

Prevention of medication errors: teaching and training

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1. Poor prescribing is probably the most common cause of preventable medication errors in hospitals, and many of these events involve junior doctors who have recently graduated. Prescribing is a complex skill that depends on a sound knowledge of medicines, an understanding of the principles of clinical pharmacology, the ability to make judgements concerning risks and benefits, and ideally experience. It is not surprising that errors occur.
2. The challenge of being a prescriber is probably greater now than ever before. Medical education has changed radically in the last 20 years, reflecting concerns about an overburdened curriculum and lack of focus on social sciences. In the UK, these changes have resulted in less teaching in clinical pharmacology and practical prescribing as guaranteed features of undergraduate training and assessment. There has been growing concern, not least from students, that medical school training is not sufficient to prepare them for the pressures of becoming prescribers. Similar concerns are being expressed in other countries. While irrefutable evidence that these changes are related to medication errors identified in practice, there is circumstantial evidence that this is so.
3. Systems analysis of errors suggests that knowledge and training are relevant factors in causation and that focused education improves prescribing performance. We believe that there is already sufficient evidence to support a careful review of how students are trained to become prescribers and how these skills are fostered in the postgraduate years. We provide a list of guiding principles on which training might be based.

Medication errors pose a major threat to patient safety. In England and Wales, over 50 000 medication incidents in National Health Service hospitals are reported annually to the UK National Patient Safety Agency [1]. Multiple factors are involved in these events, including faulty supply and labelling and errors of administration, but poor prescribing is probably the most common cause of avoidable events, accounting for over half of all preventable hospital medication errors [2]. Most serious hospital medication errors concern dose, and around 90% involve junior doctors who have recently graduated from medical school [3], making them an important potential target of intervention to improve patient safety.

The actual rate of medication errors is difficult to ascertain, in part because of variations in definition [4, 5]. A recent review of the literature concerning prescriptions made by junior doctors in hospitals found the range of reported error rates to be 2–514 per 1000 items prescribed and 4.2–82% of patients or charts reviewed [6]. These stark figures on errors probably do not include more subtle evidence of inappropriate prescribing of ineffective or

harmful drugs (e.g. unnecessary prescribing of diuretics, analgesics, antidepressants, and antimicrobial drugs), especially among elderly people, or the withholding of other treatments that are known to be effective (e.g. anticoagulants, angiotensin converting enzyme inhibitors, and statins).

It should come as no surprise that prescribing is associated with error. Prescribing is a complex and challenging task that requires diagnostic skills, knowledge of medicines, communication skills, an understanding of the principles of clinical pharmacology, appreciation of risk and uncertainty, and, ideally, experience. It is an anomaly that the hospital doctors who have least experience are expected to prescribe most often. It is also apparent that the demands on new prescribers are increasing progressively, owing to several important trends, including (i) the availability of an increasing number of licensed medicines with complex actions; (ii) an increasing number of indications for drug treatment; (iii) greater complexity of treatment regimens, leading to inappropriate polypharmacy; and (iv) more elderly and vulnerable patients. Although

errors are inevitable in these circumstances, the important challenge for a health service is to minimize risk. This will require a number of approaches, including changes to systems practices (e.g. labelling, team work, checking). However, here we shall focus on the potential influence of education and training as a means of improving knowledge and skills to prevent medication errors.

Recent changes in undergraduate education

Undergraduate medical education has undergone considerable transformation in the last two decades. These changes have come in response to concerns that students were overburdened with scientific facts and were being taught in rigid traditional discipline-based courses, with little regard to social sciences, notably communication skills. The General Medical Council (GMC), which regulates education in the UK, responded to these concerns by publishing a template for medical education, *Tomorrow's Doctors*, in 1993 [7]. This heralded a major change in direction, promoting a reduction in 'factual burden', integration of the curriculum 'both vertically and horizontally', and learning based on body systems. It 'avoided all reference to traditional subjects and disciplines . . . urging the advantages of interdisciplinarity'. These changes had an adverse effect on the teaching of clinical pharmacology and therapeutics (CPT), a traditional discipline that is factually rich and not organ-based. Identifiable courses and assessments in pharmacology and CPT disappeared in many schools, along with the teachers and departments who had delivered them [8]. As a result, many UK medical students now have little exposure to clinical pharmacologists or indeed any CPT or teaching about practical prescribing. This lack of specialists in a discipline dedicated to fostering safe and rational use of medicines has even led some schools to call on pharmaceutical company support for teaching [9]. The current standards set out for training nurse prescribers in the UK, 'a minimum of 26 days, with an additional 12 days of supervised learning practice' [10], would be the envy of many medical students [11].

