Causes of prescribing errors in hospital inpatients: a prospective study

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Summary

Background To prevent errors made during the prescription of drugs, we need to know why they arise. Theories of human error used to understand the causes of mistakes made in high-risk industries are being used in health-care. They have not, however, been applied to prescribing errors, which are a great cause of patient harm. Our aim was to use this approach to investigate the causes of such errors.

Methods Pharmacists at a UK teaching hospital prospectively identified 88 potentially serious prescribing errors. We interviewed the prescribers who made 44 of these, and analysed our findings with human error theory.

Findings Our results suggest that most mistakes were made because of slips in attention, or because prescribers did not apply relevant rules. Doctors identified many risk factors—work environment, workload, whether or not they were prescribing for their own patient, communication within their team, physical and mental well-being, and lack of knowledge. Organisational factors were also identified, and included inadequate training, low perceived importance of prescribing, a hierarchical medical team, and an absence of self-awareness of errors.

Interpretation To reduce prescribing errors, hospitals should train junior doctors in the principles of drug dosing before they start prescribing, and enforce good practice in documentation. They should also create a culture in which prescription writing is seen as important, and formally review interventions made by pharmacists, locum arrangements, and the workload of junior doctors, and make doctors aware of situations in which they are likely to commit errors.

Lancet 2002; **359:** 1373–78

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Introduction

Prescribers are human, and therefore make mistakes. In the past, the response to such mistakes has been to focus on personal accountability, whatever the circumstances. However, the systems in which people work also contribute to errors. Findings of studies of industrial errors, and from the discipline of human psychology, have resulted in development of frameworks to analyse the causes of errors and to suggest solutions. Reason[1] developed one such framework, which has been applied to medical error[2] and is the theoretical basis behind our study (figure 1).

Errors made during drug prescription are the most common type of avoidable medication error, and are hence an important target for improvement.[3,4] In the UK, the Department of Health is committed to reducing by 40% the number of serious errors involving prescribed drugs, by 2005.[5] Similar initiatives have been proposed in the USA.[6] To achieve such a reduction in mistakes, we first need to understand the frequency and cause of errors. In this prospective pilot study in a UK hospital we have defined prescribing errors, measured their incidence,[8] and aimed to understand their causes.

Methods

Study participants

Between Oct 18, 1999, and Dec 12, 1999, we asked pharmacists working at a 550-bed teaching hospital to prospectively inform one of us (BD) of any potentially serious prescribing errors made by doctors for inpatients. This hospital operates a typical ward pharmacy service. Briefly, such a service involves prescribers writing medication orders for inpatients by hand onto a formated drug chart. This document is used by nursing staff to ascertain the doses due at each medication round and to record their administration. Ward pharmacists routinely examine drug charts to initiate the supply of any treatments not stocked on the ward and to check that medication orders are clear, legal, and clinically appropriate. We gave pharmacists examples of what constituted a potentially serious error, based on cases from a similiar study.[8] Prescribers who made the reported mistakes were then contacted to request their participation in the study, at which point we explained that our aim was to explore the reasons why prescribing errors occurred and that participation was entirely voluntary.

Any member of medical staff involved in prescribing drugs for a hospital inpatient was eligible for inclusion. Since prescribing error is a sensitive subject, we reassured prescribers of confidentiality and reminded them of the hospital's non-disciplinary policy on errors made before the start of our study. All prescribers were aware that the study was taking place, as were clinical directors and all doctors, who we wrote to individually.

