PAPER

J R Coll Physicians Edinb 2007; **37**:343–346

Medication errors

DJP Williams
Consultant clinical pharmacologist, Department of Clinical Pharmacology, Aberdeen Royal Infirmary, Foresterhill, Aberdeen, Scotland, UK

ABSTRACT Medication errors, broadly defined as any error in the prescribing, dispensing, or administration of a drug, irrespective of whether such errors lead to adverse consequences or not, are the single most preventable cause of patient harm. Medication errors may be classified according to the stage of the medication use cycle in which they occur (prescribing, dispensing, or administration) although a recent classification of medication error into mistakes, slips, or lapses has been proposed. Incidences of medication error rates vary widely, as a result of the variety of different study methods and definitions used. The majority of medication errors occur as a result of poor prescribing and often involve relatively inexperienced medical staff, who are responsible for the majority of prescribing in hospital. Electronic prescribing may help reduce the risk of prescribing errors owing to illegible handwriting, although such systems can in turn lead to further problems such as incorrect drug selection, and their effect on patient outcomes requires further study. A multidisciplinary approach to solving the problem of medication errors is required which adopts an attitude of 'no blame', since incident reports have often been used as instruments of punishment, thereby creating a fear of discipline. This fear may be lessened by creating an open and safe environment for detecting and reporting medication errors. Current approaches to preventing medication errors are inadequate and require a shift in emphasis to a scientific investigation of preventable patient harm.

KEYWORDS Adverse drug event, medication error, patient safety

LIST OF ABBREVIATIONS Adverse drug event (ADE), Institute of Medicine (IOM), National Patient Safety Agency (NPSA)

DECLARATION OF INTERESTS No conflict of interests declared.

Published online ***July 2007***

Correspondence to ***DJP Williams, Department of Clinical Pharmacology, Aberdeen Royal Infirmary, Foresterhill, Aberdeen, Scotland, UK***

tel. ***+44 (0)1224 551 153***

fax. ***+44 (0)1224 551 152***

e-mail ***davidwilliams4@nhs.net***

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The National Patient Safety Agency Report 2004 (UK) and the IOM Report 2000 (USA) both highlighted that medical errors cause a large number of deaths each year. These reports recognised that the majority of errors were not the result of reckless behaviour on the part of health care providers, but occurred as a result of the speed and complexity of the medication–use cycle. Medication errors are the single most preventable cause of patient harm. Medication errors are broadly defined as any error in the prescribing, dispensing, or administration of a drug, irrespective of whether such errors lead to adverse consequences or not. The landmark IOM report estimated that errors in medical management lead to between 44,000–98,000 deaths in the US each year although these figures have been questioned.

One of the difficulties in this field is the variety of terms used in the definition and classification of medication errors. A more recent definition of medication error as 'A failure in the treatment process that leads to, or has the potential to lead to, harm to the patient' has recently been proposed, along with a psychological approach to the classification of medication errors according to whether they are mistakes, slips, or lapses.

Medication errors can occur at any stage of the medication use process and may or may not lead to an ADE. Depending on the clinical setting, about one-third to one-half of ADEs are associated with medication errors. The relationship between ADEs, potential ADEs, and medication errors is shown in Figure 1.

INCIDENCE OF MEDICATION ERRORS

Incident rates of medication errors vary widely, the reason for which can be explained by the different study methods and definitions used. The rate of medication errors varies between 2 and 14% of patients admitted to hospital, with 1–2% of patients in the US being harmed as a result, and the majority are due to poor prescribing. Medication error has been estimated to kill 7,000 patients per annum and accounts for nearly 1 in 20 hospital admissions in the US. The incidence is likely to be similar in the UK. Medication errors (7% of all incidents) were the second most common incident reported (after patient falls) in a recent National Audit Commission report on patient safety.

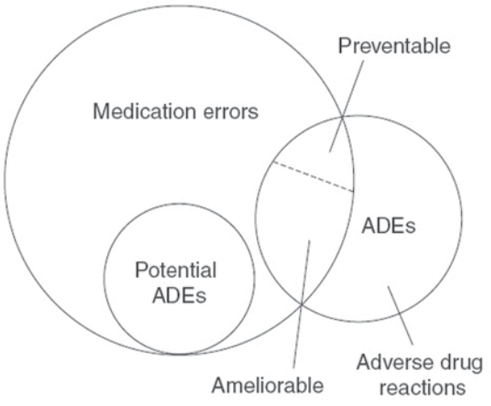

FIGURE 1 Relationship between ADEs, potential ADEs, and medication errors. (Reproduced with permission from Morimoto T, Gandhi T, Seger A, Hsieh T, Bates D. Adverse drug events and medication errors: detection and classification methods. *Qual Saf Health Care* 2004; **13**:306–14.)