Are medical students trained for safe prescribing?

Although there has been a growing perception, highlighted by clinical pharmacologists and others, that medical school education may have been lacking [12, 13], this view has been challenged [14, 15]. It has been difficult to resolve these opposing views, for several reasons. First, there has been little agreement about the required outcome of undergraduate education and no clear statement of the knowledge and skills that might be expected of a new doctor about to become a prescriber. Second,

achieving consensus on the required outcome is complicated by uncertainties about what is actually required of junior prescribers in their workplace and what level of supervision they receive. Third, very few medical schools now run exit assessments that focus specifically on safe prescribing and might provide clear evidence of educational attainment. A number of UK health service hospitals have now indicated their own concerns about preparedness of new doctors to prescribe and have developed their own assessments, sometimes with important consequences [16].

Medical students themselves have expressed concerns about their training at individual medical schools [11, 17, 18]. In perhaps the largest sample of opinion, Heaton and colleagues reported the views of around 2500 UK medical students and recent graduates [19]. The main findings were that few students now receive dedicated courses in pharmacology (25%) or CPT (17%), most want more education than they receive (74%), many feel that they would not achieve the graduation competencies identified by the GMC (42%), and (of particular concern) 56% disagree that they had been 'thoroughly tested' in this area. There was rarely a chance to practise prescribing. This study had some important weaknesses: it was a voluntary exercise that could have been subject to responder bias; it did not control for general disaffection by looking at other relevant skills beyond prescribing; and it was led by clinical pharmacologists, who might be perceived to have a significant conflict of interest. However, more recently, a study on the preparedness to practice of new doctors graduating from three medical schools, commissioned by the GMC itself, drew remarkably similar conclusions [20]. The authors concluded that

'There was a consistent thread, from primary sample data throughout the year, and from triangulation data, of under-preparedness for prescribing. Weaknesses were identified both in the pharmacological knowledge underpinning prescribing, and the practical elements of calculating dosage, writing up scripts, drug sheets, etc. While there was some feeling from triangulating data that F1s [newly qualified doctors] were prepared for prescribing, pharmacists did identify severe gaps. Prescribing was also the main area of practice in which errors were reported by respondents, indicating a significant potential risk. Risks were reduced, but not removed, by support from colleagues, with F1s speaking particularly highly about the help received from pharmacists.'

The particular significance of this study was that it examined the full range of competencies expected of newly qualified doctors and picked out prescribing as the most significant weakness. The study included a prescribing assessment for the graduates of two medical schools and,

although the test was not validated against clinically relevant outcomes, it is notable that >80% of the new doctors failed it. Much of the foregoing discussion draws on the education debate in the UK, but it is clear that others around Europe also have concerns [21], and that these are being echoed around the world [22, 23].

Are education or training factors in prescribing errors?

The questions raised about undergraduate training are of obvious relevance to a discussion on medication errors, given that recent graduates undertake a substantial proportion of hospital prescribing and make many of the recorded errors [3]. Review of these events suggests that failures in education and training are a factor. In a prospective study, 88 potentially serious prescribing errors made in a London teaching hospital were identified; 41 prescribers who had been involved were then interviewed, and the findings were analysed using human error theory [24]. Multiple contributory factors were identified, but 24 doctors (59%) cited their lack of 'skills and knowledge' as important. In another prospective study, 334 medication errors were identified among admissions to 11 medical and surgical units in two tertiary-care hospitals in the USA over a 6-month period; those involved were interviewed [25]. The authors concluded that failure in the 'dissemination of drug knowledge', particularly among doctors, accounted for 29% of the errors. Both reports show that error is usually multifactorial, but that knowledge of medicines and prior training are important.

Do educational interventions reduce medication errors?