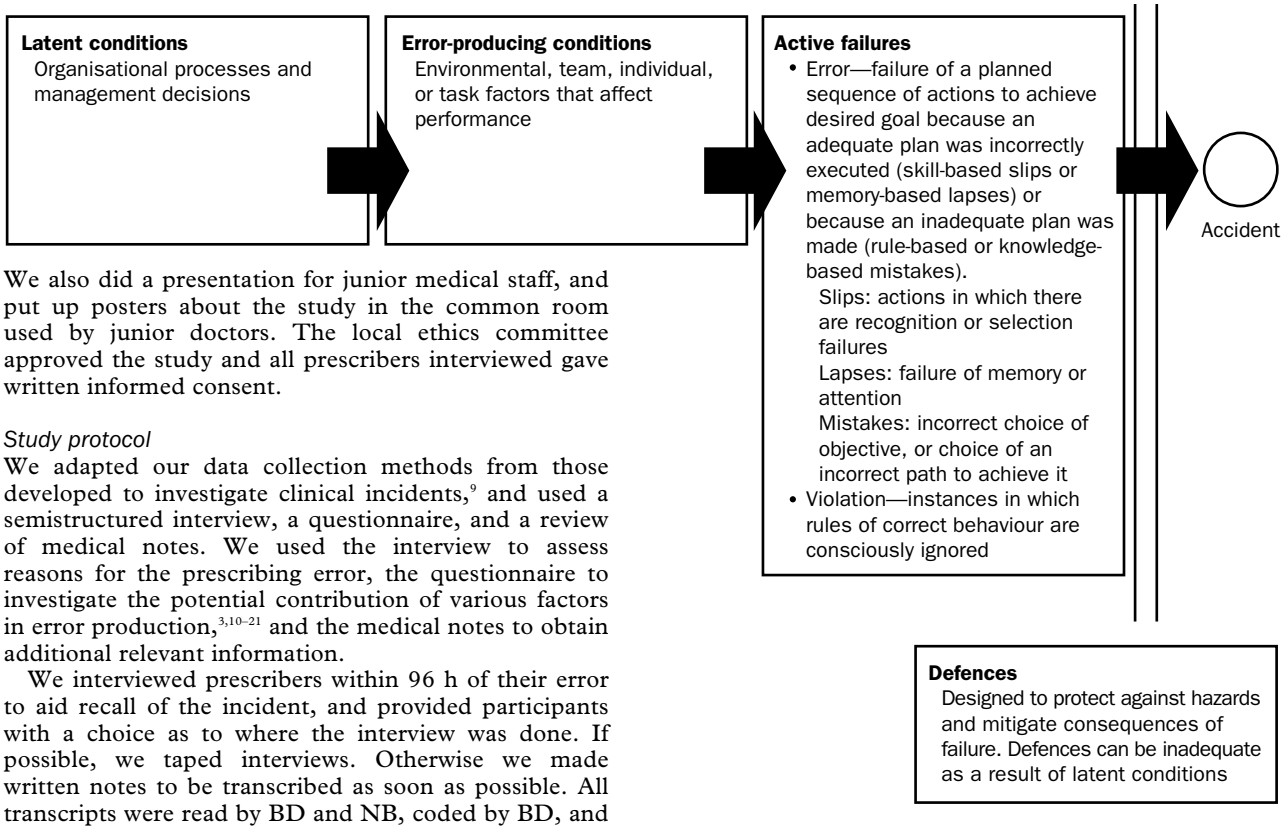

Figure 1: **Reason's model of accident causation**

We also did a presentation for junior medical staff, and put up posters about the study in the common room used by junior doctors. The local ethics committee approved the study and all prescribers interviewed gave written informed consent.

Study protocol

We adapted our data collection methods from those developed to investigate clinical incidents,[9] and used a semistructured interview, a questionnaire, and a review of medical notes. We used the interview to assess reasons for the prescribing error, the questionnaire to investigate the potential contribution of various factors in error production,[3,10–21] and the medical notes to obtain additional relevant information.

We interviewed prescribers within 96 h of their error to aid recall of the incident, and provided participants with a choice as to where the interview was done. If possible, we taped interviews. Otherwise we made written notes to be transcribed as soon as possible. All transcripts were read by BD and NB, coded by BD, and checked by NB. We resolved any differences through discussion.

We present our results according to Reason's four-stage model of human error (figure 1).[1]

Statistical analysis

We entered all transcripts into NUD*IST (version 4.0), a software package used to manage qualitative data. This system allows emerging themes to be coded and linked, and the numbers of errors in which common themes arise to be counted.

