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How are medication errors defined? A systematic literature review of definitions and characteristics

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Abstract

Objective. Multiplicity in terminology has been suggested as a possible explanation for the variation in the prevalence of medication errors. So far, few empirical studies have challenged this assertion. The objective of this review was, therefore, to describe the extent and characteristics of medication error definitions in hospitals and to consider the consequences for measuring the prevalence of medication errors.

Data sources, study selection and data extraction. Studies were searched for in PubMed, PsychINFO, Embase and CINAHL employing primary search terms such as 'medication errors' and 'adverse drug events'. Peer-reviewed articles containing these terms as primary end-points were included. Study country, year, aim, design, data-collection methods, sample-size, interventions and main results were extracted.

Result of data synthesis. Forty-five of 203 relevant studies provided a generic definition of medication errors including 26 different forms of wordings. The studies conducted in nine countries represented a variety of clinical settings and the approach was mainly descriptive. Of utmost importance is the documented prevalence of medication errors, which ranged from 2 to 75% with no associations found between definitions and prevalence.

Conclusion. Inconsistency in defining medication errors has been confirmed. It appears that definitions and methods of detection rather than being reproducible and reliable methods are subject to the individual researcher's preferences. Thus, application of a clear-cut definition, standardized terminology and reliable methods has the potential to greatly improve the quality and consistency of medication error reporting. Efforts to achieve a common accepted definition that defines the scope and content are therefore needed.

Keywords: drug errors, patient safety, hospital care, setting of care, public health, health care system

Introduction

In the Harvard Medical Practice studies of adverse events in hospitals, medication errors were found to be the main contributor constituting around one in five of the events, which were subsequently confirmed in comparable studies and studies of adverse drug events (ADEs) [1–4]. This has led to an increased focus on epidemiology and prevention of medication error in hospital settings around the world prompting numerous studies [5–13]. However, this contribution has not provided clarity or consistent findings with respect to medication errors. Quite the contrary, there appears to be a multiplicity of terms involved in defining the clinical range of medication errors and classifying consequences e.g. error, failure, near miss, rule violation, deviation, preventable ADE and potential ADE [14–18]. Moreover, it has been suggested that this inconsistency has contributed to the substantial variation in the reported occurrences of medication errors [19–21]. Thus, compared with other epidemiological fields in health care, no single definition is currently being used to determine medication errors although attempts to develop an international definition have been made e.g. National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) [22], which is

