administering medications to all of the assigned patients at a scheduled time. The medication cycle ends when the nurse completes administering all medications to the assigned patients' (p.213, Pape, 2013), and according to other authors (b) the medication round: *'starts the time when a nurse opened the medication trolley to begin the round until a medication are administered'* (p.2, Relihan et al., 2010). The above two definitions are adopted for the purposes of the present discussion article. In broader terms, medication management activity is *'any interpretation between the nurse, the patient and medication'* (p.936, Manias et al., 2005).

The nature of the MA process itself and the clinical environment make medication rounds a complex thinking process (Eisenhauer et al., 2007; Palese et al., 2009). It requires nurses' full attention, as it involves several cognitive processes (verification of patient's name, checking the details of the medical prescription and how to administer it, correspondence of what is available against the prescription) (Tomietto et al., 2012). Thereby, it is likely that 7 out of 10 nurses would experience at least one MA error during their career (You et al., 2015). Clinical experience and skills have been proved to decrease ME rates almost by 11% per year (up to 6 years) and the serious errors by 18.5% (Westbrook et al., 2011).

The practices to prevent MEs can originate from common sense, however, what remains priority is how they are evaluated in real situations and the nurses feel comfortable when they follow them (Smeulers et al., 2014). Even though MEs can occur at any stage of the MA process, the nurses are the last link to stop them before occurring and reaching patients. This is the explanation of why nurses are directly involved in ME incidents (Jones & Treiber, 2010) and why the research investigation of medication safety from a nursing perspective is valuable.

Past systematic reviews examined medication safety practices such as clinical reasoning or interventions for medication safety, their evaluation, nurses' medication competencies in emergency, medical, surgical, paediatric nursing

and various areas (Miller et al., 2007; Sulosaari et al., 2011; Raban & Westbrook, 2014; Hayes et al., 2017; Rohde & Domm, 2018; Manias et al., 2020; Millichamp & Johnston, 2020). As the past systematic reviews focused mainly on research evidence about particular types, interventions and bundle of measures; the present discussion article summarises the research evidence about several prevention practices related to 3 categories as described below at the aim of the article.

Aim: The aim of the present article is to discuss the original research evidence about nursing medication safety practices which are related to (a) nurses' characteristics, skills and competencies, (b) clinical processes and (c) clinical environment.

Design and Method

This is a discussion article which presents practices and measures implemented within clinical nursing to maintain patient safety and prevent MEs. The literature retrieved from searches in databases: PUBMED, BNI (British Nursing Index), CINAHL (Cumulative Index to Nursing and Allied Health Literature), Wiley Online library and ScienceDirect. The keywords were: registered nurses, nursing, medication errors, medication administration, medicine safety, clinical nursing practice, preventive measure, prevention; and were combined with the Boolean operators AND and OR. Inclusion and exclusion criteria were set (Table 1). Additional references and articles identified from the reference lists of the articles found in the first search, and from author's previous published work on medication safety and errors in nursing (Athanasakis, 2012; 2015; 2019; Karavasiliadou & Athanasakis, 2014). For the analysis of the data from each original research article, each of the individual medication safety practices was isolated in the beginning, then all of them were clustered into groups with similar meanings; for instance, critical thinking practices that mentioned in one study were combined with clinical judgement practices from the same or another study and made up the subchapter of cognitive competencies in the present article.

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
original research articles, systematic reviews	other article types
articles published in English	articles in languages other than English
articles published between 2000-June 2021	publication years other than the included
articles that involved mainly registered nurses as the main population of the sample or investigated medication safety practice/s only from a nursing perspective and/or nurses were directly involved in it	articles involved nursing students, pharmacists, or doctors as the main populations of the sample investigated or investigated medication safety practice/s in undergraduate nursing or from a pharmaceutical or medical perspective
articles that investigated medication safety practice/s of any type, single or combined, their features, and targeted to any type of medication error	did not meet any of the inclusion criteria, quality improvement/educational projects that their effectiveness was assessed pre and post implementation of intervention, such as interventional studies which can be examined within a meta-analysis context
articles that were conducted in hospital wards and units	were conducted in settings other than hospitals

Findings and Discussion

Nurses' characteristics, skills and competencies

Medication education: Continuous opportunities for education is a way to prevent errors in practice (Flynn et al., 2012), but this subchapter refers specifically to nurses' education about medications. In order nurses to respond to medication management they receive education about medication safety, and its principles in formal and informal ways (Aydon et al., 2016). The types of education refer to pharmacology principles (Petrova, 2010), a comprehensive training about MEs in nursing (Clifton-Koeppel, 2008), education based on patient scenarios (patient attributes and text, patient career, medication therapy) and clinical judgement education (communication, patient education skills, pharmacology knowledge), the influence of philosophy of care in medication education, updates with evidence-based medication information (Latter et al., 2000) and education for routinely administered medications (McBride-Henry & Foureur, 2007).