Role of the funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

88 potentially serious errors were reported. We identified the prescriber who made 50 (57%) of these errors, and contacted all 46 doctors; four doctors made two mistakes each. In six instances, the prescriber did not wish to be interviewed because they were too stressed (two), were too busy (two), could not remember writing the prescription (one), or had already been interviewed and felt there was nothing new to say (one). We therefore did 44 interviews with 41 doctors; three doctors being interviewed twice about different errors. 22 (50%) of the interviews were with senior house officers, 15 (34%) with junior house officers, three (7%) with consultants, three (7%) with specialist registrars, and one (2%) with a medical student in his final year. All major medical and surgical specialities were represented. We did 36 face-to-face interviews, and eight telephone interviews. 19 face-to-face interviews took place in the hospital canteen, and nine were taped. By the end of the 44 interviews, no new themes were emerging.

Active failures

We identified a main so-called active failure in each instance. Skill-based slips or lapses were most frequent (25, 57%), though rule-based mistakes (17, 39%) and violations (two, 4%) also took place (panel 1). All prescribers making slips and lapses were unable to explain why these arose, however doctors often mentioned that they were busy (31, 70%), or had been interrupted during routine tasks (13, 30%). Slips were more frequent than lapses (23 *vs* two).

All the mistakes we noted were rule-based. A common cause of such mistakes was the absence of knowledge of a relevant rule (6, 35%)—eg, how to reduce a dose of drug in renal failure. Some interviewees suggested that rules were known but inert or at the back of their mind, although in some instances this explanation might have been a socially acceptable construction of ignorance.

Other mistakes included application of the wrong rule (five, 29%). In one instance, for example, hospital dosing guidelines were misinterpreted when the paediatric dose of bendroflumethiazide was presented independent of weight rather than per kg as is normally the case. The prescriber who made the mistake multiplied the dose provided by the infant's bodyweight, resulting in a two-fold overdose.

Two violations were made, both of which involved doctors not adequately checking the doses of prescriptions written by final-year medical students, despite being aware that, according to hospital policy, the entire prescription should be checked.

Error-producing conditions

Error-producing conditions are shown in figure 2. We noted interactions between the various categories, such as workload and staffing. Doctors often cited multiple factors as having contributed to their error: the most frequent concerned the work environment, individual factors, and the working of the team (panel 2 and 3). In

Panel 1: **Examples of active failures**

Errors

Slips

"There are two drugs that we can use, can use both, I didn't mind which one was used, and set up to prescribe one but prescribed the other dose. Started writing Parlodel [bromocriptine], but didn't know the dose so looked it up in the BNF, someone else said to use Dostinex [cabergoline], so I wrote the dose of that . . . I didn't mind which drug, and wrote the dose for the other one. It's always the way, you're being asked seventy-eight questions at once, not fully concentrating, bleeps going off, everyone asking questions, especially if you're the consultant, can't totally concentrate. I wasn't paying that much attention as we were chatting in the office." (Interview 41, consultant, researcher's notes).

Lapses

". . . she was started on verapamil 40 mg tds on admission . . . I felt compliance would be better on an SR preparation and changed it to verapamil 120 mg SR, on both the inpatient chart and the TTA, which was also a dose increase. I didn't cross off the 40 mg tds from the inpatient chart . . . Probably wrote the TTAs just rushing, added a drug onto the chart without crossing off the first one." (Interview 14, senior house officer, researcher's notes).

Mistakes

Some mistakes were because of an absence of knowledge of relevant rules:

BD: At what level of renal failure would you start reducing the dose of something like ciprofloxacin?

"Don't know. Don't know how to judge the level of renal impairment. Didn't know you had to reduce it in renal failure." (Interview 44, senior house officer, researcher's notes).

In other instances rules were known, but not applied:

"We were starting anti-retroviral therapy, nevirapine and combivir together—should be nevirapine 200 mg od for two weeks then bd for two weeks . . . Most patients are on it bd, but I had forgotten that it is started as once daily. I knew the dose but forgot it when writing it." (Interview 8, senior house officer, researcher's notes).