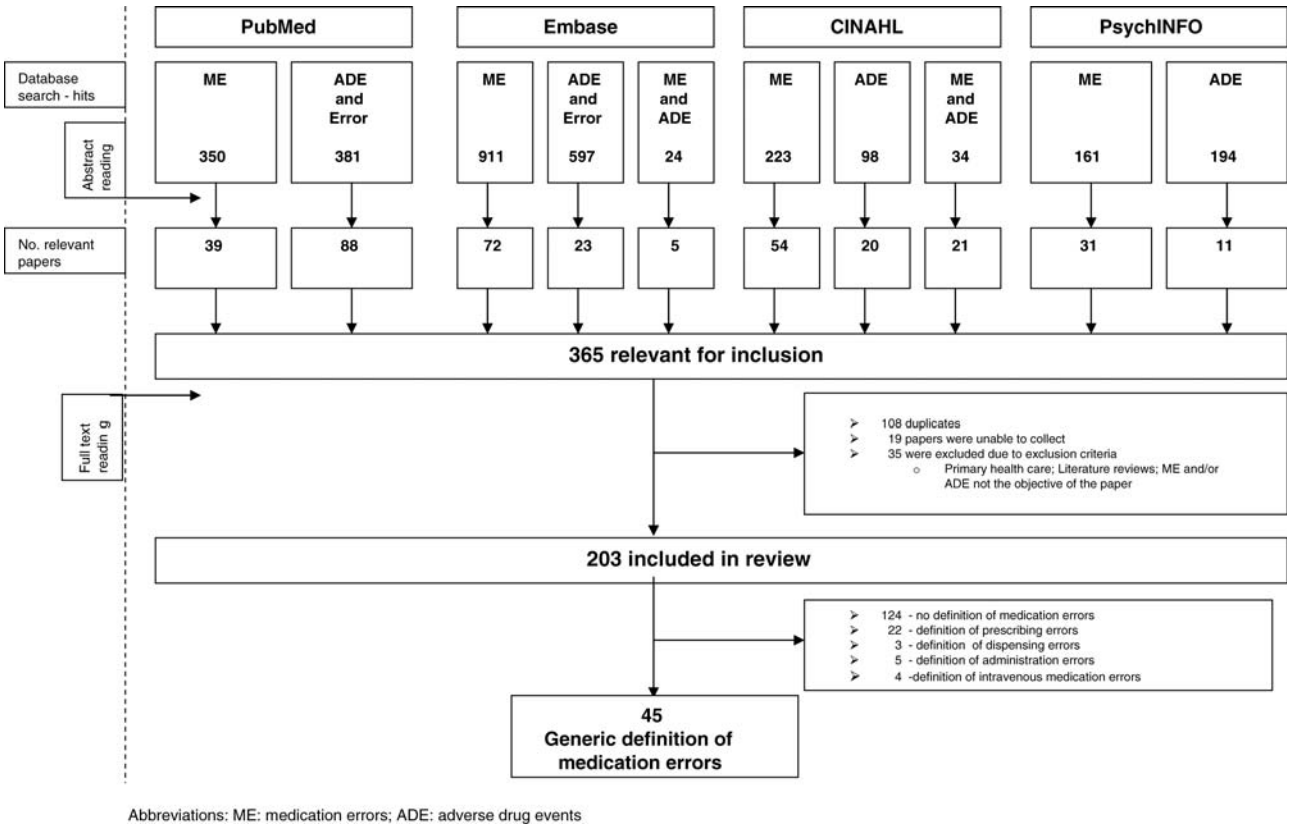

Figure 1 Summary of search and review process.

clearly reflected in the referred literature. As an important consequence, this lack of clarity hinders reliable comparison of findings across studies, clinical settings and countries.

Another obstacle to achieving consensus of a common definition is the different approaches towards interpreting and detecting medication errors such as the system-oriented approach using mandatory or voluntary-based reporting systems in contrast to the epidemiological approach using specific research methods. Choice of reliable methods, including denominators, data completeness and systematic data collection, is essential in the epidemiological approach. However, these considerations are likely to be secondary in a system approach where causation is paramount. Unfortunately, identifying error causes without consistent, reliable measures is unlikely to lead to well-targeted prevention strategies. So far, the literature has mainly emphasized the problem of inconsistent use of definitions and data collection methods, whereas few studies have explored medical error subsets, and these have often been in specific clinical settings or particular to specific patient safety organizations [5, 19–21, 23–25]. Most importantly, no studies have to our knowledge systematically provided an overview of the extent of existing definitions and their possible impact on the occurrence of medication errors. Hence, the objective of this study was to investigate definitions of medication errors and, furthermore, to describe characteristics as well as to assess whether or not there were any associations between definitions and observed prevalence in hospitals.

Methods

Data sources

A systematic search of studies related to medication errors was performed in the databases on 18 December 2006 in PubMed (1951), Embase (1948), CINAHL (1981) and PsycINFO (1806) using the following key terms: 'medication errors', 'adverse drug events', 'adverse drug events and errors' and 'medication errors and adverse drug events' (Fig. 1). To capture all possible studies of medication errors in hospitals, the search was not restricted to MeSH terms in PubMed. However, a comparable search using the MeSH term 'medication errors' was performed in which all studies from the key term search could be retrieved.