Nurses' theoretical education and practice experience is the right combination to achieve drug calculation competency (Jones, 2009). Nurses' medication calculation skills cover mainly mathematical skills, dosage calculation and pharmacological skills (Grandell-Niemi et al., 2003). For the newly qualified nurses ways to support their pharmacology education can be achieved through protected time for teaching, assessment and support of their competencies in

MA and a structured preceptorship programme (Ofosu & Jarrett, 2015). More, other ways to maintain and improve nurses' pharmacology and calculation skills include: attendance of relevant lectures (Grandell-Niemi et al., 2003), post-registration pharmacology updates focused on specific diseases (King, 2004), e-learning packages, evidence-based numeracy modules, regular updates on medication calculation skills, programmes that reflect real situations from clinical practice (Jones, 2009; Sherriff et al., 2011), and self-directed learning about pharmacology (e.g. the British National Formulary) (Joint Formulary Committee, 2021).

Knowledge and experience: Continuous updating of nurses' knowledge, maintenance of their clinical skills and understanding of the current hospital policies are always factors that influence nurses' own practice (Hand & Barber, 2000). Other factors of nursing experience (educational background, confidence levels, management of situations that do not come under any protocols, trust medical peers) (Aydon et al., 2016), nurses' knowledge levels about medication preparation and administration of intravenous medications, MA skills at undergraduate level, and relevant post-graduate courses are all significant to maintain patient safety (Di Simone et al., 2016).

As clinical practice is a field of constant changes, MA is also open to continuous improvements. Nurses' knowledge of the medication processes and awareness of the relevant medication policies updates, any alterations of medication procedures and nurses not being able to retain knowledge

about all medications they administer can affect patient safety. By having adequate levels of knowledge of the medications nurses administer on daily basis, the importance of knowing how to access medication information, have adequate knowledge of the wide range of available resources (McBride-Henry & Foureur, 2007), balance the risks when administering medications and consider patient-related factors (e.g. patient's condition, features of the medication to be administered: route, the medication itself, combinations with other medications) are tactics that eliminate error occurrence (Smeulers et al., 2014).

Cognitive competencies: Critical thinking, clinical reasoning and clinical judgement constitute the cognitive competencies. Thinking in a critical way is a basic component for decision-making and medication competence (Sulosaari et al., 2011). Nurses' critical thinking and thinking processes during the MA stages reveal that is not a technical mechanical process and involves professional knowledge, application of

knowledge in practice, technical skills, full awareness of patients' condition, interpretation of patient data in relation to the MA, observational skills, consultation with colleagues and problem solving skills (Eisenhauer et al., 2007). Specifically, the same authors identified the follow descriptive categories: communication, dose-time, checking, assessment, evaluation, teaching, side effects, work arounds, anticipating problem solving, and drug administration (Eisenhauer et al., 2007).

For the nurses, being competent in MA means they perform evaluation of patients' complex clinical conditions, respond to changing situations and make effective decisions regarding patients' medications treatment; all within their legal responsibilities to assess, plan the care, administer medications and evaluate outcomes of their administration (Aitken et al., 2006; Sulosaari et al., 2011). The range of competencies that covers nurses' MA and medication management is presented in Table 2.

Table 2 Registered nurses' medication management and medication administration competencies

Authors & Year	Meaning of competencies
Aitken, Manias, & Dunning (2006) *	giving the medications to patient, planning care, assessing and evaluating patients before, during and after administering medications
Keohane, Bane, Featherstone et al. (2008) **	information retrieval, management of physician orders, obtaining and verifying medications, uncharacterised by observer, inefficient waiting, documentation of medication administration, medication delivery
Sulosaari, Suhonen, & Leino-Kilpi (2011) **	3 major fields of competencies: decision-making, theoretical competence and practical and 11 categories: knowledge of anatomy and physiology, knowledge of pharmacology, communication, interdisciplinary collaboration, information seeking, mathematical and medication calculation, medication administration, medication education, assessment and evaluation, documentation, promoting medication safety as part of patient safety
Luokkamäki, Härkänen, & Saano (2021) **	safe ordering, handling, storing and discarding of medications, preparing of medications, the administration of medications to patients, documentation, evaluation and assessment of medication-related issues, drug calculation skills, cooperation with other professionals, cooperation with the patients, reporting of medication information

