# Clinical Pharmacology

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## Anticipating, preventing and investigating medication errors

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Last year, a specialist registrar (SpR) instructed a senior house officer of only four weeks' standing to inject vincristine intrathecally, with lethal consequences. The SpR had failed to read the prescription chart, failed to read the ampoule label stating 'not for intrathecal use' and failed to identify the correct route (intravenous). He was convicted of manslaughter and sentenced to eight months in prison.[1] The case starkly emphasises the dangers of using drugs wrongly. It is not, however, unique or even rare. Death from errors in prescribing, dispensing, drawing up and giving medicines is common. Several studies suggest that probably one in 50 inpatients in acute care settings will suffer some harm from medication errors and one in 500 will suffer permanent harm or death.[2] In this context, we need to know how errors arise, how they can be eliminated, or at least mitigated, and what to do if things go wrong.

### Some definitions

Psychologists see *errors* as disorders of intentional (planned) acts;[3] they distinguish between *mistakes* (errors in the plan) and *slips of action* or *lapses of memory* (errors in putting the plan into practice) (Fig 1, Table 1). *Technical errors* are errors due to a failure in skill; for example, failing to cannulate a vein. *Violations* are acts that deliberately break rules designed to ensure safety, such as propping open the fire door on a hot day.

#### *Mistakes*

Mistakes can arise in two ways:

1. The plan of action can be flawed by a lack of knowledge. If a doctor writes a prescription for thioridazine to treat a confused elderly patient, not knowing that this is potentially dangerous and that the Committee on Safety of Medicines has advised against it, he makes a mistake.
2. Through misapplication of a well-constructed plan. For example, applying a plan for treating hypotension by infusing noradrenaline that might be deemed appropriate in sepsis would constitute a mistake if the hypotension were due to haemorrhage or myocardial infarction.

#### *Slips and lapses*

Slips and lapses, by contrast, are related to the execution of plans. If you intend to write today's date on a prescription (or cheque), say 3rd January 2005, but in error write 3rd January 2004 – because for 365 days you have 'automatically' written the year as 2004 – that is a slip. If I intend to write a patient's discharge medication, but am distracted by a cardiac arrest call and forget to do so, my error is a lapse.

Slips are very common in everyday life; for example, I meant to put the empty milk bottle on the doorstep but have put it in the refrigerator. They can be seen as deviations from the *schema*, the unconscious template that determines the sequence of 'automatic' actions such as tying one's shoelaces.

#### *Medication errors*

The treatment process, in the context of medication errors, begins at the point that it is decided to treat the patient. A *medication error* is 'a failure in the [drug] treatment process that leads to, or has the potential to lead to, harm to the patient'[4] (Table 2).

### The effects of error

*Hazards* are things or events that can cause *harm*. The probability that a hazard will cause harm is called the *risk*.[5] For example, a syringe containing vincristine constitutes a hazard since it is capable of causing harm if it is injected intrathecally. The risk – that is, the probability that it will do so – is a product of

### Key Points

- **Errors are failure to perform intentional acts as intended**
- **Errors are involuntary and so cannot easily be prevented**
- **Medication errors are common and dangerous**
- **They occur within a complex system of care**
- **Improving the system is the key to reducing error rates**

**KEY WORDS: medication errors, risk management, root cause analysis, safety management, systems analysis**

the (low) risk that someone will inject it intrathecally and the (very high) risk that, given intrathecally, vincristine will cause harm.

## Anticipating medication errors

Medical care depends on the interrelated activities of many people, who together form a complex system.[6] Human errors in this context are a property of the system as well as of the people who make it up. Some systems are more prone to human errors than others (Table 3).[4,7]

In a retrospective study of prescribing errors in paediatrics, trainees were more likely to make errors than specialists, and more likely to make them shortly after they began their training than after several months. Errors were more likely at weekends and between 04.00 and 07.59 hours than at other times of day.[8] These findings are entirely consistent with our knowledge of what makes errors more likely.

## Knowledge and errors in medication

The prescriber needs information about both the drug and the patient to avoid knowledge-based mistakes. For example, failure to realise that intravenous vancomycin will cause dangerous vasodilation ('the red man syndrome') if administered rapidly would make error likely. Error will also be likely if the patient is unconscious and allergic to penicillin, but the allergy has not been recorded on the prescription chart or on a warning bracelet. It can be anticipated therefore that mistakes will particularly occur when doctors have incomplete information about drugs and patients.

