



REVIEW ARTICLE

An inside look into the factors contributing to medication errors in the clinical nursing practice.

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Abstract

Background: Medication errors constitute a considerable concern for the patients and healthcare professionals. Therefore, in recent years there have been remarkable efforts through research papers to assess the etiology of medication errors.

Aim: To review the current literature related to the individual and the organizational factors that contribute to the occurrence of medication errors in the clinical nursing practice.

Method and material: A combination of various search terms: medication errors, contributing/etiologic/risk factors, nurses and nursing was used to search through the Pubmed database. For the involvement of an article in the existing review, specific inclusion criteria were set such as published in English the period between January 1990-December 2012.

Results: A total of 13 original research articles were included. The contributing factors to the occurrence of medication errors in clinical nursing practice include and system related subcategories. Two tables are provided. The first outlines the basic features of the research articles that were included in this review and the second one portrays the frequent (top 5) contributing factors to medication errors, placed according to their

type and significance. Study's findings suggest that both individual and organizational factors are major determinants of medication errors.

Conclusion: Medication errors by nurses are a type of patient malpractice, where the identification of contributing factors is vital. Since both categories of causality (individual and health system related) of medication errors contribute the same to their occurrence, consequently their address and resolution are of critical importance.

Keywords: Medication errors, contributing/etiologic/risk factors, nurses, nursing

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Introduction

The implementation of medication process requires the cooperation of various healthcare professionals like physicians, pharmacists and nurses. The medication process starts with the physicians' decision about the administration of the proper medicine to a patient and finishes with the medication administration to him/her and their monitoring of response to the medicine. Nurses participate in the latest steps of the medication process and are ultimately responsible for the medication administration to the patient.¹ The medication administration procedures' steps, as described by Leape et al.,² are presented in the Table 1.

As the United Kingdom's Nursing and Midwifery Council underlines, medication administration requires scientific judgment, knowledge and skills application.³ The time period spent by nurses on each shift to deal with themes related with medicines comes up to 40% of their working time.⁴ Thus, it is more likely for front-line healthcare professionals of the medication process (nurses) to be blamed for when a medication error happened. Indeed, nurses are at the "sharp end" of this procedure.⁵



It is useful to mention the medication error definition. A systematic review of 45 articles had been conducted to record the definitions of medication errors. Results from this study showed inconsistency in defining medication errors. Also, Lisby et al.,⁶ have defined the medication error according to their preferences and the needs of their research.

However, for the purpose of this study, a definition from the American National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) will be used:

"A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures, and systems, including prescribing, order communication, product labeling, packaging, nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use".⁷

A fundamental report to medication errors research area was reported by Kohn et al.⁸ The authors in this report pointed out the significance of medical errors and also mentioned that medication errors in 1993 resulted in 7.391 deaths, compared to 2.876 deaths in 1983. In another report by the World Health Organization (WHO 2009) entitled "Improving medication safety", is reported that when medication errors happen, healthcare professionals should "look for all the contributing factors", making clear by this phrase that medication errors is a multifactorial problem.⁹

According to Evans¹⁰, there have been research efforts documenting the sources or the situations that medication errors took place. Once the etiology factors for medication errors have been

identified and detected, the application of proper measures is essential for the error prevention and consequently the reduction of medication errors incidence by nurses. Certainly, since the healthcare field is under constant development (technological and pharmaceutical), medication errors remain a challenge.

This theoretical model of the "Swiss cheese" model describes the way that leads to the occurrence of an accident. In health, it has been firstly described by Reason in 1977 and it is not used only in the healthcare area, but also in other scientific areas.¹¹ The interpretation of this model has a symbolic-representative character. Each slice of cheese represents a defense, barrier or safeguard against error. Ideally all the defenses should be intact, but in reality the layers are full of holes. So, when an error passes through the defenses, perhaps it will stop in another defense (that means medication procedure) or it will go on, resulting in the increasing likelihood of the risk or the error or the accident. In the case of well designed health systems the error would rarely be able to pass through the defenses and cause harm.^{12,13}

This is what happens in the healthcare system. The errors and the deficiencies are results of unsafe practices by humans that work in a healthcare system (e.g. the omission of re-check of the medication order by doctor), while latent conditions (like lack of communication between the primary care and secondary care services) are reflecting the faulty system structure or healthcare agency.¹³

Aim

The aim of the present review was to review the current literature related to the individual and the organizational factors that contribute to the occurrence of medication errors in clinical nursing practice.