* Medication management competencies, ** Medication administration competencies

Decision-making is a cognitive competence, as well. According to Sulosaari et al. (2011) there are 3 categories of competences: decision-making, theoretical and practical competence. Nurses support their decisions on their competencies in order to apply medication practices and maintain

safety. Three decision-making models identified by Manias et al. (2004): hypothetico-deductive reasoning (objective monitoring: e.g. check electrolyte levels before administering diuretics, asking the patient: e.g. patient was asked if they prefer to have skin cleanser, patient's body

language: e.g. nausea, vomiting), pattern recognition (patient characteristics: e.g. occurrence of chest pain/angina in cardiology patients, medication characteristics: e.g. investigate if patient has potential allergies and reactions) and intuition (patient's monitoring: e.g. levels of confusion or vital signs).

Adoption of mindful strategies: These strategies can be adopted by individuals separately and consist of 4 groups: (a) think safety: the individual nurse assess factors that could negatively affect their cognitive workload in 3 domains (self: inexperience?, life events?; context: high workload?, unfamiliar clinical area?; task: are these skill-, rule- or knowledge-based?), (b) safety actions: mindful self-checking techniques-respond to interruptions: 'now where I was?' (p.5), verbalising the verification process of patient and medication/reduce the automaticity of actions, independent double-checking of high-risk medications, (c) safety communication: 'sterile cockpit rule' which means focusing on the critical tasks (the MA) without interruption or distraction verbally or using gestures, introduction of huddles in practice, and (d) safety culture: it emerged when all the 3 previous actions are implemented and in combination with effective teamwork, leadership, and communication results to positive safety culture (Gluyas, 2018).

Time management: This strategy was reported in a study in which nurses' medication day was explored (Jennings et al., 2011). The nurses who participated in it used the follow strategies to respond to the demands of the MA to eliminate the potential of error occurrence: (a) sequencing MA: nurses prioritised to administer the intravenous antibiotics first and while waiting for the infusion to be completed, they would move on to the next intravenous antibiotic administration. Patients who were on crushed oral medications were placed at the end of a medication round.; (b) clustering care with MA: the nurses were undertaking other tasks (record observations, change dressings, complete assessments, interact with families and patients) after administering the medications-'*make one visit do*' (p.1448).; (c) multitasking during MA: undertaking multiple tasks at the same time during MA.; (d) individualised techniques for managing temporal load: for example, making lists of the exact time and how many medications were due for every patient. It worth mentioning that on this study the interruptions were seen as an action with positive

impact and that the MA itself inherently entails interruption (Jennings et al., 2011).

Skill mix: Apart from nurses' theoretical and knowledge background about medications, it is equally necessary to be adequately skilled with a combination of skills in order to maintain patient safety during MA (McBride-Henry & Foureur, 2007; Tang et al., 2007). Nurses' organisation skills are a prevailing element that co-ordinates patients' medication care (Sulosaari et al., 2011). For the support of their skills, nurses adopted the following behaviours: information seeking they used any kind of resources (online information, drug books, handbooks, medication packages, hospital policies, hospital pharmacy, hospital-based or on-call pharmacists, consulting) to make evidence-based decisions when managing medications (Sulosaari et al., 2011; Dickson & Flynn, 2012), nurses used patients' own medications (brought from home with them on admission) or looked for the required medications in other wards/units (Smeulers et al., 2014), were confident with the use of medication resources (comprehensive, up-to-date, medication protocols) (Aydon et al., 2016), were confident about their mathematical and calculation skills (Jones, 2009), checked alternative medication forms and routes (Eisenhauer et al., 2007), receptiveness to question any medication information-especially if they were unsure as nurses 'do no harm' (p.2472, Aydon et al., 2016).

Self-awareness and vigilance: This measure refers to the recognition of factors and their nature that contribute to ME occurrence, acknowledgement of nurses' own limitations and deficits, being alert and vigilant, paying attention to detail, read patients' notes and treatment plans carefully, improve record keeping practices, seek advice in general and from colleagues, work precisely when handling medications, and improve patient observation (Meurier et al., 1997; Hand & Barber, 2000; Karavasiliadou & Athanasakis, 2014; Smeulers et al., 2014; Aydon et al., 2016). An example of paying attention to details was when the nurses got in the habit of checking the medication charts and the prescriptions thoroughly and accordingly to patients' current condition, e.g. considered requesting doctors' review to reduce three types of medications for analgesia if patients did not feel pain, or patients who were due to take their medications orally, but were unable because of vomiting, nurses understood that the oral medications would not be effective (Smeulers et

al., 2014). In another study, similar findings were presented: being vigilant meant taking 'everything' into consideration: 'everything' refers to patients' characteristics, conditions, investigations and results, in combination with the medications they were on. Nurses looked for an answer if things did not look right with the medications their patients were on (Dickson & Flynn, 2012).