Violations

In the study hospital, final-year medical students were allowed to write discharge prescriptions, provided a doctor then checked and signed them:

"The locum [student] had written the drug names and I checked them briefly and signed it, then asked him to fill in the doses, too. I didn't check it afterwards as I had already checked the names." (Interview 10, house officer, researcher's notes).

BNF=British National Formulary; tds=three times daily; SR=slow release; TTA=to take away (discharge prescription); od=once daily; bd=twice daily.

31 instances workload was thought by the interviewee to have contributed to the error, in 13 the physical environment was cited, and in 15 staffing was mentioned, including 12 instances in which difficulties arose from having to attend to another doctor's patient. The terms "hectic", "hassly", and "busier than average" were used to describe workload. Sometimes, workload made doctors change their usual practice to try and save time. Time-saving efforts included writing discharge prescriptions on the ward round instead of afterwards. Part of the pressure was to get prescriptions to pharmacy so that they could be returned to the ward in time for discharge. On two occasions, personal reasons, such as wanting to get home, created the time pressure.

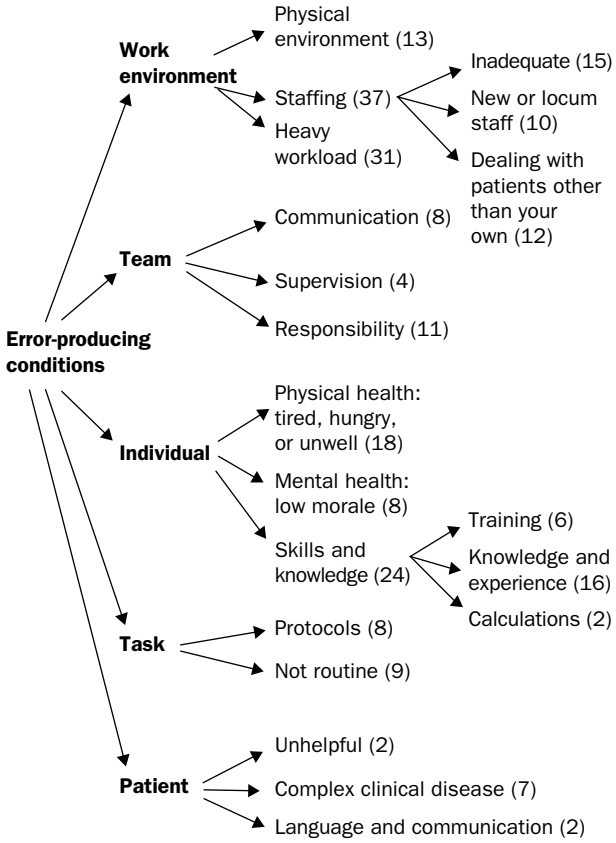

Figure 2: **Classification of error-producing conditions**
Numbers=number of doctors that cited each factor.

Staffing issues were also mentioned and included inadequate staffing, the effects of new or locum staff, and attending to another doctor's patient. Providing cover for absent colleagues not only increased workload but also meant that care was being given for patients the doctor did not know. Several doctors drew the distinction between those patients whom they had admitted and knew throughout their stay, and those whom they had to take over for only part of their treatment.

Personal factors mentioned in connection with prescribing errors included physical and mental well being, skills, and knowledge. 18 interviewees reported that they had felt tired, hungry, or unwell, and that these factors might have contributed to the error. An absence of knowledge, especially about doses, also contributed. In three instances confusion was caused by use of brand names (in UK hospital), except in rare cases, prescribing should be by generic name). In one instance the doctor transcribed Cardene (nicardipine) as Cardura (doxazosin) onto a discharge prescription, despite the pharmacist having written nicardipine alongside the word Cardene on the prescription.