Material and Method

A search of the relevant literature has been conducted in Pubmed electronic database, using the following search terms: medication errors, contributing/etiologic/risk factors, nurses, nursing. Studies that were taken into account were having the following inclusion criteria: published in English the period between January 1990-December 2012, with free full text provision, original research articles (qualitative, quantitative or mixed methodological design), using in the study sample nursing students or/and nurses working primarily in hospital settings, examined purely the spectrum of the contributing factors to medication errors or this theme was a part of their research study (i.e. examined also other factors; reporting and preventive strategies of medication errors). In line with these criteria, the studies that focused to the contribution of an individual factor to medication errors were not examined. References from the studies were assessed also and were taken into account if they met the inclusion criteria.

A total number of 45 articles was identified. After assessing the retrieved titles and abstracts, were rejected: 11 articles that were not original research papers, 24 articles were irrelevant and 10 were potential relevant with the aim of the present review. From the potential relevant articles, three articles' full text provision was not given. From the rest papers (7), their full text was found. After the full text assessing only 3 were included. Also, additional sources (10) were emerged from secondary search through the evaluation of studies' references found initially.

Results

Thirteen research studies were found to meet the inclusion criteria. Table 2, outlines the basic features of the research articles that were included in the review. Three studies originated from USA, 2 from Japan and Jordan, and one from Taiwan, Malta, Turkey, Korea, Georgia and Canada

respectively. The methodological approaches used by researchers were quantitative^{15,18,19,22,23,26,27} or mixed.^{17,20,21,25} A research paper describing a series of case studies and another one in which have been applied simulation models, were concluded in the present review.^{14,16} The size of nurses' sample participated in the studies was varying from 25 to 158^{16,17,20,21,23,25-27} and 159-284.^{14,15,22} Two studies used large sample of nurses (799¹⁸ and 983¹⁹).

Table 3, presents a taxonomy between the most frequent (top five) contributing factors to medication errors, labeled as individual or organizational factors. By retrieving data from up to date nursing literature, the existing review article points out which individual and organizational factors may be responsible for medication errors' occurrence. It is evident that both individual and organizational factors contribute almost the same to the medication errors occurrence. Worth mentioning is that in the present review (Table 3) individual outnumbered organizational factors. Furthermore, findings of previous literature reviews support that medication errors are a result of both categories' factors, whereas other emphasized the contribution of health systems' related factors.²⁹⁻³¹

Individual factors

Humans are fallible and errors inevitable. Two issues are always topical and should not be ignored: even the best people are error prone and errors fall into concurrent patterns.¹³ Doing errors is part of human nature, but so is the finding of ways to face and limit medication errors.⁸ The category of this approach concentrates on the interpretation of individual nurses' factors and their relationship with the medication error. Subcategories of these factors involve: miscommunication factors, medication package labeling misreading, medication dosology miscalculation, non-adherence of the proper steps of medication preparation (checking-rechecking,



application of the five rights which includes the right patient, right drug, right route, right time, right dose), personal neglect, difficulties in using infusion devices, nurses' physical exhaustion, and problems with physicians' prescription (illegible handwriting, unclear verbal orders).

The explanation, confirmation and generally the communication among clinicians about medication administration details are important components of the medication procedure.^{14,15} Also, nurses' clinical experience is considered to play an important role in the adherence of every step for a successful medication administration. Kazaoka and colleagues¹⁴ stated that miscommunication factors (such as no explanation between the nurse and the nurse manager about medication errors' subjects) are responsible for the medication errors. Nurses who participated in the study (100 out of 163) and had <5 years of experience were characterized by a low level of awareness relevant with the explanation and confirmation of medication information.¹⁴ Miscommunication, however, can appear not only between nurses, but among clinicians in general.¹⁵

Benner et al.,¹⁶ examined 21 cases of nursing errors and their taxonomy revealed 8 categories, with medication errors among them. The fact that in 8 out of 21 patients' cases died as a direct result of medication errors is important. The authors did not rank the risk factor of medication errors. A few causes of medication errors were: failing to follow a step of the medication procedure, misunderstanding of verbal order by telephone and pharmacy error.