Clinical processes

Adherence of fundamental MA practices: The adherence of the policies of the MA process is a fundamental element for the patient safety during MA, such as checking patients' name and identity before administering the medications to patients (which is one of the 5 'Rights') or the provision of education to patients about their medications. The nurses' comprehension of the steps that form the MA process, especially each of the steps and measures in place, nurses' accuracy of their

adherence and actions upon finding a deviation in medicine safety are all factors that configure the features and impact of the errors (Gunningberg et al., 2014). Other two studies highlighted how necessary double-checking of medications is, double-signing when necessary and performing adequate checks (McBride-Henry & Foureur, 2007; Cloete, 2015).

Additional 'Rights' to the traditional '5 Rights': The '5 Rights' are common practice nowadays, as they are applied to the everyday clinical practice before the medication administration to each patient, thereby several times during every medication round. Even though they have been taught in nursing education for a long time and are fundamental, cases of MEs are still identified despite the adherence of the '5 Rights'. Table 3 presents the additional 'Rights' beyond the basic '5 Rights'.

Table 3 The additional 'Rights'

The additional 'Right'...	Explanation/Reference
procedure	Skills, training, competence, delegation, use of correct equipment, safe use of equipment. (Dimond, 2003)
documentation/ record-keeping of dose	Nurse signs the medication chart, avoiding of repeating the dose. (Dimond, 2003; Clifton-Koeppel, 2008; Elliott & Liu, 2010; Alexis & Caldwell, 2013; Shepherd & Shepherd, 2020)
action	Justification of medication administration provide the basic information for the medication to the patient. (Elliott & Liu, 2010; Alexis & Caldwell, 2013; Shepherd & Shepherd, 2020)
to refuse	Patient refuses to/cannot take a medication, nurse refuses to administer the medication and justifies why based on evidence. (Edwards & Axe, 2015; 2018)
knowledge	Nurse's awareness of evidence-based knowledge about what to administer, pharmacokinetics, pharmacodynamics, interactions, side-effects, law perspective. (Edwards & Axe, 2015; 2018)
method	(Dimond, 2003)
reason	(Clifton-Koeppel, 2008)
drug levels?	(Clifton-Koeppel, 2008)
expiration	The nurse checks the expiry dates on materials used, the medication and diluent. (Clifton-Koeppel, 2008)
questions or challenges	The nurse asks appropriate questions of any issue related to the medication they would administer, legibility of prescription, access to resources. (Edwards & Axe, 2015; 2018)
advice	The patient is informed about their medications by the nurse. (Edwards & Axe, 2015; 2018)
outcome	The nurse documents the omission, administration and monitors patient's positive or negative response to the medication. (Edwards & Axe, 2015; 2018)

response Evaluation of the desired effect, right response by patient.
(Elliott & Liu, 2010; Alexis & Caldwell, 2013; Shepherd & Shepherd, 2020)

Adherence of protocols: The adherence of the protocols set by every organisation provides guidance to nurses and protect the patients. It is required to be clear and up-to-date (Aydon et al., 2016). When nurses managed medications and faced issues, they used protocols as an extra secure source, e.g. when required parenteral administration of antibiotics for their patients, and by this way their autonomy was enhanced. MA protocols were also used by nurses when were moved from the wards they usually worked on to other clinical areas (Manias et al., 2005). Protocols regarding medication preparation and administration involve practices like checking of patients' identity wristband, implementation of bedside bar coding for MA, checking of the basic '5 Rights' independently (plus any additional depending on local policies) and uniformly (in same order each time), and double-checking MA (2 nurses checking certain medications, all parenteral, opioids, specific oral tablets) by a graduate and an experienced nurse. The double-checking of all meds, especially for vulnerable patients (e.g. newborns), provides safety, but entails disadvantages like the non-immediate availability of the second checker or low staffing levels (Manias, et al., 2005; Clifton-Koeppel, 2008; Petrova, 2010).

