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Medication errors: problems and recommendations from a consensus meeting

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Here we discuss 15 recommendations for reducing the risks of medication errors:

1. Provision of sufficient undergraduate learning opportunities to make medical students safe prescribers.
2. Provision of opportunities for students to practise skills that help to reduce errors.
3. Education of students about common types of medication errors and how to avoid them.
4. Education of prescribers in taking accurate drug histories.
5. Assessment in medical schools of prescribing knowledge and skills and demonstration that newly qualified doctors are safe prescribers.
6. European harmonization of prescribing and safety recommendations and regulatory measures, with regular feedback about rational drug use.
7. Comprehensive assessment of elderly patients for declining function.
8. Exploration of low-dose regimens for elderly patients and preparation of special formulations as required.
9. Training for all health-care professionals in drug use, adverse effects, and medication errors in elderly people.
10. More involvement of pharmacists in clinical practice.
11. Introduction of integrated prescription forms and national implementation in individual countries.
12. Development of better monitoring systems for detecting medication errors, based on classification and analysis of spontaneous reports of previous reactions, and for investigating the possible role of medication errors when patients die.
13. Use of IT systems, when available, to provide methods of avoiding medication errors; standardization, proper evaluation, and certification of clinical information systems.
14. Nonjudgmental communication with patients about their concerns and elicitation of symptoms that they perceive to be adverse drug reactions.
15. Avoidance of defensive reactions if patients mention symptoms resulting from medication errors.

In July 2008, a group of individuals interested in medication errors met in Erice, Sicily, at the invitation of Giampaolo Velo, who organized the meeting. They discussed the problem intensively over 2 days. From this emerged EMERGE, The Erice Medication Errors Research Group. The group resolved on two initial courses of action: to formulate recommendations in the field of medication errors and to prepare this special issue of the *British Journal of Clinical Pharmacology*, in order to highlight in more detail all aspects of the problem.

Here we list 15 recommendations that emerged from the meeting in Erice. A common theme was the lack of specialist clinical pharmacologists and clinical pharmacists to teach and train others, to carry out research, to monitor for medication errors, and to oversee the implementation of remedial procedures.

Education and assessment

Student education

There is evidence that changes in the style of modern medical school curricula in the UK may have reduced the visibility of traditional scientific disciplines that underpin safe prescribing, such as pharmacology and clinical pharmacology. There is also evidence that poor knowledge and

preparation underlie a proportion of errors made by junior doctors and that focused education in prescribing can improve performance [1–3]. It is also a perception among medical students that of all the clinical skills that they will be expected to practise after graduation, the one for which they are least well prepared is prescribing [4, 5]. It is clear that high-quality learning can flourish in different styles of curriculum. However, whatever the setting, learning should be based on enthusiastic leadership, ample sessions that focus on safe prescribing practices, and provision of online learning resources, including a limited student formulary.

Recommendation 1: provision of sufficient undergraduate learning opportunities to make medical students safe prescribers

Much of the medical school curriculum is devoted to the acquisition of knowledge, and sometimes its application to the skills required in the clinical environment is forgotten. Students should be encouraged to practise relevant clinical skills as soon as possible. These might include taking medication histories, writing new prescriptions and reviewing lists of established prescription medicines in relation to the patient's clinical history, calculating drug doses, and preparing and administering medicines under supervision.

Recommendation 2: provision of opportunities for students to practice skills that help to reduce errors

Medical students are often unaware of the potential hazards posed by medicines when they are prescribed in error, or of the frequency with which this occurs. They should be taught about drugs that are used commonly and pose particular challenges (e.g. anticoagulants, insulin, diuretics), how to monitor the effects of drugs so that potential dangers can be avoided, and the important contribution to error reduction made by good communication and record keeping.

Recommendation 3: Education of students about common types of medication errors and how to avoid them

Taking an accurate medication history

An accurate medication history is an important element in patient safety. Inaccurate histories, particularly on admission to hospital, can lead to prescribing errors, such as duplication of drugs or unintended discontinuation of medications, with consequent unwanted interactions, failure to detect drug-related pathology, and loss of efficacy of established therapy. In all, 67% of medication histories have at least one prescription error, 22% of which have the potential to harm the patient significantly [6]. Specific drugs are associated with increased risks of errors in the drug history; these include commonly prescribed agents such as anticoagulants and analgesics [7].