Three studies mentioned the variable "personal neglect" in top five contributing factors of medication errors. In the first study, a high percentage (86.1%) of nurses considers so.¹⁷ In the second one, it was observed as the third factor of error causality. Concerning the third study, two items, this of "unfamiliarity with the

medication" and "advanced medication preparation and administration without checking", fall under the category of personal neglect. Nurses ranked the above factor as the leading risk factors of medication error, receiving the first factor 45.5% and the second one 45%.¹⁵

Other factors related to medication issues were problems with the infusion devices, which emerged in two studies and miscalculation of the medication dose.^{16,18-20} By being confused with different types and functions of the infusion devices or setting wrong infusion rate and not calculating medication dose precisely were factors considered as responsible for medication errors. Furthermore, non-adherence to the proper steps of the medication procedure, such as the failure to follow the "5 rights" and the checking-rechecking process, are also mentioned as potential risk factors.^{21,22}

Another research study, which was conducted in Malta, investigated nurses' perceptions about medication errors. Results of this study revealed that nurses (37% of the whole sample) considered the physical exhaustion/tiredness as the top source of medication errors.²⁰ Themes relevant with the good physical status (stress, fatigue) were also mentioned in a cross-sectional survey by Mahmood et al.,²³ as a factor that may lead to medication error. In contrast, nurses having participated in a number of studies, believed that illegible handwriting of medication orders is responsible for medication error.^{19,20,21,23} A USA nonprofit organization for safe medication use (Institute for Safe Medication Practices, ISMP) stated that unclear writing of prescriptions causes more than 150 million pharmacists calls to physicians for further information.²⁴

Organization related factors

This type of approach offers an holistic view of the medication errors issue. It concentrates on the interpretation of a number of healthcare system



factors (working environment and organizational factors), their relationship and interaction with the medication error. Subcategories of these factors include: interruptions/distractions, heavy workload, high nurse-patient ratio, new staff and medication related topics (poor labeling/packaging, similar names).

The clinical environment is characterized as busy and complex, where interruptions and distractions in workflow are constant. Various studies classified the factor "interruptions or distractions" in the top five factors contributing to medication errors. Interruptions and distractions occur when a nurse is performing an intervention and before finishing with it, another task arises. As a result, the duration of nursing tasks (scheduled and non-scheduled) increases and nurses have to manage many interventions simultaneously.^{18-20,22,25}

Two studies attributed medication errors primarily to the factor "interruptions or distractions".^{19,22} The sources of nurses' distraction was other patients, coworkers or events on the unit.^{19,20} Except for the events on the unit, similar sources of distractions found also in another Jordanian research study.¹⁸ Qualitative data derived from the study of Stratton and colleagues²², which included adult and pediatric nurses population, found that both categories of them, considered the factor "interruptions or distractions" as the top factor of medication errors. Furthermore, in a Turkish study, interruptions were observed to cause medication calculation errors, because nurses' attention was distracted in the preparation and administration phase of the entire medication process.²⁵

Increased workload was observed in a series of studies, conducted in pediatric and other hospital settings.^{15,17,23,25-27} Nurses usually are expected to fulfill many responsibilities and duties during their working shift, thus the possibility of medication errors' occurrence is increased particularly when nursing staff shortage is dominant. Apart from the

above factor, the authors found insufficient protocols regarding the working environment conditions and the late arrival of medication from pharmacy.²⁵ Besides the morning shift; increased workload can be observed usually in the afternoon shifts. While, another study assures that medication errors occurred usually in the day shift (43.3%) and the evening (29.7%), rather than the night one (27%).¹⁷ The "increased workload" factor may be responsible for wrong dose medication errors. Heavy workload can be indirectly associated with medication errors, which means, that in conjunction with the busy environment, it can cause fatigue and distraction and then lead to a failure of a medication step e.g. checking-rechecking method.¹⁵

In a study is mentioned that the factor "increased workload" is obvious in the morning and the evening shift, when physicians give many orders and the number of nurses is decreased to 1/3 of that in the morning shift, respectively.²⁷ Moreover, it seems that the variables "high nurse-to-patient ratio" and "increased workload" have a similar relationship like that of cause and effect. Namely, high number of patients per nurse implies a severe consequence: when a ward is not sufficiently staffed with nurses the workload is rising. The factor "high patient to nurse ratio" was among the top three frequently contributing factors to medication errors.²¹⁻²³

Working conditions (workload and lack of experience) influence the occurrence of medical near-miss errors related to intravenous medication in a study at a hospital in Japan. Also, the authors added that sufficient clinical experience could encourage nurses to detect errors before their occurrence.²⁷ Otherwise, new staff probably would miss the detect of "signs" that would lead to an error during the performance of medication procedures.¹⁶ The factor "new staff" was emerged as medication etiology factor in two studies.^{17,26} The "new staff" factor was concerning nurses that had been recently graduated or change working



environment.