Team factors, such as communication, supervision, and responsibility also affected risk of prescribing errors. Absence of or poor communication within and between teams contributed to errors. Causes included inability to read handwriting, not documenting drug allergies onto drug charts, inept crossing off of drugs, absence of documentation in the patient's notes of the prescribed drug and justification for its use, and removal of drug charts from the wards. In some instances junior doctors felt supervision was inadequate, and in another there were overlapping responsibilities between teams, which were not clearly defined. In several cases a senior doctor asked

Panel 2: **Examples of error-producing conditions related to the work environment**

Physical environment

"There is no desk, so TTAs are written standing up." (Interview 35, senior house officer, researcher's notes).

Workload

"[the workload is] too much. Especially when one of the other SHOs is away, like it is at the moment, [name of SHO] is away. So the SHO ends up also taking the roles of the other SHO. That's the way the house officers cover each other at this hospital . . . and the two SHOs have the largest two firms. So, it ends up, last week, two weeks ago, with me having 45 patients on my own. Under my care. Also me being on call, for, 24 hours in one day. And the rest of the time doing 12 hours on the wards. So 130 hours that week." (Interview 28, senior house officer, verbatim).

Dealing with another doctor's patients

"Well, I'm not quite sure to be honest, although it had been decided on the ward round for, um, for it to be started, there is no actual written entry in the notes for when it was started and what reason . . . had I written everything myself in the first instance, then obviously I would have known exactly what I was transcribing." (Interview 18, senior house officer, verbatim).

Hurried to prescribe

"I think because there is a lot of pressure from the wards to get them [discharge prescriptions] to pharmacy as soon as possible, because they take so long to come back from pharmacy. So you are really pressurised to even write them on the ward round, while you are walking around; do them quickly while you are just on the ward. You know, it is not something that people take a lot of stock by, so . . . It's just really to try and get the medications up as soon as possible." (Interview 23, house officer, verbatim).

TTA=To take away (discharge prescription); SHO=senior house officer.

Panel 3: **Examples of error-producing conditions relating to team and individual prescriber**

Team factors

Written communication:

"The person who clerks the patient should write any allergies on the drug chart, too, but it's not often done." (Interview 42, senior house officer, researcher's notes).

"The patient had two charts, I remember that it was a messy chart. Lots of things crossed off. Everyone has different ways of crossing off, you need a better way of doing it so you can clearly see which ones are current." (Interview 7, senior house officer, researcher's notes).

Verbal communication

"The majority of prescriptions are made by the consultant, all are made by the consultant, and we as the SHOs actually prescribe, as in write them on the drug chart, so I mean, yes, it was just on the ward round and she was already on fluconazole treating an infection, and then cisapride was added . . . you know, as far as how the decisions are made, so I don't know, it may be better for you to talk to a registrar, we are really just like pawns, and do what we're told sort of thing." (Interview 30, senior house officer, verbatim).

"My team is a house officer, senior registrar and consultant. So no-one to ask. Just me and the BNF. Would be easier if there was an SHO." (Interview 3, house officer, researcher's notes).

Individual factors

Hunger

"Um, well I suppose it's all back to post-take, and not having eaten since the night before, and carrying on working."
[BD: And how do you think that affected you?]
"Um, you just sort of want to speed things up and get it done quicker so you can go and get some food." (Interview 27, house officer, verbatim).

Tiredness

"In fact, I've been given the thankless task, at 1:30 in the morning, of re-writing someone's chart who's probably on multiple medications. And, it's basically, renders itself to error, because you've been asked to do a mindless task at 1:30 in the morning, just before you go to bed, on your round . . . I think that's the main problem. It's such a boring, thankless, tedious job that you're not going to sit there and use your clinical judgment at that time of the night . . ." (Interview 28, senior house officer, verbatim).

Knowledge

"Er, yeah, I know what it [thyroxine] does, but it is one of the things that I wouldn't necessarily know the dose of without looking it up. There are some drugs that I would know immediately that I had written it wrong. Whereas that's something I would need to look up, to look at the doses. I mean, I would only prescribe it if somebody came in actually already on the drug. So I'd only effectively copy down from the list what the GP had sent in." (Interview 23, house officer, verbatim).

SHO=senior house officer; BNF=British National Formulary; GP=general practitioner.

a junior doctor to prescribe a drug, who did so without asking questions, assuming that to do so was correct. Some junior doctors were unclear whose responsibility prescription of drugs was in such instances, and felt that if there was a problem, responsibility would rest with the senior doctor.

