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Medication Errors: A Review of Classifications

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ABSTRACT

Medication errors (MEs) are preventable mistakes that occur when there is a failure in the treatment process of any disease that can cause potential harm to patients. Having an effect on patients, health outcomes and costs incurred, it does burden our economically-developing country. Database systems have been created worldwide for the reporting of MEs, but varying countries practise different classifications of MEs hence it poses a challenge to categorize them. This makes it next to impossible to fully curb this continual problem. There are a number of classifications of MEs, based on mistakes and errors based on skills, based on the mistakes itself, based on symptoms and based on the stages of drug delivery system. This review summarizes the pre-existing classifications of MEs.

INTRODUCTION

A medication error (ME) is a preventable occurrence where there is a failure in the treatment process of any ailments that can potentially lead to the harm of the patients while the medication is still handled by healthcare professionals or patients themselves[1]. Many of these errors can shorten one's life expectancy or even accelerate the death process of someone who is critically ill. These unintended acts and implementation errors cause many preventable deaths worldwide. In the United States alone, it is the third leading cause of death making 78% of the total deaths of 575,000 patients between the years of 2000 and 2002 preventable iatrogenic deaths[2].

Looking at a more local scenario, a geriatric outpatient pharmacy in a teaching hospital in Malaysia, reported approximately 20 cases of medical errors occurring daily. This resulted in a daily cost of RM300 which cumulatively has a projected cost of RM111,000 annually[3]. This cumulative amount is a large burden to our economically-developing country. Two thirds of the medication errors reported were prescription errors, where 98% had no harmful effects, which was detected by the pharmacists as the patients go to them as a second-line in the healthcare system[4].

To improve the number of MEs, Ministry of Health, Malaysia launched a Medication Error Reporting System (MERS) in 2009 for both public and private sectors. MERS is aimed to compile a database of medication errors, analyse the reports made, propose solutions and for monitoring. Even though underreported, this system has drastically improved the rate of occurrences of the preventable mistakes[5].

Methods

A systematic search of studies related to medication errors was conducted on PubMed and Google Scholar. Keywords used were 'medication errors', 'adverse reactions', 'outcomes of medications errors', and 'prescription errors'. We included classification of MEs which mainly looked at the types of MEs and at the stage of ME occurrence.

Terminologies of MEs

The terms used for patient safety in relation to drug administration, procedural errors and prescription mistakes are something that is still very heterogeneous. Amongst the terms used in literature includes, most commonly MEs, looking at the process in medication uses, medication-related adverse drug reactions and its clinical based outcomes. These terminologies broadly classifiy the process and its outcomes under drug-related problems[6]. Besides this, some include unintentional procedural errors and prescription errors in this broad heading of MEs[7]. Due to the lack of homogeneity in the terms used, abundant numbers of MEs are still under reported at primary care, district hospitals and tertiary hospital levels worldwide. This could be due to the complexity of the reporting systems, varying from country to country.

Classifications of MEs

Table 1 Summary of classifications

Classifications	References
Knowledge-, memory-, rule-, and action-based errors	Aronson, 2009[8]
Errors of omission, errors of commission	Benjamin, 2013[9]
Mistakes, skill-based errors (slips and lapses)	Ferner and Aronson, 2006[10]
Adverse drug reaction from MEs, MEs that do not cause adverse events, MEs that cause harm that are not adverse drug reactions	Ferner and Aronson, 2006[10]
Categories A to I based on the extent and the outcome of errors	Agency for Healthcare Research and Quality, 2012

MEs can be classified into knowledge-based, memory-based, rule-based and action-based errors[8]. Knowledge-based error is related to general and specific knowledge. Ignorance of staff to improve themselves continuously education wise is also classified under this category. Rule-based error is further subdivided into misapplication or failure to apply established rules or merely the usage of bad rules. The performance of a specific action which was not intended is characterized under action-based error. Memory-based

rules look more at the memory capacity of the medical staff on the patients' current or underlying issues.