Patient engagement and education: A simple practice to educate patients about their medication is through discussion (Keohane et al., 2008). The educational discussions involve details like medications' therapeutic reason, indications, and side effects. It is important to listen and respond to any queries patients may have at any point during their admission (Dickson & Flynn, 2012). Practically patients' participation in MA safety processes includes 3 stages: engaging in process of MA (e.g. visual checking, active questions to nurses), being 'half in, half out of it' (e.g. patients feeling too weak, too sick, mentally confused), and perceiving nurses' time (e.g. nursing working time not enough, value the time for nurse-patient interaction) (Macdonald et al., 2014). Through all the above interactions a therapeutic relationship is built and rapport between patient and nurses. Keeping patients active as participants in their MA acted as a final safety net to ensure safety and quality (Popescu et al., 2011). In another study,

nurses described that patient education increased patients' knowledge about the medication they were on and was a core measure to prevent errors by the patients themselves or the nurses. When nurses collected information about their patients' medications was '*the best defence to prevent MEs from reaching the patient*' (p.7, Dickson & Flynn, 2012).

Clinical environment

Interruptions/distractions: The identification of when interruptions and distractions occur, what are they like and their effects on errors are necessary to design strategies that would eliminate them. Research evidence recommend avoiding unnecessary conversations during medication-related tasks, avoid interrupting colleagues and wait until the medication-related task is completed. If nurses are interrupted by families or colleagues during MA, they can respond: '*I can answer that question in a minute...I need to focus on this medication right now.*' (p.77). Telephone calls, family questions, emergencies cannot be controlled. Visible signs such as 'Do not interrupt' can be used for staff reminder about the impact of interruptions have to the MA (Clifton-Koeppel, 2008). In order to manage interruptions and distractions, the measure of protected medication rounds has been introduced to clinical practice. This measure refers to the performance of medication rounds without any interruptions/distractions and was proposed by the nurses themselves to minimise errors (Fry & Dacey, 2007). Evidence from other studies suggested limited phone calls during MA which again helped nurses to focus on any of the tasks of the MA process and not '*losing the train of thought*' (p.10, Dickson & Flynn, 2012), the handling of nurses' calls by medical secretaries (except for the emergencies) (Nguyen et al., 2010; Dickson & Flynn, 2012; Freeman et al., 2013), or the awareness of the ward team and other professionals who visit the ward to be aware of the impact interruptions can potentially have on medication safety and medication rounds (Hand & Barber, 2000).

Ward design and clinical room: The ward design belongs to the multifactorial influences on the MA safety, for example when medication

supplies were in close proximity from the nurses' base ward, the possibility of delaying MA was minimised (Popescu et al., 2011). Further, the medication/treatment room belongs to the structure of clinical environment and has its own basic role, as the nurses dedicate several working time in it for the medication preparation and management. A well-designed, spacious and tranquil medication room where nurses prepare medications calmly, with adequate lighting, adequate storage for all medication supplies, non-cluttered workspaces with low noise levels and wards solely dedicated to MA minimise the error potential (McBride-Henry & Foureur, 2007; Smeulers et al., 2014; Cloete, 2015). In addition to the above, the safe storage of medications in locked bedside drawers leads to safer and quicker medication rounds (Manias et al., 2005; McBride-Henry & Foureur, 2007). Bedside medication lockers may entail benefits, however the nurses must always remember that regular checks needed to avoid mixing medications between the patient who was in a specific bedspace and the patient that is coming to the same bedspace after the discharge of the first one (Hogg et al., 2012; Grima & Tai, 2015).

Conclusion and Relevance to Clinical Practice:

There are various practices and measures integrated in everyday clinical nursing that nurses follow to ensure medication safety for patients. Evidence from the present part articulates that medication safety practices concerned nurses' characteristics, skills, competencies, clinical processes, and clinical environment. Each medication safety practice has its own significance and contribution to the medication safety chain. Although every single medicine safety practice and intervention maintains its own value, it is usually a bundle of interventions that makes difference in medication safety (Clifton-Koeppel, 2008). The examples mentioned in this article are indicative and can vary among healthcare organisations and nursing teams. What is more important is that the heart of all medicine safety practices is their practicality, simplicity, effectiveness, positive contribution to the improvement of safety culture and the constructive learning outcomes for all clinical teams. It is hoped that the discussed practices and measures constitute initiatives, resources and practical guidance for the frontline clinical nurses to enhance medicine safety and protect patients from any deviations from safety; but can be

potential influence for nurse leadership, senior management and policy-makers. For instance, senior nurses can strengthen team learning through staff meetings, setting ground rules, opportunities for staff to engage with them and discuss relevant issues (Drach-Zahavy & Pud, 2010). Further original research studies would be valuable to get insights into the nature of every medicine safety practice or interventions and their relation to ME occurrence, their long-term impact, disseminate safety behaviours and best practices, develop well-designed tools and strategies, and understand the contribution of education in medication safety.