Finally, task and patient-specific factors were mentioned as possible causes of prescription errors. Task factors included the unavailability of suitable protocols, and having to do tasks outside the normal routine. Some prescribers wanted guidance on doses, but they had not looked beyond the British National Formulary (BNF), and the required information was in their hospital formulary. Another admitted knowing there was an antibiotic policy, but could not be bothered to look up the drug concerned. In two instances the patient was cited as a contributing factor. In one, the patient was judged a difficult person; in the other, the case was clinically complex.

Latent conditions

Many doctors did not seem to consider the task of prescribing drugs important. The act of prescribing was often embodied in a drug's name ("put them on verapamil"), and the details of dose, form, frequency, route, duration, &c, left to the house officer to complete. Learning about how to choose the dose seems to fall into a chasm between medical school (where, in our sample, the subject was not taught) and employment (panel 4). This situation sends a message about the unimportance of doses, which would seem to be supported by our previous study, in which 78 (55%) potentially serious errors were dosage errors.[8] Junior doctors are put in a position in which they have to prescribe without knowing how to do so.

Transcription was not seen as prescribing. Medical staff are responsible for writing new drug charts on admission, rewriting full charts, and writing discharge prescriptions. These acts of transcription were seen as mechanical and were not done with the same care as when prescribing a new drug.

Panel 4: **Example of latent conditions and defences**

Latent conditions

Training

"We get told about the drugs, the side effects, we learn, um, we don't use the brand names, um, we use the original, proper names, and we learn a lot about side effects. We don't learn about doses at medical school, how much to give, what frequency to give it at, that's not taught, it's something you pick up really in your first few weeks as a house officer." (Interview 29, house officer, verbatim).

"Writing TTAs, especially CDs, is taught the day before we start the house officer job, it's never taught in medical school. It's assumed that by generally being around the wards we'll pick it up." (Interview 10, house officer, researcher's notes).

"[Ward pharmacist] has the drug dose guidelines. There may be renal information on the ward, I don't know." (Interview 9, senior house officer, researcher's notes).

Defences

Pharmacists

"It's fine, I mean, you know that everyone does it, so it's not like it's something that no-one talks about, everyone gets phoned up by pharmacy, you know, almost every day, to say by the way you've done this, I think it should have been this, do you mind if I change it? Useful things." (Interview 25, house officer, verbatim).

"It's my responsibility, but don't have time to look in the BNF for drugs not familiar with, know someone will look." (Interview 26, house officer, researcher's notes).

TTA=To take away (discharge prescription); CD=controlled drug.

There was low self-awareness of making errors. At interview, most doctors reported that they were unaware of having made errors previously. In view of the fact that we identified a prescribing error in 1·5% of all medication orders in the study hospital,[8] this statement seems unlikely. The fact that doctors answered in this way suggests that they might have been embarrassed about their mistakes, might not have been aware of previous errors due to intervention by pharmacists, or did not consider previous mistakes to be prescribing errors.

Finally, there were some indications that the culture and power in medical teams leads to junior doctors and nurses not questioning the decisions of senior doctors, or not asking for clarification if they were unsure of exactly how to prescribe a drug. One consultant also felt that hospital management had a token attitude to risk management.

Defences

Defences could be within the prescriber's own internal thought process or provided by nurses or pharmacists (panel 4). Pharmacists were the main source of defence, identifying and rectifying all the errors in this study, and were mentioned specifically in 16 interviews. Doctors welcomed help from pharmacists, since they not only identified mistakes, but also provided an educational role to the individuals in doing so. However, some junior doctors suggested that they trusted the pharmacists to do this role so much that they would sometimes not bother to look up doses.

Several doctors mentioned that when they had written the prescription something had seemed wrong, however, they could not identify the problem at the time. Nurses and midwives were also mentioned as being part of the defences.