A medication history should elicit specific information from the patient [8]. This should include the details of all prescription medications, over-the-counter drugs, and herbal and other alternative remedies. Drug allergies and previous intolerances should be accurately documented; the dose of the drug, the reaction suffered, and its temporal relation to the drug should be described and susceptibility factors should be sought [9]. The history should be supplemented by examination of the patient, looking for the effects of drugs, and, when appropriate, by relevant laboratory investigations [10]. In addition, one should attempt to ascertain adherence to treatment, from the patient, general practitioner, or family, recognizing that accurate information may be difficult to obtain.

Pharmacists obtain better medication histories than physicians [11] and reduce the rate and severity of medication errors during acute admissions [12]. Furthermore, pharmacists attending medical or surgical post-take (admission) ward rounds improve drug history documentation, reduce prescribing costs, and prevent adverse drug reactions [13].

Recommendation 4: Education of prescribers in taking accurate drug histories

Assessment of skills

Prescribing is probably the practical skill that is most commonly required of all new doctors, but of all the skills that newly qualified doctors are expected to have mastered, they are least confident about prescribing. Medical schools should have effective assessments in place that discriminate between students who have sufficient knowledge and skills for safe medication practices and those who do not. The required standard will differ to some extent, depending on the level of supervision available after graduation. Postgraduate assessment should also be encouraged, as part of appraisal.

Recommendation 5: Assessment in medical schools of prescribing knowledge and skills and demonstration that newly qualified doctors are safe prescribers

Identifying hazardous systems

Hazards abound in clinical practice. They include:

- *Hazardous drugs* These need not be new drugs; well-established drugs are often subject to medication errors.
- *Hazardous patients* Patients present several risk factors for medication errors; there is limited knowledge about how to estimate individual patient risk, although elderly patients constitute a readily identifiable group.
- *Hazardous professionals* There is a lack of specialists (clinical pharmacologists and clinical pharmacists) trained in

the specific problems of medication safety. Consequently, many prescribers are not adequately trained in practical prescribing.
- *Hazardous settings* Some settings are more susceptible to involvement in medication errors, such as nursing homes, geriatric home care, surgical departments, intensive care units, and ambulatory care.

Hazardous drugs Several studies have confirmed persistent problems in prescribing well-established medications [14]. Although there is often a huge amount of knowledge about such medications, less attention is paid to the major safety problems. In some cases safer alternatives to some older risky medications (e.g. warfarin, amiodarone) are not available. Prescribing habits can also be influenced by local habits and advertisement (for example, the use of pentoxifylline in 20% of older adults in the Czech Republic, even though it is not approved in several European countries [15]).

Recommendation 6: European harmonization of prescribing and safety recommendations and regulatory measures, with regular feedback about rational drug use

Old patients Many problems that lead to medication errors particularly affect elderly patients, in whom cognitive impairment, renal insufficiency, dependence on carers, and polypharmacy are the major predictors of drug-related hospital admissions. Instruments for determining individual patient risk, particularly in patients with multiple comorbidities and several susceptibility factors, are not available for clinical use. There is a lack of professionals specifically trained in geriatrics, geriatric pharmacology, and pharmacoepidemiology. Clinicians do not routinely apply even basic safety recommendations [14], and insufficient attention is paid to well-known risks. There have been few studies on the long-term efficacy in elderly patients of safer low-dose regimens for frequently used medications [16]. In practice, most substances are usually prescribed in too high doses or in low-dose regimens with no evidence of primary or secondary long-term benefit in elderly patients. Drug formulations that contain low doses are less often available.

Recommendation 7: Comprehensive assessment of elderly patients for declining function [17]
Recommendation 8: Exploration of low-dose regimens for elderly patients and preparation of special formulations as required
Recommendation 9: Training for all health-care professionals in drug use, adverse effects, and medication errors in elderly people

Involving clinical pharmacists

Hospital care takes place in a complex and hierarchical organization encompassing different disciplines, which converge at the bedside. Many findings, decisions, and actions take place simultaneously and often acutely. In hospitals, medication and other errors can have many different causes and explanations and often occur at the bedside, where the different disciplines interact. Incidental distraction of attention is likely, and in the case of a specialized activity, such as checking and administering medicines, can lead to suboptimal performance. These types of errors typically occur in the absence of the pharmacist.