Authorship Statement: The views expressed are those of the author and not necessarily those of the NIHR.

References

- Aitken R., Manias E. & Dunning T. (2006) Documentation of medication management by graduate nurses in patient progress notes: a way forward for patient safety. *Collegian* 13:5-11.
- Alexis O. & Caldwell J. (2013) Administration of medicines-the nurse role in ensuring patient safety. *British Journal of Nursing* 22:32-35.
- Armitage G. & Knapman H. (2003) Adverse events in drug administration: a literature review. *J Nurs Manag* 11:130-140.
- Athanasakis E. (2012) Prevention of medication errors made by nurses in clinical practice. *Health Science Journal*, 6:773-783.
- Athanasakis E. (2015) The method of checking medications prior to administration: an evidence review. *Int. J. Caring Sci.*8(3), 801-818.
- Athanasakis E. (2019) A meta-synthesis of how registered nurses make sense of their lived experiences of medication errors. *J. Clin. Nurs.* 28:3077-3095.
- Aydon L., Hauck Y., Zimmer M. & Murdoch J. (2016). Factors influencing a nurse's decision to question medication administration in a neonatal clinical care unit. *J. Clin. Nurs.* 25:2468-2477.
- Chang Y. & Mark B. (2011) Effects of learning climate and registered nurse staffing on medication errors. *Nursing Research* 60:32-39.
- Clifton-Koeppel R. (2008) What nurses can do right now to reduce medication errors in the neonatal intensive care unit. *Newborn Infant Nurs Rev* 8:72-82.
- Cloete L. (2015) Reducing medication errors in nursing practice. *Nursing Standard* 29:50-59.
- Di Simone E., Tartaglini D., Fiorini S., Petriglieri S., Plocco C. & Di Muzio M. (2016) Medication errors in intensive care units: nurses' training needs. *Emergency Nurse* 24:24-29.
- Dickson G.L. & Flynn L. (2012) Nurses' clinical reasoning: processes and practices of medication safety. *Qualitative Health Research* 22:3-16.