Discussion

Our results suggest that the human error theory can be used to identify the causes of potentially serious prescribing errors. Although prescribers must be accountable for their actions, our findings indicate that errors usually arise as a result of other factors. Prescribing errors could be reduced by training, adherence to existing systems of work, and through the introduction of new working practices.

Junior doctors should be trained in how to ascertain the correct dose of a drug and its frequency of administration, and how to identify when it might need adjustment. New doctors rely on the BNF when prescribing drugs, and on pharmacists to notice and explain their mistakes. This haphazard approach is hard to justify. A young prescriber should be able to tackle new prescribing conditions, however, they should also be trained to deal with those they are expected to meet routinely.

Several prescribing errors happened because current good practice was not adhered to. The basis for avoiding prescription and drug administration errors is set out in the Gillie report.[22] This report states that a drug chart should stay with the patient, that the doctor should write prescriptions clearly, that there should be minimal transcribing of medication orders, and that all medication orders should be checked by pharmacists. Other examples of good practice that might reduce prescribing errors include documenting the reason for prescribing a drug in a patient's notes, detailing allergies on the chart, and adhering to existing prescribing policies.

In addition to enforcement of these systems, a change in culture and the introduction of new procedures is needed. If, as we suspect, prescribing, as understood by doctors, is primarily the naming of a drug, and that all subsidiary information and acts are seen as secondary, then medical teams must change the way in which they communicate treatments. The drug should always be accompanied by its dose, form, route of administration, &c, and prescription-writing should be recognised as a high-risk activity. The team would also benefit from discussions about prescribing detail (the exact dose and why it is right), reviewing the drug chart on rounds, and regularly reviewing prescribing errors with their ward pharmacist.

In the UK, pharmacists play a key role in the defences against prescribing error.[23] This role should be maintained and developed as a part of a strategy to reduce prescribing errors. Pharmacists provide a supply role and also monitor prescriptions to detect any errors that arise. However, the less time that a pharmacist has to spend on each prescription, the less time they can spend checking for errors.[24,25] The shortage of pharmacists in the UK (40% of the hospitals' pharmacist posts were vacant at the time of the study) means that their monitoring role must be protected. Some junior prescribers admitted to us that they probably adopted riskier behaviour than normal because they assumed that the pharmacists would check their work. However it is not clear whether such risk homeostasis[26] actually occurred or whether this excuse was cited as mitigation in defence of their errors. One way to reduce the number of prescribing errors might be for pharmacists to take on a greater prescribing role. Pharmacists already write discharge prescriptions in some hospitals,[27] and their knowledge should allow them to take on both supplementary and independent prescribing roles. Doctors could also improve their own defences by recognising circumstances in which they might make errors—eg, when looking after another doctor's patients, having an unusually heavy workload, feeling that something is not quite right with the prescription and dealing with unusual drugs.

Our study did have limitations. In particular, our study was done at only one teaching hospital, and the people who had made mistakes were presenting their own account of what happened to a researcher. We cannot, therefore, ascribe causality with certainty. Furthermore, the study was done between October and December; we would expect more prescribing errors to arise in August and February, when junior medical staff begin new rotations. However, we believe that our findings are representative of the year overall. Additionally, the response rate was high, with only six prescribers declining to participate. Prescribers might have valued the opportunity to talk about errors and why they occurred, in a non-threatening environment.

Human beings develop through reflexive processes—ie, they do something, observe the consequences, and consider how they could do it better next time. Prescribing can be improved by increasing that reflexivity, by bringing the detail of prescribing into the open, and by reviewing errors in prescribing and by sharing them openly, so that prescribers learn and patients benefit. All the prescribing errors that we identified might have been avoided by the implementation of small measures, which could have been enacted swiftly and at little financial cost.

Contributors

The study was designed by all the authors. B Dean coordinated the study, collected the data, and analysed it with N Barber. N Barber was the project guarantor and wrote the report with B Dean, with help from M Schachter and C Vincent.

Conflict of interest statement

None declared.

Acknowledgments

We thank the steering group and prescribers who participated in this study. The work was funded by the NHS Executive London Research and Development Responsive Funding Programme.

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