Study selection

Only studies performed in hospital settings having medication errors and/or ADEs as the main objective were included in the present review, excluding studies performed solely in primary health care and literature reviews of medication errors and ADE (Fig. 1). Although there is no reason to believe that the occurrence of medication errors would be significantly different from hospitals, primary health care was excluded in this review due to assumed differences in medication handling and to the limited amount of completed medication error research in primary health care when the

Table I Levels of evidence, Oxford Centre for Evidence-based Medicine (2001) and pharmaco-epidemiological study design

Oxford Centre for Evidence-based Medicine	Pharmaco-epidemiological design	Evidence level
Randomized controlled trial (RCT) individual	RCT	Ib
RCT without blinding or <80% follow up	Cohort study	IIb
Controlled study (prospective)		
Cohort study		
Ecological study	Ecological study	IIc
Case–control	Case–control study	IIIb
Prevalence study	Case-series	IV
Cross-sectional study ± time-series		IV
Expert opinions	Case report	V

In Table 1, study-designs, in respectively, Oxford Centre for Evidence-based Medicine (therapy/prevention/aetiology/harm) and in the Pharmaco-epidemiological literature are provided along with the matching evidence levels (right column). In the present review, the evidence levels of the included studies were classified in accordance to these study-designs, as appropriate.

literature search was conducted. Finally, the search was limited to peer-reviewed studies with abstracts and studies presented in English.

First, titles and abstracts were examined in accordance with inclusion and exclusion criteria. Secondly, papers that met the inclusion criteria or papers in which inclusion could not be determined directly e.g. whether a setting was representing primary care were obtained. Thirdly, all duplicates between databases, papers that did not meet the inclusion criteria or papers that could not be obtained were excluded.

Data extraction

Definitions of medication errors and ADEs were registered along with included error types and whether the paper focused on ordering, dispensing, administering and monitoring. Moreover, general information regarding journal, author, year, title, aim, setting, participants, design, methods, intervention, results and evidence level were registered in an Access database.

Determination of evidence level was based on modified Oxford Criteria (Table 1). Studies in which evidence level could not be determined on behalf of available information, were discussed with a clinical pharmacologist and a professor in Public Health.

Due to the obvious lack of standard methodology and outcome measures, data could not be statistically summarized. However, prevalences of medication errors were reported for studies in which denominators were accessible. In pre–post studies and controlled studies, only prevalences of medication errors at baseline or from a control group were presented, whereas no prevalences could be calculated in studies using data from reporting systems [26]. Definitions were analysed with regard to similarities in content leading to the following five categories: (i) studies using the term error; (ii) studies using the NCC MERP definition; (iii) studies using failure; (iv) studies using deviation; and, finally (v) other terms. In each category, definitions from included studies were presented along with study characteristics. Finally, possible tendencies towards associations between definitions and prevalences were examined.

Results of data synthesis

The literature search revealed 203 eligible papers (Fig. 1) of which 45 (23%) included a generic definition of medication errors. An additional 30 studies included a stage-specific definition; 22 prescribing, 3 in dispensing, 5 in administering and, finally, 4 studies contained a definition of intravenous errors. However, in 124 studies, no definitions were provided.

Overall characteristics

The 45 included studies were published in 26 different peer-reviewed journals in the period from 1984 to 2006 with half of them in the period 2005–06. The majority of studies were conducted in North America, representing 36 studies; 2 were done in Australia, 6 in Western Europe and, finally, 1 in Asia. The studies were conducted in a variety of clinical settings with almost 50% assessing more than one type of setting e.g. medical and surgical departments. Moreover, 20 studies included only adults, 9 studies only children, 9 studies both adults and children and, finally, 8 studies included other types of participants e.g. nurses and pharmacists. In 13 studies an intervention was addressed of which 9 were technologies in the medication process (e.g. computerized order entry (CPOE) either alone or combined with clinical decision support (CDS) systems, dose dispensing systems and infusion pumps with CDS). Descriptive designs were employed in 37 studies, whereas 2 studies were conducted as randomized clinical controlled studies, 1 as a case–control study and 1 as a prospective cohort study, and, finally, 4 studies were conducted using other designs e.g. case reports. Nine out of 10 studies were classified as evidence level IV or V, and, finally, chart review and reporting systems were the most frequently used methods to detect medication errors.

Prevalence of medication errors

In 21 of 45 studies, it was not possible to determine a prevalence of medication errors due to lack of valid denominators. These were in particular studies using reporting systems,

interview and questionnaires as data collection method. Overall, a prevalence of 75% was found, with the majority being below <10% (Tables 2–4).