Is there any evidence that educational interventions alone can reduce prescribing errors? Some defend the status quo on the basis of the paucity of research linking variations in early education experience to subsequent errors [14, 15]. There are obvious difficulties in delivering such evidence because of the large numbers of students required, the long and detailed follow-up, difficulty detecting medication-related events and measuring the quality of prescribing practice, achieving random allocation of learning experience, constant change in curricula, and overcoming the confounding effects of other relevant factors such as working environment and postgraduate education. However, several studies have shown that educational interventions can improve prescribing performance, although most have relied on assessments early after intervention and under controlled conditions rather than on hospital wards. Ross and Loke recently reviewed the literature for trials of educational interventions aimed at improving medical student or junior doctor prescribing

[26]. After screening 3189 records they found only 11 controlled trials and four 'before and after' trials that met relevant quality criteria. All but one small study of prescribing errors amongst paediatric residents [27] (notably the only one that examined errors in clinical practice) demonstrated evidence of improved prescribing. However, lack of randomisation in this study was a major weakness and it is possible that good prescribers chose not to attend the tutorial. This careful review suggests, first, that the available evidence supports efforts to support more intensive educational intervention, and second, that further and better studies are needed. These should ideally look at whether any performance benefit extends significantly beyond the training period, is generalizable beyond specific problems addressed in training and can be realized in clinical practice.

Some defend the status quo on the basis of the paucity of research linking variations in early education experience to subsequent errors [14, 15]. There are obvious difficulties in delivering such evidence, because of the large numbers of students required, the need for long and detailed follow-up, the effects of repeated changes in curricula, and the difficulties in detecting medication-related events, measuring the quality of prescribing practices, achieving random allocation of learning experience, and overcoming the confounding effects of other relevant factors such as the working environment and postgraduate education. However, several studies have shown that educational interventions can improve prescribing performance, although most have relied on assessments early after intervention and under controlled conditions rather than in hospital wards. Ross and Loke have recently reviewed the literature on trials of educational interventions aimed at improving medical student or junior doctor prescribing [26]. After screening 3189 records they found only 11 controlled trials and four 'before and after' trials that met relevant quality criteria. All but one small study of medication errors by paediatrics residents (notably the only one that examined errors in clinical practice) demonstrated evidence of improved prescribing. This careful review suggests, first, that the available evidence supports efforts to support more intensive educational interventions, and second, that further and better studies are needed. These should ideally investigate whether any performance benefit extends significantly beyond the training period, is generalizable beyond specific problems addressed in training, and can be realized in clinical practice.

Other uncertainties exist. When is the ideal time to provide education? We are among many commentators who believe that the undergraduate stage is a critical period, because courses are of prolonged duration (5–6 years full time), are undertaken when long-term attitudes and skills can best be developed, and are the only preparation available before the assumption of legal responsibility for prescribing. In contrast, postgraduate

interventions are significantly limited by time constraints imposed by clinical schedules, are more difficult to supervise effectively, and compete with other training requirements (e.g. resuscitation skills). However, postgraduate education does have the potential advantage that it would be delivered when prescribing skills are frequently being practised in a clinical setting. Prescribing and therapeutics is one of the most rapidly changing aspects of any doctor's clinical practice, and keeping up to date throughout a career that may last several decades presents a major challenge. All will require the necessary time to be set aside for continuing professional development of relevant knowledge and skills and should ideally receive other support in the form of bulletins, audits, and feedback on prescribing activity. The central importance of prescribing as an influence on the quality of medical care should make it a focus within any appraisal and revalidation processes.

Which methods of education might be most effective? The rise of problem-based learning has been a major educational trend, and prescribing education lends itself extremely well to this format, although in one recent study there was no benefit over more traditional didactic methods [28]. An alternative and increasingly popular approach is the development of eLearning packages to support rational prescribing [29–31], allowing learning opportunities to be taken up flexibly at times that best suit learners, a major potential advantage for postgraduates. However, evidence of efficacy is still awaited.