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CLASSIFICATION OF MEDICATION ERRORS

The multiple steps in the medication chain, from when a drug is prescribed to when a patient receives the drug, leads to significant scope for error. However, significant improvements can be achieved from the prevention of medication errors, in terms of reduced patient morbidity, length of hospital stay, and healthcare costs. A classification system based on a psychological approach has been proposed which allows one to identify broad categories of error, quantify them, and develop an intervention to prevent them. This classification system divides errors into mistakes, slips, or lapses (see Figure 2).

Mistakes may be defined as errors in the planning of an action and may be knowledge-based (e.g. giving a medication without having established whether the patient is allergic to that medication) or rule-based. Rule-based errors can further be classified as either the misapplication of a good rule (e.g. injecting a medication into the non-preferred site) or the application of a bad rule or the failure to apply a good rule (e.g. using excessive doses of a drug). Slips and lapses are errors in the performance of an action – a slip through an erroneous performance (e.g. writing the more familiar 'chlorpropramide' instead of 'chlorpromazine') and a lapse through an erroneous memory (giving a drug that a patient is already known to be allergic to). Technical errors are the result of a failure of a particular skill (e.g. in the insertion of a cannula) and are therefore a subset of slips (skill-based errors).

Medication errors may also be classified according to where they occur in the medication use cycle, i.e. at the stage of prescribing, dispensing, or administration of a drug.

PRESCRIBING ERRORS

Prescribing errors may be defined as the incorrect drug selection for a patient. Such errors can include the dose, quantity, indication, or prescribing of a contraindicated drug. Lack of knowledge of the prescribed drug, its recommended dose, and of the patient details contribute to prescribing errors. Other contributing factors include:

- Illegible handwriting.
- Inaccurate medication history taking.
- Confusion with the drug name.
- Inappropriate use of decimal points. A zero should always precede a decimal point (e.g. 0·1). Similarly, tenfold errors in dose have occurred as a result of the use of a trailing zero (e.g. 1·0).
- Use of abbreviations (e.g. AZT has led to confusion between zidovudine and azathioprine).
- Use of verbal orders.

In a four-week UK prospective study of 36,200 prescriptions, 1·5% were found to have a prescribing error, 25% of which were potentially serious. When only serious errors were examined, 58% of the errors originated in the prescribing decision and 42% in medication order writing. This distribution is different from that seen in non-serious errors. Of further concern was the fact that the majority of errors were made by relatively junior medical staff, who are responsible for the majority of prescribing in hospitals. Medical graduates themselves feel unprepared to prescribe shortly after graduation, emphasising the need to ensure sufficient education in prescribing skills. Using a human error approach, Dean *et al.* suggested that most mistakes were made as a result of slips in attention, or because prescribers did not apply relevant rules. Risk factors for the development of prescribing errors such as work environment, workload, whether prescribing for own patient, communication within the team, physical and mental well being, and lack of knowledge were all identified. Organisational factors such as inadequate training, low perceived importance of prescribing, a hierarchical medical team, and an absence of self awareness of errors also contributed to these errors. In primary care the rate of prescribing errors has been estimated to be 11%. Communication of prescribing information between primary and secondary care has also been shown to be less than ideal as evidenced by a study which estimated that 50% of patients were failing to take the correct medicine one month after discharge.

Electronic prescribing may help to reduce the risk of prescribing errors resulting from illegible handwriting, although it can in turn lead to further problems such as incorrect drug selection. Computerised physician order entry systems eliminate the need for transcription of orders by nursing staff and for interpretation of orders by pharmacy staff and have been shown to have a significant effect on reducing medication errors. However, the