- Dimond B. (2003) Principles for the correct administration of medicines: 1. *Br. J. Nurs.* 12:682-685.
- Drach-Zahavy A. & Pud D. (2010) Learning mechanisms to limit medication administration errors. *Journal of Advanced Nursing* 66:794-805.
- Edwards S. & Axe S. (2015) The 10 'R's of safe multidisciplinary drug administration. *Nurse Prescribing* 13:398-406.
- Edwards S. & Axe S. (2018) Medication management: reducing drug errors, striving for safer practice. *Nurse Prescribing* 16:380-389.
- Eisenhauer L.A., Hurley A.C. & Dolan N. (2007) Nurses' reported thinking during medication administration. *Journal of Nursing Scholarship* 39:82-87.
- Elliott M. & Liu Y. (2010) The nine rights of medication administration: an overview. *Br. J. Nurs* 19:300-305.
- Flynn L., Liang Y., Dickson G.L., Xie M. & Suh D.C. (2012) Nurses' practice environments, error interception practices, and inpatient medication errors. *Journal of Nursing Scholarship* 44:180-186.
- Freeman R., McKee S., Lee-Lehner B. & Pesenecker J. (2013) Reducing interruptions to improve medication safety. *Journal of Nursing Care Quality* 28:176-185.
- Fry M.M. & Dacey C. (2007) Factors contributing to incidents in medicine administration. Part 2. *Br. J. Nurs* 16:676-681.
- Gluyas H. (2018) Understanding the human and system factors involved in medication errors. *Nursing Standard*, Jul 18.
- Grandell-Niemi H., Hupli M., Leino-Kilpi H. & Puukka P. (2003) Medication calculation skills of nurses in Finland. *Journal of Clinical Nursing* 12:519-528.
- Greenwalt M., Griffen D. & Wilkerson J. (2017) Elimination of emergency department medication errors due to estimated weights. *BMJ Quality Improvement Reports* 6:1-5.
- Grima G. & Tai B. (2015) Bedside medication lockers: the hidden danger upon discharge. *Journal of Pharmacy Practice and Research* 45:302-305.
- Gunningberg L., Pöder U., Donaldson N. & Leo Swenne C. (2014) Medication administration accuracy: using clinical observation and review of patient records to assess safety and guide performance improvement. *Journal of Evaluation in Clinical Practice* 20:411-416.
- Hand K. & Barber N. (2000) Nurses' attitudes and beliefs about medication errors in a UK hospital. *International Journal of Pharmacy Practice* 8:128-134.
- Hayes C., Jackson D., Davidson P.M., Daly J. & Power T. (2017) Calm to chaos: Engaging undergraduate nursing students with the complex nature of interruptions during medication administration. *Journal of Clinical Nursing* 26:4839-4847.
- Hogg A., Scullin C., Luo R., Currie A., Scott M.G. & McElnay J. C. (2012) Do patient bedside medicine lockers result in a safer and faster medicine administration round? *European Journal of Hospital Pharmacy: Science and Practice* 19:525-528.
- Jennings B.M., Sandelowski M. & Mark B. (2011) The nurse's medication day. *Qualitative Health Research* 21:1441-1451.
- Joint Formulary Committee. (2021) British National Formulary. London: BMJ Group and Pharmaceutical Press. Retrieved from <http://www.medicinescomplete.com>
- Jones J.H. & Treiber L. (2010) When the 5 rights go wrong: medication errors from the nursing perspective. *J. Nurs. Care Qual.* 25:240-247.
- Jones S.W. (2009) Reducing medication administration errors in nursing practice. *Nursing Standard* 23:40-46.
- Karavasiliadou S. & Athanasakis E. (2014) An inside look into the factors contributing to medication errors in the clinical nursing practice. *Health Sci. J.* 8:32-44.
- Keohane C.A., Bane A.D., Featherstone E., Hayes J., Woolf S., Hurley A., Bates D.W., Gandhi T.K. & Poon E.G. (2008) Quantifying nursing workflow in medication administration. *J Nurs Adm* 38:19-26.
- Kim K.S., Kwon S.H., Kim J.A. & Cho S. (2011) Nurses' perceptions of medication errors and their contributing factors in South Korea. *J Nurs Manag* 19:346-353.
- King R.L. (2004) Nurses' perceptions of their pharmacology educational needs. *J. Adv. Nur.* 45:392-400.
- Kohn L.T., Corrigan J.M. & Donaldson M. (1999) *To err is human: Building a safer health system.* Washington DC: National Academy Press.
- Latter S., Yerrell P., Rycroft-Malone J. & Shaw D. (2000) Nursing, medication education and the new policy agenda: the evidence base. *International Journal of Nursing Studies* 37:469-479.
- Leape L.L., Kabcenell A., Berwick D.M. & Roessner J. (1998) *Reducing Adverse Drug Events.* Boston, Institute for Health Care Improvement: Breakthrough Series Guide.
- Luokkamäki S., Härkänen M., Saano S. & Vehviläinen-Julkunen K. (2021) Registered nurses' medication administration skills: a systematic review. *Scandinavian Journal of Caring Sciences* 35:37-54.
- Macdonald M.T., Heilemann M.V., MacKinnon N.J., Lang A., Gregory D., Gurnham M.E. & Fillatre T. (2014) Confirming delivery: understanding the role of the hospitalized patient in medication administration safety. *Qualitative Health Research* 24:536-550.
- Manias E., Aitken R. & Dunning T. (2005) How graduate nurses use protocols to manage patients' medications. *Journal of Clinical Nursing* 14:935-944.
- Manias E., Aitken R. & Dunning T. (2004) Decision-making models used by 'graduate nurses' managing patients' medications. *Journal of Advanced Nursing* 47:270-278.
- Manias E., Kusljic S. & Wu A. (2020) Interventions to reduce medication errors in adult medical and surgical settings: a systematic review. *Therapeutic Advances in Drug Safety* 1:1-29.
- McBride-Henry K. & Foureur M. (2007) A secondary care nursing perspective on medication administration safety. *Journal of Advanced Nursing* 60:58-66.
- Meurier C.E., Vincent C.A. & Parmar D.G. (1997) Learning from errors in nursing practice. *Journal of Advanced Nursing* 26:111-119.
- Miller, M.R., Robinson, K.A., Lubomski, L.H., Rinke, M.L. & Pronovost, P.J. (2007) Medication errors in paediatric care: a systematic review of epidemiology