An average of nine error types (min/max: 1/38) were identified in 38 of the 45 studies. In seven studies no error types were included due to study design. The study having one error type, namely, overdose (gentamicin) accounted for the highest prevalence in the review. Unfortunately, it was not possible to retrieve prevalence in the study using the highest number of error types, as data were collected from voluntary reporting. Dosing errors were the most frequent single error type, and in studies including all stages in the medication process, prescribing errors accounted for the highest percentage.

Definitions

Of the 45 definitions, 26 differed in wording and/or content. One definition used harm or potential for harm as a criterion for medication error, whereas one explicitly included intercepted medication errors [27–29]. Finally, five definitions were limited to deviations between ordered and administered drugs and doses [30–34]. In all other definitions no restrictions were specified.

A crude categorization of the revealed definitions was performed based on similarities in wording and/or content. Tables 2–4 provide an overview of definitions and characteristics of each study. Table 2 shows 15 definitions using the word 'error/s' followed by information about included stages in the medication process. In seven definitions, information regarding injury or intercepted errors is stated. Table 3 reveals characteristics of 17 studies using the definition from NCC MERP [22]. Finally, Table 4 presents five definitions using failure instead of error; five focusing on deviations between ordered and administered drugs/doses and three using other definitions.

Trends towards association between definition and prevalence

In the first category (Table 2), it was possible to ascertain prevalence in all studies ranging from 2 to 75% with the two European studies as the main contributors. In the second category (Table 3), which included studies using the definition from NCC MERP, it was possible to retrieve prevalence in 1 out of 17 studies, due to the use of reporting systems. This study revealed a prevalence of 8%. In the third category (Table 4) consisting of five studies using the term 'failure', it was not possible to provide information about prevalence due to study design and data collection methods. Finally, in the fourth category (Table 4), a prevalence of 3–16% was observed in studies focusing on deviations between ordered and administered drugs/doses.

Discussion

To our knowledge, this is the first study to systematically explore the extent and impact of generic definitions of medication errors in hospital settings. The literature review confirmed an inconsistent use of definitions. However, other aspects have to be considered in order to explain the variation in prevalence of medication errors, as interpretation of the included definitions did not suggest any tendencies.

It is of particular relevance that fewer than half of the studies explicitly defined medication errors either as an overall definition (generic) or a stage/route-specific term. Furthermore, fewer than a quarter presented a generic definition despite that being the main objective of the studies. Thus, the inconsistency in terminology only represents the tip of the iceberg. Additionally, the present review has confirmed that the overall poor understanding of the epidemiology of medication errors can, at least, partly be explained by choice of design, data collection methods and study population, including denominators [19–21, 23]. Based on these shortcomings, we have revealed a prevalence of 2–75% in studies that included a generic definition of medication error.

The second important problem is the choice of denominator or study population. It has previously been suggested that to use opportunities for errors rather than number of patients as denominator reduces the risk of case-mix bias [26]. Here we demonstrated a variety of denominators including drug order, doses, opportunities for errors, patients, nurses, reports and triggers. In addition, the frequent use of a reporting system excluded calculation of valid prevalence in almost half of all the studies thereby increasing the lack of clarity.

Thirdly, the impact of error types should be considered. It could be assumed that increasing the number of error types being measured, would automatically result in higher occurrences of medication errors due to an increased probability of detecting more errors. However, the study with the highest prevalence of errors (75%) in the present review included only one error type, namely, dosing errors, which conflicts with this assumption [35]. On the other hand, not all error types are mutually exclusive e.g. dosing errors, which inevitably includes all errors resulting in wrong or omitted dose (under-dose, overdose, omission of dose). Thus, the number of error types has to be weighed against type of error and the sensitivity of error detection methods. Unfortunately, the present review did not provide sufficient information on the impact of error types with regard to prevalence.