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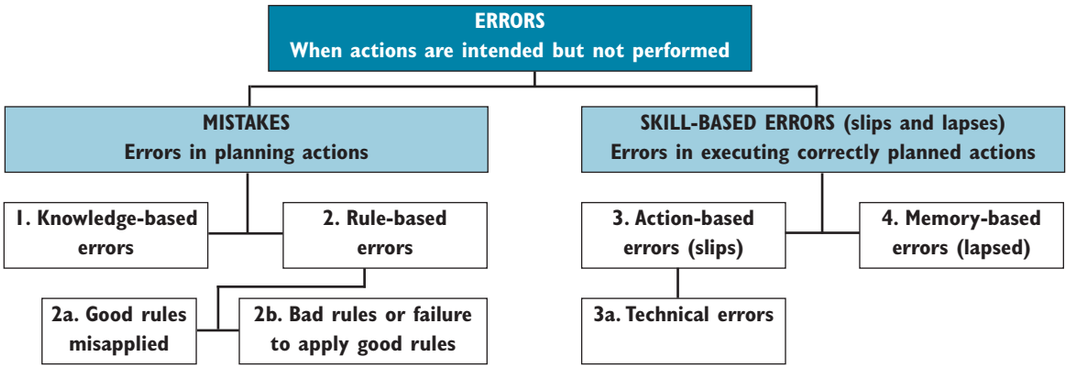

FIGURE 2 The classification of medication errors based on a psychological approach. (Reproduced with permission from Ferner RE, Aronson J. Clarification of terminology in medication errors. Definitions and classification. *Drug Saf* 2006; **29:**1011–22.)

effects of such systems on patient outcomes remain understudied and, when studied, provide variable results.

DISPENSING ERRORS

Dispensing errors occur at any stage of the dispensing process, from the receipt of the prescription in the pharmacy to the supply of a dispensed medicine to the patient. Dispensing errors occur at a rate of 1–24 % and include selection of the wrong strength or product. This occurs primarily with drugs that have a similar name or appearance. Lasix® (frusemide) and Losec® (omeprazole) are examples of proprietary names which, when hand-written, look similar and further emphasise the need to prescribe generically. In the US, the Food and Drug Administration has insisted that the proprietary name of Losec® be changed as a result of a number of fatalities associated with this confusion. Elsewhere, the name Losec® remains. Other examples of pairs of drugs with similar names where confusion occurs include amiloride 5 mg and amlodipine 5 mg tablets. Other potential dispensing errors include wrong dose, wrong drug, or wrong patient and the use of computerised labelling has led to transposition and typing errors which are among the most common causes of dispensing error.

Approaches to reducing dispensing errors include:

- Ensuring a safe dispensing procedure.
- Separating drugs with a similar name or appearance.
- Keeping interruptions in the dispensing procedure to a minimum and maintaining the workload of the pharmacist at a safe and manageable level.
- Awareness of high risk drugs such as potassium chloride and cytotoxic agents.
- Introducing safe systematic procedures for dispensing medicines in the pharmacy.

ADMINISTRATION ERRORS

Administration errors occur when a discrepancy occurs between the drug received by the patient and the drug therapy intended by the prescriber. Drug administration has long been associated with one of the highest risk areas in nursing practice, with the 'five rights' (giving the right dose of the right drug to the right patient at the right time by the right route) being the cornerstone of nursing education. Drug administration errors largely involve errors of omission where the drug is not administered for a variety of reasons. Other types of drug administration errors include an incorrect administration technique and the administration of incorrect or expired preparations.

The intravenous route of administration is a particularly complex process during which errors frequently occur and is associated with significant risk to patients as some have died as a result of the administration of cytotoxic drugs intrathecally instead of intravenously. The result has been that the Department of Health has made this particular type of error one of its prime targets in increasing patient safety. A recent study of intravenous drug administration suggested an error rate of 50% in either the preparation of the drug or its administration. The most common type of error identified was the deliberate violation of guidelines when injecting bolus doses faster than the recommended time of 3–5 minutes. Causes of administration errors included a lack of perceived risk, poor role models, and lack of available technology. Mistakes tended to occur when drug preparation or administration involved uncommon procedures with causes including a lack of knowledge of the preparation or administration procedures and the complex design of equipment. In contrast a major error rate of 0·19% in 30,000 cytotoxic preparations has been reported, suggesting that medication error rates may be lower in situations where intravenous drugs are administered in specialised units. Whilst this rate may be interpreted as being low, if such a rate were to be extrapolated each year across a large clinical area, the numbers of patients affected would be significant.

Contributing factors to drug administration errors include a failure to check the patient's identity prior to administration and the storage of similar preparations in similar areas. Environmental factors such a noise,

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interruptions whilst undertaking a drug round, and poor lighting may also contribute to these errors. The likelihood of error is also increased where more than one tablet is required to supply the correct dose or where a calculation to determine the correct dose is undertaken. Approaches to reduce drug administration errors include:

- Checking the patient's identity.
- Ensuring that dosage calculations are checked independently by another health care professional before the drug is administered.
- Ensuring that the prescription, drug, and patient are in the same place in order that they may be checked against one another.
- Ensuring the medication is given at the correct time.
- Minimising interruptions during drug rounds.