- and an evaluation of evidence supporting reduction strategy recommendations. *Quality & Safety in Health Care*, 16(2), 116-126.
- Millichamp T. & Johnston A.N.B. (2020) Interventions to support safe medication administration by emergency department nurses: An integrative review. *International Emergency Nursing* 49:100811.
- Nguyen E.E., Connolly, P. & Wong V. (2010) Medication safety initiative in reducing medication errors. *Journal of Nursing Care Quality* 25:224-230.
- Nursing and Midwifery Council (NMC) (2010) Standards for medicine management. Retrieved from: <https://www.nmc.org.uk/globalassets/sitedocuments/standards/nmc-standards-for-medicines-management.pdf>
- Ofori R. & Jarrett P. (2015) Reducing nurse medicine administration errors. *Nursing Times* 111:12-14.
- Palese A., Sartor A., Costaperaria G. & Bresadola V. (2009) Interruptions during nurses' drug rounds in surgical wards: observational study. *Journal of Nursing Management* 17:185-192.
- Paparella S. (2008a) Choosing the right strategy for medication error reduction: Part I. *Journal of Emergency Nursing* 34:145-146.
- Paparella S. (2008b) Choosing the right strategy for medication error prevention--part II. *Journal of Emergency Nursing* 34:238-240.
- Pape T.M. (2013) The effect of a five-part intervention to decrease omitted medications. *Nursing Forum*
- Petrova E. (2010) Nurses' perceptions of medication errors in Malta. *Nursing Standard* 24:41-48.
- Popescu A., Currey J. & Botti M. (2011) Multifactorial influences on and deviations from medication administration safety and quality in the acute medical/surgical context. *Worldviews on Evidence-Based Nursing* 8:15-24.
- Raban M.Z. & Westbrook J.I. (2014) Are interventions to reduce interruptions and errors during medication administration effective?: a systematic review. *BMJ Quality & Safety* 23:414-421.
- Relihan E., O'Brien V., O'Hara S. & Silke B. (2010) The impact of a set of interventions to reduce interruptions and distractions to nurses during medication administration. *Quality & Safety in Health Care* 19:e52. <https://doi.org/10.1136/qshc.2009.036871>
- Rohde E. & Domm E. (2018) Nurses' clinical reasoning practices that support safe medication administration: An integrative review of the literature. *Journal of Clinical Nursing* 27:e402-e411. <https://doi.org/10.1111/jocn.14077>
- Shepherd M. & Shepherd E. (2020) Medicines administration 1: understanding routes of administration. *Nursing Times* [online] 116:42-44.
- Sherriff K., Wallis M. & Burston S. (2011) Medication calculation competencies for registered nurses: A literature review. *Australian Journal of Advanced Nursing* 28:75-83.
- Sheu S.J., Wei I.L., Chen C.H., Yu S. & Tang F.I. (2009) Using snowball sampling method with nurses to understand medication administration errors. *Journal of Clinical Nursing* 18:559-569.
- Smeulders M., Onderwater A.T., van Zwieten M.C. & Vermeulen H. (2014) Nurses' experiences and perspectives on medication safety practices: an explorative qualitative study. *Journal of Nursing Management* 22:276-285.
- Sulosaari V., Suhonen R. & Leino-Kilpi H. (2011) An integrative review of literature on registered nurses' medication competence. *Journal of Clinical Nursing* 20:464-478.
- Tang F.I., Sheu S.J., Yu S., Wei I.L. & Chen C.H. (2007) Nurses relate the contributing factors involved in medication errors. *Jour of Clin Nur* 16:447-457.
- Taxis K. & Barber N. (2003) Ethnographic study of incidence and severity of intravenous drug errors. *British Medical Journal* 326:684.
- The Medicines Safety Improvement Programme from NHS England. (2019) Retrieved from: <https://www.england.nhs.uk/patient-safety/national-medicines-safety-programme/>
- Tomietto M., Sartor A., Mazzocoli E. & Palese A. (2012) Paradoxical effects of a hospital-based, multi-intervention programme aimed at reducing medication round interruptions. *Jour of Nur Manag* 20:335-343.
- USA National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) (2001) About medication errors. Retrieved from: <http://www.nccmerp.org/about-medication-errors>
- Westbrook J.I., Rob M.L., Woods A. & Parry D. (2011) Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. *BMJ Quality and Safety* 20:1027-1034.
- World Health Organization. (2017) Medication Without Harm-Global Patient Safety Challenge on Medication Safety. Geneva: World Health Organization.
- You M.A., Choe M.H., Park G.O., Kim S.H. & Son Y.J. (2015) Perceptions regarding medication administration errors among hospital staff nurses of South Korea. *International Journal for Quality in Health Care* 27:276-283.