Among system factors the organizational and physical environmental variables should be taken into account. Physical environment variables, such as insufficient space for documentation for charting (78.6%) was perceived in leading to medication errors. In addition, staff and organizational variables include overwork and stress (70.2%).²³

Discussion

Patient safety can be at risk anytime and by various factors. Medication errors are such a factor. Although, in whole, other health professionals (physicians, pharmacists) also participate in the medication process, nurses have an active role in the management of patients' medication. The examination of medication errors in the clinical nursing practice is crucial, since serious patient harm is potential. Moreover, medication errors are a burden for the hospital organization and the health professionals as well. Besides, having already acknowledged the medication errors' contributing factors, their prevention can be achieved by the implementation of relevant strategies against their occurrence.^{18,28} Paparella et al.,³² proposed a combination of safety principles for the development of a medication safety plan, rather than only education measures or the composing of new policies.

The included studies stressed the significance of each category of factors. Understanding the role of both individual and organizational factors and disseminate which factors and the mode that contribute to medication errors are useful to raise nurses' awareness and vigilance about medication errors. Although nurses participate in the steps of the medication process, they should always ensure that the previous steps have been performed correctly and finish the drug administration safely.

However, it is intriguing to ascertain the critical role of hospital management against medication errors. For example, nursing administration should foster the application of policies and guidelines during medication process, after careful assessing of the literature data, encourage medication error reporting and established a non-punitive working environment.¹⁸ Another essential dimension for the head nurses is the determination of sufficient staffing levels in every shift (to face high RN-to-patient ratio and heavy workload) and the installation of periods of time, when medication preparation and administration are performed; during a shift that allow nurses to be concentrated in that procedures, in order to work effectively (to face interruptions).¹⁵

In addition, taking for granted that education is an integral part of nurses' career and since the acknowledgement of the contributing factors to medication errors has been achieved in a several degree, it is imperative to implement respective educational strategies to impede errors' appearance or enhance their proper management.³³ For instance, interventions with educational content deemed to be valuable. Namely, nurses can be educated and trained through lectures, projects, simulation methods, practice and other didactic measures in special medication errors' fields (e.g. medication calculation skills, distractions/interruptions, etc) or even wider prevention issues.³⁴⁻³⁶ Also, prevention-focused functions may contain the promptly detection of errors before they reach the patient, the analysis of cases and conditions that induce medication errors and render nurses vulnerable to commit medication errors. The ultimate goals of such interventions is nurses' role improvement, making safer the medication process and thereby the delivery of care quality to the patients.

Conclusion

To reach a conclusion, nurses should always

ensure for the best nursing care delivery to every patient and try to avoid any type of harm. Undoubtedly, medication errors put patients' health in unnecessary risk. This literature review indicates that there are plenty of factors or situations, which "permit" medication errors to happen, derived from the hospital staff or the health system. In the end, the goal of medication errors elimination is difficult to be achieved; instead the reduction of their rate can be accomplished by giving the required attention to the risk factors and applying the suitable preventive measures.

Implications for further research

Jordan stated clearly that nurses should proceed in the direction of changes in the nursing field and expecting a little information emerged from research papers.³⁷ Since the assessment of the majority of the contributing factors to medication error had been done, the application of relevant measures is crucial. To prevent the occurrence of any medication error type, future interventional studies should target in the direction of testing strategies which might have an effect in the reduction of medication error incidence.^{24,37} Additionally, when healthcare organizations promote adjustments in patient care procedures, the estimation of their impact (positive or negative) both for patients and the staff, is useful to be explored as well.³⁰ Another impetus for research is the examination of medication errors in various clinical settings.¹

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ANNEX

Table 1. The medication administration steps, as described by Leape et al.²

The steps of medication administration procedure	
1.	Physicians' decision on the administration of the proper medication
2.	Physicians' medication prescription
3.	Receiving medication prescription from the pharmacist
4.	Preparing medication and dispense by the pharmacist
5.	Delivery of medication to the ward
6.	Preparing of medication administration by the nurse
7.	The nurse administrates the medication to the patient
8.	The nurse records the administration to the patient chart
9.	The nurse monitors patient response to the medication

Table 2. Summary of the basic features of the research articles that were included in the review.