Clinical pharmacists are key to ensuring the safe use of medicines and the current system whereby wards are visited daily by clinical pharmacists places them in a good position to recognise particular training needs that can be addressed.

Finally, an alternative approach to reducing medication errors is to target high alert drugs and procedures. The implementation of a carefully planned series of low-cost interventions focused on high-risk medications, driven by information derived largely from internal event reporting , and designed to improve a hospital's medication safety, have been shown to significantly reduce patient harm as a result of medication errors. Drugs which have been identified as having a high potential for error include potassium chloride, high strength narcotics, cancer chemotherapy, heparin, insulin, vasoactive drugs, and epidural infusions. Attempts to reduce the harm caused by intravenous errors in the past have focused on restricting choice and removing the nurse from the drug preparation step. Restricted supply of strong potassium chloride to reduce medication errors has long been recommended and only stocking one strength of morphine ampoule on paediatric wards has been successful in preventing errors involving selection of the incorrect ampoule. Design issues such as ampoules that look similar and the complex design of infusion pumps have been recognised as risk factors for intravenous administration errors and puts the onus on manufacturers to supply products to a high safety standard.

It has been suggested that the pharmaceutical industry could apply a framework of human error theory at the product design stage and include consultations with health care professionals who will be using their product. The licensing process could also consider any differences between the product used in clinical trials and that used in clinical practice and the medication error potential of a particular product should be formally assessed during the post-marketing surveillance process.

CONCLUSIONS

All healthcare professionals have a responsibility in identifying contributing factors to medication errors and to use that information to further reduce their occurrence. A multidisciplinary approach to solving the problem of medication errors needs to be taken. Significant increases in the reporting of medication errors have been noted where confidential, no-fault reporting has been implemented. Creating a culture of safety does not just mean eradicating the culture of blame but also involves changing the entire way one thinks about and approaches the work in the medication cycle. Whilst it may seem counterintuitive to reward people for reporting failures, this is what is required in order to create a culture of safety in order that one can understand what causes medication errors and implement systems to prevent them recurring. However, confidential, non-punitive reporting has its faults including the fact that the true number of medication errors will still not be known and that confidential reports may be difficult to validate. We must recognise that the current approaches to preventing medication errors are inadequate and require a shift in emphasis to a scientific investigation of preventable patient harm. Medication use systems can be made safe by making them resistant to error and by adding important checks and controls. Unfortunately the difficulties associated with making systems failsafe explain the significant number of medication errors that continue to occur.

KEYPOINTS

- Medication errors are one of the most preventable causes of patient injury although the incidence of such errors varies widely as a result of differing definitions and methodologies.
- The majority of medication errors occur as a result of poor prescribing, emphasising the need to improve prescribing skills.
- The problems, sources and methods of avoiding medication errors are multifactorial and multidisciplinary.
- A non-punitive approach should be adopted to improve the rate of reporting of medication errors, allowing further investigation of these important causes of preventable patient harm.

FURTHER READING

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J R Coll Physicians Edinb 2007; **37:**343–346

Medication errors can occur throughout the medication-use system. Such as, when prescribing a drug, upon entering information into a computer system, when the drug is being prepared or dispensed, or when the drug is given to or taken by a patient. The U.S. Food and Drug Administration (FDA) receives more than 100,000 U.S. reports each year associated with a suspected medication error. FDA reviews the reports and classifies them to determine the cause and type of error. A medical error is a preventable adverse effect of care ("iatrogenesis"), whether or not it is evident or harmful to the patient. This might include an inaccurate or incomplete diagnosis or treatment of a disease, injury, syndrome, behavior, infection, or other ailment. Globally, it is estimated that 142,000 people died in 2013 from adverse effects of medical treatment; this is an increase from 94,000 in 1990. Medication errors can occur in deciding which medicine and dosage regimen to useÂ Although medication errors can occasionally be serious, they are not commonly so and are often trivial. However, it is important to detect them, since system failures that result in minor errors can later lead to serious errors. Reporting of errors should be encouraged by creating a blame-free, non-punitive environment. Medication Errors John Chuo George Lambert Definitions A medication error is defined as the failure of a planned action to be completed as intended or the use of the wrong plan to achieve a specific aim (1). A medication error is such an error that occurs during the medication use process (2). Essentially, the rightâ€¦