## Slips and lapses in medication

A common occurrence is for the schemata (the unconscious templates of the plans) for two different actions to become confused. Such slips can occur easily in prescribing and giving medicines. For example, a doctor who was used to giving pethidine (meperidine) for pain, killed a patient by administering diamorphine 100 mg. The dose was appropriate for pethidine but at least ten times too high for diamorphine.

Another common cause of slips is confusion of drug names. 'Look-alike' and 'sound-alike' slips are made more likely by the coexistence of several similar names: the compound drugs (co-dydramol, co-codamol, co-proxamol etc) are one example.[9] 'Look-alike' packaging represents a hazard when drugs are dispensed and administered; it results in error if clinicians rely on the packaging to distinguish one drug from another (Fig 2, Table 2).

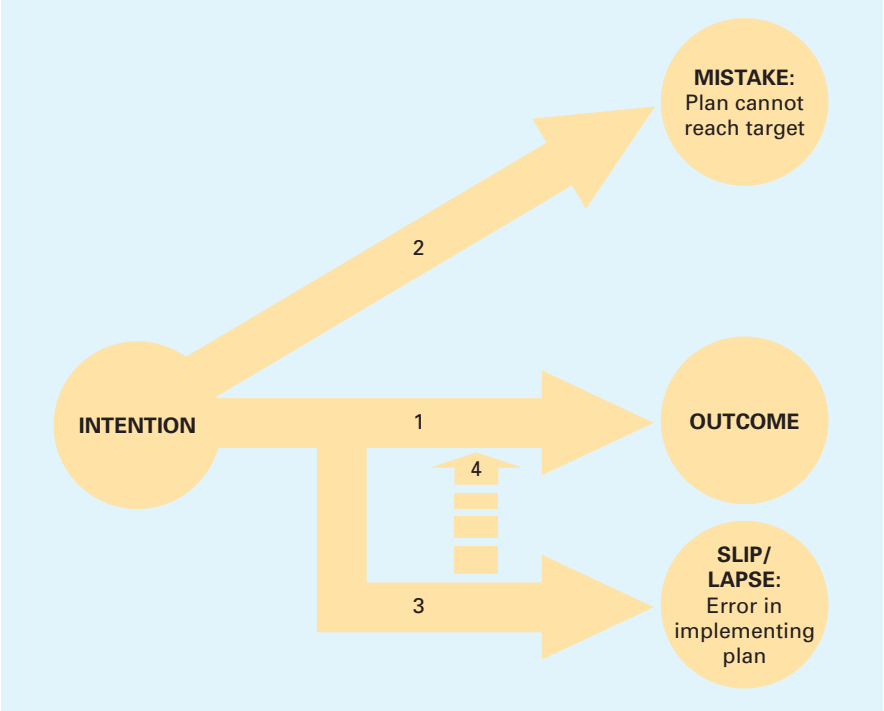


**Fig 1. Diagram of the 'routes of error'.** An intention of how to achieve a desired outcome is formulated: (1) The right plan correctly executed will lead to the desired outcome. (2) *Mistakes* constitute an *error* in the formulation of the plan. (3) A wrongly executed plan constitutes a *slip* or *lapse* and will take the plan off course. (4) If the error is detected and corrected en route, the desired outcome can still be reached.

**Table 1. Examples of error in everyday life and in the use of medications.**

| Term | Everyday example | Medication error example |
|---|---|---|
| Mistake | Believe that Bristol (2°35' West) is west of Edinburgh (3°12' West) | Prescribe verapamil injection to a patient also receiving a beta-blocker, ignorant of the potential for fatal interaction |
| Slip | Write the wrong date on a cheque (a common occurrence early in a new year) | Write chlorpropamide instead of chlorpromazine |
| Lapse | Forget to post a letter on the way to the shops | Intend to write a patient's discharge medication but be distracted by a cardiac arrest call |

## Preventing medication errors

Some errors are unimportant or innocuous. They may be detected before they cause harm or may have no health consequences; others kill patients. Piecemeal solutions that control only a small number of the most threatening hazards can distract clinicians from more general solutions that reduce all errors, including those that have relatively benign consequences. Such general solutions require careful analysis of the root (fundamental) causes of an error,