Author & country	Objective	Method, data collection & analysis	Sample & setting	Findings
<i>Al-Shara</i> ²⁶ <i>Jordan</i>	To determine the factors contributing to medication errors.	Quantitative design Use of a questionnaire	126 RN from 2 private hospitals Over 65 RN had less than 5 years of experience	A large variety of contributing factors identified. ME resulted from interrelated factors concerning the types, stages, and causes of errors.
<i>Benner et al.</i> ¹⁶ <i>USA</i>	To develop a taxonomy of nursing errors.	A series of case studies	21 case studies of nursing errors from 9 State Boards of Nursing files were analyzed	8 categories of nursing errors identified and one of them are ME. In each case analyzed causes for the error, at the system and practice responsibility levels were mentioned.
<i>Jones & Treiber</i> ²¹ <i>Georgia</i>	To describe nurses' perceptions about how and why ME occur and their relevant personal experiences.	Quantitative and qualitative data were applied Descriptive design Use of a 4-point scale	158 RN working primarily in hospital wards	78% of the sample admitted making ME. Nursing feelings about the ME were culpability, shame self-blame, loss of self-esteem and professional self-image.
<i>Kazaoka et al.</i> ¹⁴ <i>Japan</i>	To investigate about the communication problems in the team nursing systems.	Use of simulation models	100 nursing students of the 3 rd year of study 163 RN from wards of municipality hospitals Mean duration of years experience: 5 years	Communication problems between nurses are influenced by the relationship in the workplace in the team nursing system.
<i>Kim et al.</i> ¹⁵ <i>Korea</i>	To identify nurses' perceptions of medication errors.	Cross-sectional descriptive study Use of a questionnaire	Snowball sampling method, n=220 nurses from 7 hospitals Duration of years experience: 13-24 months	Nurses suggested that continuous training around medication themes, reduction of interruptions during medication preparation and improvement of communication between nurses are the most effective strategies to prevent the ME.
<i>Mahmood et</i>	To understand nurses'	Cross-sectional design	84 RN from hospital	Apart from the staff and

Author & country	Objective	Method, data collection & analysis	Sample & setting	Findings
<i>al.</i> ²³ Canada	perceptions of how physical environment affects ME.	Use of multisection survey questionnaire	settings Mean duration of years experience: 11.3 years	organizational factors there are other factors (e.g. lack of privacy in nurses' work area, inappropriate space layout in the unit) that perceived to be 'very important' or 'somewhat important' in leading to ME.
<i>Mayo & Duncan</i> ¹⁹ USA	To describe nurses' perceptions about ME.	Self-report survey method Collect data using Modified Gladstone instrument	983 RN from multiple types of hospitals and wards Mean duration of years experience: 18.7 years	The 45.6% of the sample of nurses believed that all ME are reported.
<i>Mrayyan et al.</i> ¹⁸ Jordan	To describe nurses' perceptions about various issues related to ME.	Descriptive correlational study Collect data using Modified Gladstone instrument	799 nurses from public and private hospitals 48.3% of nurses were having 1-4 years of experience	ME rate per nurse was 2.2. ME occurred mainly when particular factors were existed. Strategies to reduce or eliminate ME are required.
<i>Ozkan et al.</i> ²⁵ Turkey	To examine the frequency of pediatric medication administration errors and contributing factors.	Mixed methods Use of OAM and CIT Observation sheet Semistructured interviews	25 RN from a pediatric ward of a university hospital Observation of 2.344 MDA Duration of years experience: 1-14 years	From 2.344 MDS, ME were made in 36.5% of them. Errors arise from problems within the system.
<i>Petrova et al.</i> ²⁰ Malta	To identify nurses' perceptions of ME, including factors that may contribute to errors, barriers to reporting them and possible preventive measures.	Quantitative and qualitative data were applied Descriptive design Use of a questionnaire use in previous studies	38 nurses from medical wards at a state general hospital A minimum of one year's experience	In order to decrease the frequency of ME, the hospital policies and the development of structured protocols should be introduced in clinical practice.
<i>Seki & Yamazaki</i> ²⁷ Japan	To explore which working conditions influence the occurrence of medical near-miss errors related to intravenous administration.	Quantitative Use of self-reporting questionnaire	88 nurses from 4 wards of a public hospital Mean duration of years experience: 10.6±8.0 years	No significant difference detected relevant with the occurrence of near-miss errors among the 3 shifts (day-evening-night). Nurses with low perceived level of fatigue before the shift, those with many years of experience and those who had longer sleep duration during the evening shift had also high frequency possibilities to commit a near-miss error.
<i>Stratton et al.</i> ²² USA	To estimate of the proportion of ME that were reported by nurses.	Descriptive study Use of a questionnaire	284 RN (227 adults nurses and 57 pediatric nurses) from 33 acute care units (27 adult and 6 pediatric) from 11 hospitals Mean duration of years experience: 12 years	The ME rates per 1.000 patient-days computed from actual occurrence reports were higher on pediatric (14.80), in contrast with adult units (5.66).
<i>Tang et al.</i> ¹⁷ Taiwan	To understand nurses' views on the factors contributing to ME.	Mixed method Descriptive analysis Focus group Semi-structured questionnaire	72 nurses Snowball sampling method 9 RN participated in the focus group	Errors are not a result of a single factor, but a combination of some. Medical and ICU units presented high incidence of ME. Common ME types: 'wrong dose' and 'wrong drug'.