Finally, choice of data collection method should be considered important. Previously, chart review has been considered as the most appropriate method to detect prescribing errors and direct observation the most sensitive method to detect dispensing and administration errors, as opposed to voluntary reporting, which was found to be the least sensitive method [32, 36]. In recent years the availability of computer-generated signals in error detection has increased, which allow an objective detection of all incidents that have been defined as an error in the computer. Thus, it can be assumed that such systems will increase the detection of systematic documented electronic data such as dosing of gentamicin [35]. In the present review the most frequently applied error detection method was chart review, which might have

Table 2 Studies using errors in definition of medication errors

Author	Country (year)	Definition of medication error	Design evidence level[a]	Intervention	Setting	Participants/ cases	Stage	Methods	Prevalence ME: *n*/*N* (%)
Bates [38]	USA (1999)	Error in the process of ordering, dispensing or administering medication, regardless of whether an injury occurred or whether the potential for injury was present	Descriptive IV	CPOE and CDS	Medical	Baseline: 10 070 orders	P	Pharmacist reports; order review; chart review	ME: 242/ 10 070 (2)[b]
Bates [15]	USA (1995)	Errors occurring at any stage in the process of ordering or delivering a medication	Descriptive IV	None	Medical	10 070 orders	P, T, D, A	Chart review	ME: 530/ 10 700 (5)
Bates [37]	USA (1995)	Any error in the process of ordering, dispensing and administering drug	Descriptive IV	None	Non-obstetric	4031 patients	P, T, D, A	Chart review	ME: 264/ 4031 (7)[c]
Cimino [48]	USA (2004)	Any error large or small, at any point in the medication system from the time the drug is ordered until the patient receives it. An error may or may not result in an ADE	Descriptive; pre–post IV	Site-specific intervention	ICU paediatric	12 026 orders	P	Medication error survey forms	ME: 3247/ 12 026 (27)[b]
Eslami [35]	Netherland (2006)	Any error in the medication process that involves the prescribing, dispensing or administration of medication. A medication error may or may not result in patient harm; however, it is considered preventable	Descriptive IV	CDS—default value for gentamicin and tobramicin	ICU	392 doses	P	Computer-generated signals	ME. 292/392 (75)
Fortesque [39]	USA (2003)	Errors in the medication ordering, transcribing, administering or monitoring	Descriptive IV	None	Paediatric	10 778 orders	P, T, D, A	Order review; chart review	ME: 616/ 10 778 (6)
Gurwitz [43]	USA (2003)	Errors in prescribing, dispensing, patient adherence and monitoring	Descriptive IV	None	Ambulatory care	27 617 patients	P, D, A	Reports; review; computer-generated signals	ME: 421/ 27 617 (2)[b]
Gandhi [28]	USA (2005)	Any error that occurred in the medication use process (including ordering/prescribing, dispensing, adherence and monitoring)	Descriptive IV	None	Ambulatory care	1879 orders	P	Order review; chart review	ME: 143/ 1879 (8)

(*continued*)

Table 2 Continued

Author	Country (year)	Definition of medication error	Design evidence level[a]	Intervention	Setting	Participants/ cases	Stage	Methods	Prevalence ME: *n*/*N* (%)
Gandhi [40]	USA (2005)	Any error in the medication process, including ordering, dispensing, transcribing, administering and monitoring, even if the error was intercepted and corrected prior to reaching the patients	Descriptive IV	None	Chemotherapy	10 112 orders	P, T, D, A	Order review; chart review	ME: 306/ 10 112 (3)
Kaushal [7]	USA (2001)	Errors in drug ordering, transcribing, dispensing, administering or monitoring	Descriptive IV	None	Paediatric	10 778 orders	P, T, D, A	Chart review; order review; voluntary reporting	ME: 616/ 10 778 (6)
King [49]	Canada (2003)	Any event involving medication prescription, dispensing, administration or monitoring of medication irrespective of outcome	Descriptive IV	CPOE	Paediatric	36 108 discharges	P, T, D, A	Reporting system	ME: 804/ 36 108 (2)
Kopp [8]	USA (2006)	An error occurring during the medication use process, regardless of whether an injury occurred or the potential for injury was present	Descriptive IV	None	ICU	645 doses	P, T, D, A	Observation	ME:172/645 (27)
Lisby [10]	Denmark (2005)	Errors in the medication process: ordering, transcription, dispensing, administration and discharge	Descriptive IV	None	Medical and surgical	2467 OE	P, T, D, A	Chart review; Observation; control visit	ME: 1065/ 2467 (43)
Rothschild [41]	USA (2005)	Errors during ordering, transcribing, dispensing, administration and monitoring	Descriptive IV	Intravenous pump with CDS vs. usual intravenous pump	ICU	10 659 log reports	D, A	Pump log reports; chart review; incident reports	ME: 219/ 10 659 (2)
Walsh [42]	USA (2006)	An error in drug ordering, transcribing, administering or monitoring	Descriptive IV	None	Paediatric	6916 orders	P, T, D, A	Chart review	ME: 104/ 6916 (2)