In the past few decades, the profession of clinical pharmacy has developed the specialism of pharmaceutical care, which aims at ensuring optimal individual pharmacotherapy and appropriate and errorless drug handling. Involvement of clinical pharmacists in almost the entire medication process, from dispensing to administration to the patient, can reduce medication errors [18]. This can be achieved through special medication ward rounds [19], the use of computer-assisted and barcode-controlled bedside dispensing (see below) [20, 21], and an extra check whenever a pharmaceutical formulation is modified before administration (e.g. crushing a capsule for a patient with an nasogastric tube [22]), entered via an unusual route, or injected into an intravenous line.

Recommendation 10: More involvement of pharmacists in clinical practice

Using uniform prescription forms

Although electronic prescription systems (see below) can improve prescribing quality, they are expensive and can generate new types of errors [23]. Integrated prescription forms have also been developed for use in hospitals, with the aim of reducing errors in prescribing and drug dispensing. The prescription is handwritten by the doctor and countersigned by the nurse after administration. The potential advantages are that a single sheet of paper contains all the necessary information about the patient's care, transcription is avoided, communication between physicians and nurses is simplified, and feedback control is facilitated. Although training is required, it is not time-consuming. In addition, uniform prescription charts can be easily implemented at low cost. To improve communication between medical staff and nurses, cooperation should be encouraged, verbal prescription should not be allowed, and only a limited number of abbreviations should be permitted. Feedback control must include immediate notification of errors by medical staff and pharmacists (potential harm deriving from prescription) as well as nurses (incorrect writing), while the prescriber can monitor actual drug administration [24]. Frequent (e.g. daily) review of prescriptions allows identification of potential harm from drug–drug interactions and adverse drug reactions. Audits should be performed periodically to evaluate the appropriateness of the procedures and encourage implementation of the prescription form [25]. Most errors made by junior hospital doctors occur shortly after they come to a

new hospital; national prescription forms would help to mitigate this effect.

Recommendation 11: Introduction of integrated prescription forms and national implementation in individual countries

Bar-coded medication administration

Before the administration of a medication in hospitals and other institutionalized care settings, the 'five rights' must be verified: the right patient, drug, dose, route, and time. Traditionally, the nurse does this by visually checking the medicine and the patient. However, there is evidence to suggest that this traditional method does not adequately protect the patient from medication-related harm. About 35% of all medication errors occur at the administration stage, and these errors are more likely to affect the patient than errors introduced at earlier stages [26].

In bar-coded medication administration a nurse typically scans a bar code on the employee identification badge, the patient's wristband, and the medication to be administered. The portable computer at the bedside sends the information to a server, which checks the prescription. The system can generate warnings or approvals, provide administration instructions and information about the drug, or deliver reminders for further actions. After administration, the system documents the activity in the patient's medication record for future use.

Case studies and anecdotal reports suggest that bar-coded medication administration can produce significant reductions of at least 50% in the number and types of medication administration errors [26–28]. Besides patient safety, secondary reasons for implementing bar-coded medication administration include improved workflow, documentation, billing, and public relations.

Although this technology has considerable potential to reduce medication errors, the risk of creating new kinds of errors should be minimized [29]. It is important, for example, that nurses use the technology systematically after it has been implemented [30].

Monitoring for medication errors

Prevention is ideal, but detection of errors that have occurred is also necessary, in order to identify those that are common in the particular setting, to identify their sources, and to prevent them from happening again.

Monitoring for drug harm is systematic assessment aimed at detecting and sometimes quantifying the harm [31]. It can be pre-emptive (systematically evaluating new medicines for potential risks of error), or by examination of spontaneous reports, or experimental. Regulatory agencies are explicitly asked to consider medication errors in Risk Management Plans [32], but strategies for doing so are not well developed and there have been hardly any studies devoted to techniques for monitoring medication errors during routine practice [33, 34]. 'Look-alike' errors are regularly reported with new medicines [35], despite the availability of strategies to reduce them [36]. Physicians do not regularly review prescription charts and should be encouraged to do so [37], while nurses are less effective at detecting medication errors than pharmacists [38].

We can infer that some monitoring takes place with spontaneous reporting schemes, such as those run by the National Reporting and Learning System in the UK and the Medication Errors Reporting Program in the USA, because warnings of serious potential hazards usually indicate the number of relevant events [39]. However, sophisticated statistical analysis of the sort that is now standard in pharmacovigilance does not seem to be used. This may partly be the result of a failure to classify reported events by the underlying failure modes and so allow common features to be drawn out. Systems for the investigation and reporting of deaths in which medication errors play a part are also weak.