ME: Medication Error/s, **RN:** Registered Nurses, **ICU:** Intensive Care Unit, **OAM:** Organizational Accident Model, **CIT:** Critical Incident Technique, **MDA:** Medication Administration Doses.



Table 3. Classification of the most frequent (top 5) contributing factors to medication errors (placed according to their type and significance).

Author & country	Contributing factors of ME	
	Individual/staff factors	Organizational/health system related factors
<i>Al-Shara</i> ²⁶ Jordan	3. Personal neglect 4. Unfamiliarity with the medication 5. Insufficient training	1. Heavy workload 2. New staff
<i>Benner et al.</i> ¹⁶ USA	Misreading issues/Do not read the medication label (not check the medication 3 times) Misunderstood verbal physicians' order Do not apply the '6 rights' Set wrong infusion rate Miscalculation of a medication dose	
<i>Jones & Treiber</i> ²¹ Georgia	1. Illegible physician's handwriting on the prescription chart 2. Failure to follow the '5 rights' 4. Unclear verbal orders	3. High RN-to-patient ratio 5. Insufficient staffing
<i>Kazaoka et al.</i> ¹⁴ Japan	The study highlighted three communication problems as contributing factors to ME: 1) the way information is transmitted in the workplace, 2) the requests for medications by the nurse leader are usually approved of in clinical settings and 3) the necessity of interpersonal communication is neither understood nor observed in order to avoid interruptions.	
<i>Kim et al.</i> ¹⁵ Korea	1. Unfamiliarity with the medication (personal neglect) 2. Advanced drug preparation and administration without checking (personal neglect) 4. Miscommunication while conveying verbal orders 5. Miscommunication among clinicians	3. Heavy workload
<i>Mahmood et al.</i> ²³ Canada	4. Health staff not working as a team 5. Illegible handwriting by health professionals	1. Poor training of health staff 2. Overwork, stress or fatigue of health professionals 3. RN-to-patient ratio
<i>Mayo & Duncan</i> ¹⁹ US	1. Illegible physicians' writing of the order 3. Tiredness and exhaustion 5. Miscalculation of a medication dose	2. Distractions 4. Confusion between two medications with similar name
<i>Mrayyan et al.</i> ¹⁸ Jordan	2. Confusion with different types and functions of infusion devices 4. Set of infusion device incorrectly 5. Tiredness and exhaustion	1. Poor quality or damaged labels/packaging 3. Distractions
<i>Ozkan et al.</i> ²⁵ Turkey	4. Patient characteristics (physiological characteristics, communication difficulties, needing more intensive care)	1. Workload and emergencies 2. Task related themes (inadequate medication preparation administration protocol) 3. Management 5. Interruptions
<i>Petrova et al.</i> ²⁰ Malta	1. Tiredness and exhaustion 2. Illegible physician's handwriting on the prescription chart 4. Failure to check patient's identification bracelet with MAR 5a. Miscalculation of a medication dose	3. Distractions/interruptions 5b. Confusion between two medications with similar name
<i>Seki & Yamazaki</i> ²⁷ Japan	Few years of experience (at the evening shift)	Heavy workload
<i>Stratton et al.</i> ²² USA	4. Not double-checking doses	1. Distractions/interruptions 2. High RN-to-patient ratio 3. Volumes of medication administered
	The authors separated the results to those emerged from pediatric nurses and those from adult nurses. The sequence and significance of factors were common for both categories with the exception that there was differentiation in the percentages of their occurrence.	
<i>Tang et al.</i> ¹⁷	1. Personal neglect	2. Heavy workload

Author & country	Contributing factors of ME	
	Individual/staff factors	Organizational/health system related factors
<i>Taiwan</i>	4. Unfamiliarity with the medication 5. Complicated doctor-initiated order	3. New staff

ME: Medication Error/s, RN: Registered Nurses, MAR: Medication Administration Record.