[a]Oxford Centre for Evidence-based Medicine Levels of Evidence. Abbreviations: P: prescription; T: transcription; D: dispensing; A: administration; CPOE: computerized order entry; CDS: clinical decision support; OE: opportunities for errors; MEOS: medication error outcome scale. [b]Pre-intervention. [c]Preventable ADE + potential ADE.

Table 3 Studies using the NCC MERP definition of medication errors

Author	Country (year)	Design (evidence level)[a]	Intervention	Setting	Participants/cases	Stage	Methods	Prevalence ME: *n*/*N* (%)
Bacic-Vrca [44]	Croatia (2005)	Descriptive IV	None	Medical	4951	P	Chart review	ME: 379/4951 (8)
Ballard [50]	USA (2003)	Descriptive	None	Mixed	N/A	N/A		N/A
Brown [51]	USA (2006)	Other V	None	N/A	61 participants		Focus group interview patients	N/A
Grasso [52]	USA (2003)	Descriptive IV	None	Psychiatric	31 patients	P, T, D, A	Chart review; error reporting	N/A
Grasso [53]	USA (2005)	Descriptive IV	None	Psychiatric	31 patients	P, T, D, A	Voluntary reporting; chart review	N/A
Handler [54]	USA (2004)	Descriptive IV	None	Long-term care	88 reports	D, A	Reporting system; questionnaire	N/A
Hartis [55]	USA (2005)	Descriptive; pre–post IV	None	Mixed	1806 triggers	P, D, A	Chart review	N/A
Kelly [56]	USA (2001)	Other IV	None	N/A	447 reports	P, T, D, A	Review case reports	N/A
Kelly [57]	USA (2001)	Other IV	None	N/A	227 reports	P, T, D, A	Review case reports	N/A
Moore [58]	USA (2004)	Case series IV	None	Mixed	156 reports	P, T, D, A	Reporting systems	N/A
Marcellino [59]	USA (2001)	Other IV	None	N/A	846 reports	P, T, D, A	Review case reports	N/A
Pinilla [60]	Spain (2006)	Case–control IIIb	None	Mixed	86 reports	P, T, D, A	Voluntary reporting system	N/A
Rolland [61]	USA (2004)	Descriptive	None	Mixed	82 reports	D	Reporting system	N/A
Rudman [62]	USA (2002)	Case series IV	None	Mixed	2700 reports	P, T, D, A	Reporting system	N/A
Seals [63]	USA (2005)	Cohorte IIb	Prescribing instructions	Mixed	96 caregivers	A	Questionnaire; pill-loading rate and accuracy	N/A
Wolf [64]	USA (2006)	Descriptive IV	None	Mixed setting	1305 reports	P, T, D, A	Reporting system	N/A
Zhan [65]	USA (2006)	Case series IV	CPOE + CDS	Mixed	235 164 reports	P, T, D, A	Reporting system	N/A

NCC MERP definition: 'Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in control of the health-care professional, patient or consumer. Such events may be related to professional practice, health-care products, procedures and systems, including prescribing; order communication; product labelling, packaging and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use.' [a]Oxford Centre for Evidence-based Medicine Levels of Evidence. Abbreviations: P: prescription; T: transcription; D: dispensing; A: administration; CPOE: computerized order entry; CDS: clinical decision support; N/A: not applicable.