Benjamin classified these errors into an error of commission, where someone had acted incorrectly and error of omission, where there's a failure to act correctly[9]. This classification of errors is also correlated to communication barriers and insufficient interactions between patients and healthcare staff. To curb the illegible handwriting issues in prescription writing, it could potentially be converted into a computerized physician order entry. Benjamin also suggests that the prescriptions be maintained in the universal English language, and not in Latin, to iron out any language barriers.

Ferner and Aronson have categorized MEs into a few different types of classifications[10]. The first classification is based on symptoms, adverse drug reactions from MEs, MEs that cause harm that are not adverse drug reactions and MEs that do not cause adverse events.

Aronson also classified it based on errors that are unintended mistakes and mistakes surrounding skills (slips and lapses), where the occurrence of errors happen in planned actions as shown in Table 1[8].

Table 2 Types and subtypes of medication errors with examples correlating with medical-related side effects[10]

Types of medication errors	Sub-classifications		Examples	Medical-related side effects
Mistakes	Knowledge-based		Administering a type of analgaesic (i.e. diclofenac) without asking patient of his allergy history	Anaphylaxis
	Rule-based	Applying a good rule mistakenly	Injecting diclofenac at the deltoid muscle instead of the gluteus muscle	Haematoma
		Applying a bad rule	Continuously giving intramuscular diclofenac 8 hourly to a patient in the out-patient department; continuously giving loading dose of a medication	Haematoma
Skill-based errors	Action-based (slips)		Intending to write carbimazole on prescription slip instead of carbamazepine; writing a prescription beginning with carb, followed by scribbles	Unnecessary risks for patient (side effects of drug which was unintended to be administered)
	Technical errors		Dispensing the wrong strength of medication in the paediatric ward based on weight; improper blood pressure measurement; failing to turn off the intravenous set post-infusion of medication	Under or overtreatment; air embolism
	Memory-based (lapses)		Omitting the duration of warfarin for a patient with atrial fibrillation in the prescription; failure to inform patient regarding drug-food interactions in patients on warfarin	Bleeding tendencies; failure of efficacy of warfarin

Mistakes in planning actions are further divided into knowledge-based errors and rule-based errors (good rules misapplied or bad rules). The latter includes slips, action-based errors, and lapses, memory-based errors.

A retrospective study conducted in a general hospital in Saudi Arabia showed that MEs were divided into a few main categories, improper dose, wrong drug, wrong route of administration, wrong strength, mistakes with durations, dosages and drug omission. The highest occurring MEs were wrong route of administrations, wrong dosage form and strength[11].

Allard and colleagues had rated these medication errors based on stages[12, 13]. This would make an ideal homogenous classification that can be enforced worldwide as it tackles the problem in a systematic method aiming at each stage of treatment process. The types of MEs for each stage of the drug delivery process are shown in Table 3 with its classes of error and examples[14]. An additional stage, general, is added to summarize errors from the aspect of knowledge, attitude and patient to personnel ratios. If the type of MEs can be correlated to the stage of the occurrences, this problem can be easily curbed as each stage involves a variety of healthcare personnel.

Table 3 Types of MEs based on the drug delivery system with its classes of errors and examples

Stages of the drug delivery system	Classes of error	Examples
Prescribing	Wrong drug	A patient with lung cancer was wrongly given vecuronium and midazolam which was meant for a patient that was involved in a motor vehicle accident that was getting prepped for intubation[15].
	Wrong patient	
	Wrong route of administration	Intended intramuscular diclofenac was given intravenously (unpublished data).
	Wrong dosage	In a study involving HIV/AIDS patient, 9.80 errors per 1000 new prescriptions had wrong dosages[16].
	Incomplete prescriptions	Out of 545 outpatient prescriptions, almost 10% lacked the prescriber's name[17].
	Contraindicated drugs	In a study involving HIV/AIDS patient, 9.51 errors per 1000 new prescriptions had drugs contraindicated to the disease[16].
	Omitting essential information	In a study done in the out-patient department in Oman, 23% of the prescriptions omitted dosage information[18].
Transcribing	Dispensing of wrong drugs	A 71-year-old lady was prescribed thiothixene (Navane) instead of amlodipine (Norvasc) for 3 months[19].
Dispensing	Incorrect preparation of drug(s) or infusion(s)	A 6-month-old child was given intravenous azithromycin diluted using adult dosage and child succumbed to cardiac arrest[20].
	Incorrect drug storage	Around 11% of MEs was due to inadequate drug storage based on a study done in a teaching hospital in Brazil from 2012 to 2013[21].
	Medications with similar shape and size	An octogenarian was dispensed Novasone (scalp lotion) for her eyes instead of lubricating eyedrops[22].