Recommendations for improved training in prescribing

Irrefutable evidence that more prescribing training will reduce the harm patients suffer from medication errors has yet to emerge. However, the combination of widely voiced concerns about existing education, growing challenges faced by prescribers, and the relative ease with which errors are identified has led many to advocate precautionary change [32–35]. Important steps have been taken in the UK, where the GMC and the Medical Schools Council convened a Safe Prescribing Working Group, which brought together representatives of relevant stakeholders. For the first time it was possible to achieve consensus on a list of prescribing competencies that should be expected of all graduates of medical schools and against which undergraduate education can be judged [36] (Table 1). Although this is an advance, it has not addressed the central question of how these outcomes can be achieved.

Several recommendations have been published in recent years, notably those of the British Pharmacological Society, the European Association for Clinical Pharmacology and Therapeutics, and the Association of American Medical Colleges [37, 38, 39]. All such guidance should rec-

Table 1

The list of competencies in relation to prescribing to be expected of all graduates of UK medical schools, as defined by the Safe Prescribing Working Group convened by the General Medical Council and Medical Schools Council in 2007 [36]; the full report is available at <http://www.chms.ac.uk/documents/finalreport.doc>

All new medical graduates should be able to:
• Establish an accurate drug history
• Plan appropriate therapy for common indications
• Write a safe and legal prescription
• Appraise critically the prescribing of others
• Calculate appropriate doses
• Provide patients with appropriate information about their medicines
• Access reliable information about medicines
• Detect and report adverse drug reactions

ognize the differing ethos of medical curricula adopted in medical schools around the world. These range from a more traditional style, with preclinical phases consisting of traditional sciences taught as disciplines, often by lecture, through to those that are based entirely on problem-based learning in small groups. We believe that education for safe prescribing can thrive in all settings, although it should follow some important principles (Table 2).

Conclusion

Medical education has changed greatly in recent years, often for the good. However, it is a matter of regret that specific courses in clinical pharmacology and therapeutics, the discipline that underpins safe and effective prescribing, have been lost. There seems to have been a prevailing view from some that this area of learning will 'take care of itself' as students are exposed to the clinical environment. This has clearly proved to be false. We believe that learning in this area needs to be carefully planned and enthusiastically led for students to achieve the greatest benefit.

Teaching and training of prescribers form only part of the approach to protecting patients from medication errors. Support from other colleagues (for example, clinical pharmacists) will be vital, along with the spread of electronic prescribing with decision support, but we believe that it will ultimately be the knowledge and instincts of prescribers that will be their most important protection against irrational and unsafe use of medicines.

Competing interests

None to declare.

Table 2

Recommendations for improving prescribing education for medical students and junior doctors (adapted, in part, from reference 35)

<p><i>Undergraduate</i></p> <ol style="list-style-type: none"> 1. Prescribing and therapeutics should be identified as an important vertical theme that is visible throughout the medical curriculum, integrating with and identifiable within relevant horizontal modules. 2. Students' core learning objectives should be clearly identified, including knowledge and understanding about drugs, skills related to the prescribing of drugs, and attitudes towards drug therapy. 3. The factual burden imposed by the large numbers of medicines that are encountered should be eased by prioritizing learning around a core list of around 100 commonly used drugs (a student formulary). 4. There should be an identifiable and robust assessment that tests whether the knowledge and skills outcomes identified above have been achieved; although this might form part of an integrated assessment, it should never be possible to compensate for a poor performance in prescribing by a good performance in other items. 5. Each medical school should identify an individual teacher to oversee this area of the curriculum, who will champion the importance of prescribing as a clinical skill and will ensure that the relevant opportunities are available to allow the relevant learning outcomes to be met.
<p><i>Postgraduate</i></p> <ol style="list-style-type: none"> 1. Prescribers should have protected time to update and reflect on their prescribing practices; dedicated training events should be provided at least once a year. 2. Prescribers should get feedback in the form of quality markers of prescribing relevant to their area of clinical practice. 3. Prescribers should, in the first year after graduation, receive genuine supervision that allows them to discuss problems and seek advice in a non-judgemental way. 4. Prescribers should not be pressurized into prescribing medicines of which they have little experience or understanding. 5. Whenever possible, errors that are identified should be drawn to the attention of the individuals concerned to afford a blame-free learning opportunity; all clinical units, including junior and senior doctors, should review and discuss prescribing incidents at regular intervals. 6. eLearning resources should be made available to support continuing professional development for prescribers at all levels. 7. Prescribing champions should be present in all large healthcare organizations to oversee the processes outlined above.

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