Table 4 Studies using 'failure, deviation or other' terms in definition of medication errors

Author	Country (year)	Definition medication error	Design (evidence level)[a]	Intervention	Setting	Participants/ cases	Stage	Methods	Prevalence ME: *n*/*N* (%)
Failure									
Abeysekera [66]	AUS (2005)	A failure to give the drug or dose of drug that was intended	Case series IV	None	Anaesthetics	8088 reports	D, A	Reporting system	N/A
Balas [67]	USA (2006)	The failure of planned actions to be completed as intended or use of wrong plans to achieve a goal	Descriptive	None	Critical care	502 nurses	N/A	Questionnaire	N/A
Campbell [27]	UK (2006)	A failure in the treatment process that leads to, or has the potential to lead to, harm to the patient	Descriptive IV	None	ICU	268 long-term drug	P	Order review; chart review	N/A
Fogarty [68]	AUS (2006)	A failure in the drug treatment process resulting in appropriate medication use	Descriptive IV	None	N/A	176 participants	N/A	Questionnaire	N/A
Winterstein [69]	USA (2004)	Failure of a planned action to be completed as intended or use of a wrong plan to achieve an aim	Case series IV	None	Mixed settings	240 reports	P, T, D, A	Reporting system	N/A
Deviation									
Barker [30]	USA (1984)	A dose of medication that deviates from the physician's medication order on the patient's chart and an error was viewed as an instance of failure of the medication system	RCT Ib	Dose dispensing	Surgical	1775 OE	D, A	Observation	ME: 282/ 1775 (16)[b]
Dean [31]	UK (1995)	A dose administered (or omitted) that deviated from the most recently written medication order for that patient	Descriptive IV	Unit dose vs. ward-based dispensing	Mixed	USA: 919 OE; UK: 2756 OE	D, A	Observation	ME: 63/ 919 (7) USA; ME: 84/2756 (3) UK
Flynn [32]	USA (2002)	Any discrepancy between the prescriber's interpretable medication order and what was administered to a patient	Descriptive IV	None	Mixed	2556 doses	P, T, D, A	Observation; chart review; Incident reporting	ME: 300/ 2556 (12); ME: 17/ 2556 (0.7); ME: 1/ 2556 (0.04)

Kirk [33]	Singapore (2004)	A medication error has occurred if there was an under-dose (below the agreed value), an overdose (above the agreed value) no frequency of administration specified, no dose given or excessive total daily dose	Descriptive IV	Calculator in CPOE vs. traditional CPOE	Paediatric	4274 orders	P	Computer database	ME: 833/4274 (20)
Kozer [34]	Canada (2005)	Drug regimen different from the recommended (dose differed from the recommended dose by $\geq$20%, deviation by $\geq$2 h from the recommended interval between doses, and wrong unit or route of administration)	RCT Ib	Pre-printed order sheet vs. regular order form	Paediatric	787 orders	P	Chart review	ME: 105/787 (13)[b]
Other:									
Cordero [70]	USA (2004)	The completion of the entire cycle, from physician order through medication administration by the nurse. Time-related errors were not separately identified	Descriptive; Pre–post IV	CPOE	ICU neonatal	111 pre-CPOE; 100 post-CPOE	P	Chart review; computer system	ME: 14/111 (13)[b]
Miller [71]	USA (2006)	An act or omission (involving medication) with potential or actual negative consequences for a patient that based on standard of care is considered to be an incorrect course of action	Case series IV	None	Paediatric	581 reports	P, T, D, A	Reporting system	ME: 1010
Wolf [72]	USA (1996)	Mistakes that involve patients and are associated with drugs and intravenous solutions. They are made during prescription, transcription, dispensing and administration phases of drug preparation and distribution	Descriptive IV	None	Nursing school	157 nurses		10 Error vignette; MEOS	N/A

[a]Oxford Centre for Evidence-based Medicine Levels of Evidence. Abbreviations: AUS: Australia; UK: United Kingdom; P: prescription; T: transcription; D: dispensing; A: administration; CPOE: computerized order entry; CDS: clinical decision support; OE: opportunities for errors; N/A: not applicable; MEOS: medication error outcome scale.[b]Prevalence from a control group or pre-intervention.

contributed to an underestimation of the occurrence of medication errors when applied to detection of errors other than prescribing.