Administration	Rarely prescribed drugs	A 60-year-old man was admitted for a total knee arthroplasty. His maintenance medications included a high-risk medication, dofetilide (an antiarrhythmic agent) which was started by the surgical resident. It was ordered to be administered *bis in die*, 6am and 6pm. As the patient was supposed to be transferred to the operation theatre at 6am, the overnight nurse gave the dose early, at 4am. During preoperative rounds by the doctor, the patient was noted to have severe QTc prolongation on his electrocardiogram which increased his risk of getting torsades de pointes, which can be fatal. This resulted in a postponement of his operation[23].
	Wrong timing	
	Wrong drug	Case of unintended epinephrine ampoule swaps with ephedrine (unpublished data)
	Wrong dosage	An 80-year-old patient was administered 0.2 mL of a 100 µl/mL solution instead of 2 units of insulin[24].
	Wrong route of administration	In 2011, 152 cases of wrong patient and route of administration had occurred in the state of Pennsylvania[25].
	Wrong patient	
	No drug administered	Patient was aware during an operation due to an accidental omission of induction agent[26].
	Infusion pump	A study conducted over 7 months in 2007, resulted in 32% of MEs was due to incomplete labelling of IV tubing, 8% of MEs was omission of infusion diluent from the medication chart and around 2% was caused by the discrepancy between what was infused compared to the prescribed[27].
	Not signing off on the medication chart post administration	A patient was ordered to be given an analgaesic for his headache caused by his blast crisis in the haematology ward. The nurse did not sign in the medication chart due to a rush in the change of shift and it was not passed over to the next shift hence no one on duty knew (unpublished data).
General	Causing harm to patient	A patient was given vecuronium instead of cefazolin developed post-traumatic stress disorder as he was conscious but paralyzed[28].
	Exhaustion of healthcare professionals	An increase in the number of prescriptions per shift of staff was associated with increase rate of pharmacist errors during order checking and dispensing[28].
	Patient-nurse ratio	
	Patient-doctor ratio	
	Inadequate training of healthcare professionals	A trainee doctor (house officer) administered intravenous diclofenac instead of intramuscular for a patient with musculoskeletal pain post motor vehicle accident (unpublished data).
	Lack of pharmacology knowledge	
	Lack of communication	75% of patients on five or more drugs experience MEs due to lack of understanding of physician's instructions which resulted in 5% of very severe consequences[29].

Agency for Healthcare Research and Quality under the US Department of Health & Human Services classified MEs into nine categories as shown in Table 4, based on the extent and outcome of the ME[30]. Categories A to D do not require any intervention or medicational therapies. It merely requires monitoring. Whereas, categories E to I necessitate medicational and interventional managements for potential life-saving efforts.

Table 4 Types of MEs based on the extent and the outcome of errors[30]

Categories	Description
A	No ME occurred but had the capacity for one to occur
B	ME but did not reach the receiving end, the patient
C	ME that reached the patient but unlikely to cause any harm, omission errors
D	ME that reached patient which needed extra monitoring
E	ME that cause temporary/reversible harm
F	ME that caused harm which needed hospitalization
G	ME that results in permanent harm
H	ME that required life-saving interventions
I	MEs that results in death

CONCLUSION

Full, partial and no disclosure of MEs to patient should be made into a full disclosure system if a homogenized classification is aided by a flow chart of ways to disclose such MEs to patients and ways to handle the problem. If this system can be established, consensus can be done on which specific aspect that could be improved on. This system can also be a guide whereby it can prompt and suggest ways for them to inform of the ME to the patient. In the long run, this improves overall efficiency of the healthcare personnel. The funds which are freed up due to the reduction of MEs can be channelled into other aspects of the healthcare system.

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