**Table 2. Examples of medication errors.**

| Cause | Examples | | Error | Comment |
|---|---|---|---|---|
| Look-alike drugs: in packaging | see Fig 2 | | Similarities between ampoules can cause errors | Check ampoules before use |
| in writing | ISMN | ISTIN | An abbreviated form of isosorbide mononitrate can be mistaken for the trade name for amlodipine | Use approved names only; do not use abbreviations |
| Sound-alike drugs | Clotrimazole | Co-trimoxazole | Detected if the routes of administration are different | Sound-alike drugs may be the source of error if, for example, instructions are given over the phone. These drugs may also look similar when hand written |
| | Carbamazepine | Carbimazole | Both may be given orally, although dose ranges are different | |
| | Losec® | Lasix® | Hard to detect, as both may be given in the same dose orally | |
| Inappropriate units | 5IU | 5 units | May be read as 5 IU, 51 U or 510 | Avoid abbreviations such as IU and µg |
| Inappropriate route | S/C | S/L | Incorrect reading of the prescribed route leads to the wrong route | Use only approved abbreviations; double-check before administering medicine |
| Calculation errors | A child weighing 10 kg is prescribed 1 mg/kg of lidocaine | The incorrect dose of 100 mg (a normal adult dose) is given; the child develops seizures | Calculation errors are common in paediatric prescribing because doses involved seem 'reasonable' | Double-check all calculations before dispensing and administration |
| Reading errors | A patient is prescribed .5 g of tolbutamide | The prescription is read and administered as 5 g | Tenfold errors are common because of slips in the position of decimal points | Avoid decimal fractions where possible. Always use leading zeros (0.5 mg); never use trailing zeros (5.0 mg) |

ISMN = isosorbide mononitrate; ISTIN® = amlodipine; S/C = subcutaneous; S/L = sublingual.

whether or not it led to harm. This is possible only if errors of no consequence are reported, as happens in aviation, where 'near-miss' events guide strategies for reducing all errors.

Mistakes can be reduced by a strategy that makes certain that the knowledge needed for a task is available when the task is being performed. Computer systems that issue warnings of potential drug interactions, for example, can do this,[10,11] as can the active participation of pharmacists.[12] So, too, can better education of clinicians in the practical knowledge and attitudes required for using medicines safely. Clearer statements of the assumptions underlying good rules can prevent their misapplication. For example, the recent warning that adolescents should not receive selective serotonin reuptake inhibitors will reduce mistakes in the treatment of depression. Slips that result from 'look-alike' errors can sometimes be prevented. For example, in the USA Losec (omeprazole) was renamed Prilosec to avoid confusion with Lasix (furosemide). Ensuring a good working environment with a minimum of distractions can also reduce the probability of a slip, but may be impossible in a busy hospital setting.

**Table 3. Factors that increase the likelihood of error**.

- The *environment*: eg if it is noisy or poorly lit
- The *person*: eg if he/she is ill-trained, tired, faced with many competing tasks or a high workload
- The *task*: eg if it is ambiguously specified, requires the solving of a novel or abstract problem or is not covered by standard procedures

## Investigation of errors

The view that errors should be investigated to find out 'who is to blame' is strongly entrenched but counterproductive in that it:

- hides the underlying defects in systems that make them vulnerable to human failings
- deters the reporting of errors, and
- is ineffective in changing behaviour.

Errors are unintended, so it follows that exhortation to do better and exemplary punishment are equally useless in preventing them. For systems to be improved, good reporting and constructive investigation are paramount, and reporters should be protected. In some systems, they are anonymous.

Constructive investigation of errors seeks to establish:

- the facts
- the proximate causes (what went wrong this time), and


**Fig 2. Ampoule similarity.** At first glance, the plastic ampoules with yellow labels look similar but a close-up view shows the difference.

- the latent causes – what underlying defects in the system for giving drugs allowed these causes to operate.

Several formal methods can be used, the best known of which is 'root cause analysis'.[13] They are best employed by a team that includes both senior people who have the power to change systems and those involved day-to-day in the processes that have failed. When the factors leading to an error have been identified, remedies can be put in place. These may involve improved training, the introduction of further 'error-traps' (checking procedures) or the redesign of systems to reduce the chances of human error.

The case of intrathecal administration of vincristine described above led to a meticulous examination of the reasons for such errors. Among many recommendations was one that spinal needles be designed to make it impossible to connect them to standard syringes.[14]

## Conclusions

Medication errors are common and commonly lead to harm. Humans inevitably make errors which neither exhortation nor punishment can prevent. Errors are best prevented by improving the systems in which the humans work. Thorough investigation of errors can establish the underlying causes and suggest ways to improve systems. Ultimately, all healthcare professionals need to know that they are fallible and that mistakes are legitimate, while failure to report, investigate and learn from them are not.

### *Conflicts of interest*

REF is a member of the Patient Safety Research Programme Steering Group of the National Patient Safety Agency. JC none.

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