Definition and prevalence

Interestingly, definitions, which at first glance appeared to be similar (Table 2), turned out to have the widest range in prevalence of medication errors. A closer scrutiny revealed that 10 of 15 studies in this category were affiliated with the same institutions in Boston, USA [7, 15, 28, 37–43]. In addition, these studies demonstrated the lowest occurrence of medication errors ranging from 2 to 8% regardless of whether intercepted errors were included or not, suggesting consistency in error detection methods. However, prevalence in the two studies from Europe exceeded the American studies by as much as eight times, despite use of virtually identical definitions [10, 35]. No obvious circumstances can explain these extreme differences, apart from use of data collection methods, as the study with the highest prevalence used computer-generated signals to detect dosing errors [35].

The majority of studies used the definition by NCC MERP. Unfortunately, it was only possible to retrieve one valid prevalence of medication errors [44]. This definition was initially developed for medication error reporting and, therefore, was an obvious choice for studies using reporting systems, which was the case for almost all the studies in this category [22]. An important drawback to reporting systems is an increased risk of underestimating the occurrence of medication errors due to the reporter's awareness of errors, attitudes towards reporting errors and fear of sanctions [45]. In addition, reporting systems are by nature denominator free as they do not provide information on the whole population; on the contrary, retrospective fitted denominators, such as time period or admissions, are frequently employed to demonstrate error rates [26]. Thus, reports of incidence or prevalence in studies using reporting systems should be avoided or interpreted with caution. Unfortunately, this expelled a unique opportunity to compare prevalence in studies using identical definitions.

Surprisingly, only 1 of the 45 definitions restricted medication errors to failures that either result in harm or have the potential to lead to harm [27]. Contrary to other definitions of medication errors in the present review, this approach relates process and outcome factors within the same definition, which previously has been suggested as minimizing the risk of accepting associations between errors and processes as synonyms for causation [46]. Moreover, this definition has been tested in an Australian study, in which it proved to be the most robust among other definitions, when evaluated in comparison with different medication error scenarios [25]. However, due to the design of this study it was not possible to elucidate that a restricted definition would lead to lower occurrences of medication errors compared with more profound definitions [15].

Finally, definitions that considered a medication error as a deviation between an ordered and administered drug and dose seemed to be more homogeneous with regard to prevalence despite representing different countries and employing different study designs [30, 32–34, 47]. However, these studies predominantly used the same types of denominator (opportunities for errors; doses and orders) as well as the most sensitive and appropriate data collection methods, e.g. direct observation in studies of dispensing and administration errors. A possible explanation for this consistency is the clear-cut limitation to deviations, which might appear simpler and be a less subjective approach in determination of medication errors. However, this approach excludes prescribing errors, as prescriptions serve as the gold standard in these definitions.

Limitations

The aim of this review was to investigate the multiplicity of definitions used in studies having medication errors and/or ADEs as the main objective. Hence, the characteristics and prevalence reported here might not reflect the overall occurrence of medication errors. However, it could be assumed that prevalence ranging from 2 to 75% represents the vast majority of studies in medication errors. Secondly, the literature search was limited to four major databases and restricted to papers in the English language. It is, therefore, possible that studies that would have met the inclusion criteria, were not indexed by these databases or were published in other languages than English. Nevertheless, due to experience from the current literature search, in which studies from a time span of >20 years were included, we assume that studies that might have been unintentionally disregarded in the search strategy would rather have added to the current inconsistency than contributed to clarification of the terminology. Third, the groupings we selected were somewhat arbitrary and this might have affected our chances of seeing an effect.

Conclusions

In the present systematic literature review of 45 studies we have confirmed inconsistency in defining medication errors as well as lack of definitions. Most of the definitions were profound, including minor deviations as well as fatal errors, whereas a single definition was restricted to harmful or potentially harmful errors.

Most importantly, it appears that definitions of medication errors and methods of detection, rather than being reproducible and reliable methods, are subject to individual researcher's preferences. Thus, it is obvious that application of a clear-cut definition, standardized terminology and reliable methods will greatly improve the quality and consistency of medication error findings. Efforts to achieve a commonly accepted definition that defines the scope and content is required in future studies.

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