Recommendation 12: Development of better monitoring systems for detecting medication errors, based on classification and analysis of spontaneous reports of previous reactions, and for investigating the possible role of medication errors when patients die

Communication

Interprofessional communication

With the dawn of the digital age, the process of communication has undergone a profound change. As the amount of information increases, the need for effective means of communication becomes paramount. It is therefore nowadays becoming increasingly difficult to find a person who does not make daily of use e-mail, mobile telephony, and chat or social networking services (such as Facebook or My Space). Yet medical professionals are not yet fully benefiting from modern technology, as exemplified by the delays and increasing costs of implementing IT technology in health-care and other systems in the UK [40, 41]. One of the concerns usually named among the reasons for this is the problem of information safety in digital communication, coupled with the high sensitivity and confidentiality of medical information, which becomes exacerbated outside of closed computer networks.

However, digital communication is not only fast, convenient, and inexpensive, but can also provide a high degree of security, through the use of encryption algorithms. The secure e-mail provider Zmail is a fine example of a service that offers an economical and secure means to send medical information over the internet. In addition, most broadband telephony providers are also integrating encryption options into their services, making them more attractive for use in medical communication (such as tele-

medicine and long-distance telephony). Finally, as the options for digital communication become increasingly available, reliable, and secure, they will also be increasingly used for sending medical information.

Published research strongly suggests that modern information systems have a substantial role in preventing medication errors at each step of the medication process. Computerized order entry and decision support systems reduce errors at the prescription stage by producing legible orders, by ensuring the correct dose and route, and by providing point-of-care alerts about potential drug allergies or drug–drug interactions. In a closed-loop system, the electronic orders are automatically transmitted to the pharmacy, altogether eliminating errors of transcription. Automated dispensing devices and robots ensure that the medication being dispensed is matched accurately against the physician's order. Bar-coded medication systems facilitate the verification of the 'five rights' by nurses during the administration stage (see above).

The usefulness of information systems derives from their ability to organize and link multiple pieces of information with consistency and reliability. A good informatics-enabled medication process will spare the clinicians repetitive boring tasks, so that they can focus on complex clinical decision-making and communicating with each other and their patients.

It must be clearly understood that information systems are not a panacea. A few studies have reported that if not implemented and monitored appropriately, they can lead to increased chances of errors, due to problems such as a faulty computer interface, miscommunication with other systems, lack of adequate decision support, and other human errors (e.g. lack of knowledge, distractions, and typing errors).

Recommendation 13: Use of IT systems, when available, to provide methods of avoiding medication errors; standardization, proper evaluation, and certification of clinical information systems

Communicating with patients

Patients' attitudes to medicines influence the ways in which they use them [42]. Some carry out their own evaluations of prescribed medicines, using their own criteria [43]. Up to 50% are non-adherent, in the sense that they do not take the medicine 'as prescribed', and few solutions to this longstanding problem have been identified [44]. Blind adherence to medication can lead to harm if patients are insufficiently informed about the dangers of prescribed medicines [45]. All of this suggests that it is better to engage with patients' own evaluations and aim for shared goals rather than ignoring or condemning 'non-adherence'. Such an approach requires further research and development.

As far as medication errors are concerned, patients and their carers will usually be the first to notice any observable problems that result, although they will probably be unable to distinguish between medication errors and adverse drug reactions. Little is known about how patients understand drug-related problems or how they make attributions of adverse effects. Some research suggests that their cognitive models of adverse drug reactions are closely related to models of illness perception [46]. The elements of such models are cause, symptom, time, consequence, and cure. Attributions of adverse drug reactions are related to people's previous experiences and to their level of education. The evidence suggests that, on the whole, patients' reports of adverse drug reactions are accurate [47]. However, they do not report all the problems they perceive and are more likely to report those they do perceive as being severe. Patients may not report problems attributed to their medications if they are fearful of doctors' reactions, and some authors have proposed the use of a symptom checklist to elicit patients' reports of suspected adverse drug reactions [43]. Doctors, for their part, may respond inappropriately to patients' concerns, for example by ignoring them [48], and professionals' inappropriate emphasis on adherence may be dangerous when a medication error has occurred.

Recommendation 14: Nonjudgmental communication with patients about their concerns and elicitation of symptoms that they perceive to be adverse drug reactions.

Recommendation 15: Avoidance of defensive reactions if patients mention symptoms resulting from medication errors.

Competing interests

None to declare.

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