

# A proposal to reduce medication errors made by newly qualified doctors by adopting the drills used for *ab initio* aviation training

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**ABSTRACT** Recent articles in the lay and medical press have again drawn attention to the preponderance of medication errors made by inexperienced, newly qualified physicians. With medical training currently undergoing transformation, perhaps there remains an opportunity to adapt some of the drills used in aviation training, which concentrate on the provision of safety above all. Aviation and medicine share many characteristics, and the concept of crew resource management, created to understand and minimise errors in aviation, has already been adapted and transferred to some of those areas of medical practice that involve teamwork across different disciplines. This paper describes some of the drills used in early aviation training and discusses how these might be adapted and applied towards the reduction of medication errors by newly qualified doctors.

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**LIST OF ABBREVIATIONS** Crew resource management (CRM), General Medical Council (GMC), National Aeronautics and Space Administration (NASA), National Patient Safety Agency (NPSA)

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'To err is human, to forgive divine'  
– Alexander Pope, *An Essay on Criticism*, 1711

## INTRODUCTION

To judge from recent reports in both the lay and medical press<sup>1,2</sup> and three papers in a recent issue of this journal,<sup>3–5</sup> it would seem that medication errors are on the increase. The GMC<sup>2</sup> has offered a grant of £100,000 'to support research to determine the prevalence and causes of prescribing errors and recommendations about educational or ethical interventions the GMC could take to reduce the prevalence or causes'. In its information,<sup>6</sup> the GMC specifically draws attention to errors made by 'newly qualified doctors'.

Outside surgery the most common errors are complications of drug therapy: the wrong or inappropriate drug or dose, therapeutic mishaps such as intrathecal instead of intravenous injection, diagnostic error or failure to administer drugs that had been prescribed.<sup>7</sup> An accurate assessment of the frequency of these errors is almost certainly hampered by under-reporting, but a retrospective review of the records of 1,014 patients in two hospitals<sup>8</sup> found that 10–12% of these patients had single or multiple unintended injuries caused by medical mismanagement, of which half were deemed preventable with ordinary standards of care. Extrapolating from this

pilot study, the authors suggest that about 5% of the 8.5 million patients admitted to hospital in England and Wales in one year will suffer a preventable unintended injury, adding some three million bed days and around £1 billion to the total National Health Service costs. A more recent study found that of 736 medication charts, 335 (45%) had a prescription error.<sup>3</sup>

## ATTRIBUTING CAUSALITY

The cause of medication errors has been attributed to the multiple steps in the medication chain leading to significant scope for error,<sup>4</sup> and the similarity of some drug names, although when names are changed the law of unintended consequences intervenes and confounds.<sup>9</sup> Illegible handwriting and transcription errors have been implicated,<sup>4</sup> along with the risk of using abbreviations, in particular OD, as was highlighted some years ago.<sup>10</sup> The similarity of clear-glass ampoules and difficulty in reading the printing on the ampoules have also been blamed, but clear glass is the most easily checked for contamination or discolouration of the contents. More relevantly perhaps, mistakes occur more frequently with inexperienced physicians<sup>3,4,11,12</sup> or when new techniques are introduced. Most prescribing errors occur among first-year postgraduate residents, with 45% of house officers in internal medicine admitting to at least one error.<sup>11,12</sup>

## THE CONCEPT OF CREW RESOURCE MANAGEMENT

In and of themselves, aircraft and drugs are inert until activated by human intervention, with aviation and medicine sharing the multiple steps between starting and the error occurring. It is, therefore, of interest that in 1979 NASA and representatives of the commercial airline industry held a conference to study the causes of air transport accidents.<sup>13</sup> The research identified the human errors behind the majority of air crashes, with the major factors being failure of interpersonal communications, decision making and leadership. As a result of this conference, the concept of cockpit resource management was developed for the training of air crews in an attempt to reduce pilot error,<sup>14</sup> and the airlines represented at the conference established training programmes to improve the performance of their flight crews in these areas. Now in the fifth generation and renamed, less specifically, crew resource management (CRM), these concepts and training have been adopted by most of the major airlines.

More recently, the concepts of CRM have been adapted and applied to medical practice, in particular to those specialties where collaboration and teamwork are required, with surgery being the most obvious example.<sup>15</sup> Like pilots, anaesthetists work as part of a team and face the double jeopardy of human error and equipment failure, so it is not surprising that they have been pioneers in developing modern research techniques into drug safety.<sup>16</sup>

Basic training in CRM involves modules that address decision-making strategies, situation awareness and stress management, aimed at breaking the chain of errors that leads to a disaster, and in changing individual style and behaviour, such as diffidence in seeking advice or clarification by juniors and authoritarian attitudes by senior staff. As with any new proposal, the concept of CRM did not immediately receive universal acceptance in the airline industry, and some of the early CRM programmes did not always work well, particularly in countries outside the US, where the concepts presented were incongruent with the local pilot culture.<sup>14</sup>

Even within the USA not all pilots accepted CRM, some disparaging it as 'only a form of charm school', saying that it was an attempt to manipulate their personalities. Some complained that it would never eradicate all errors, so for them remedial training proved to be ineffective.<sup>17</sup> Certain personality characteristics were identified early as being important indicators of the likely success or failure of the training being accepted and valuable.<sup>14</sup> Given the ubiquity of human error, it will never be possible to ensure the elimination of all such errors, but the criticism misses the point that the concept of CRM concentrates first on avoiding an error, second on trapping an incipient error

before it occurs and third on mitigating the consequences of the error.<sup>14</sup>

At first sight, it might seem that the admirable concepts behind CRM can be applied only to what might be described as group situations, where argument, arrogance, deference to rank and status, diffidence, disagreement, inexperience or misunderstanding can all combine to cause an error; and that the concept would therefore not be relevant to an inexperienced physician responsible for medication requirements specified by senior staff. In fact, the situations are similar, with unlimited opportunities for interpersonal relations and leadership on the one hand and inexperience and hesitancy to seek clarification, on the other. For these reasons I believe that aspects of pilot training and the teaching drills developed for the training of novice pilots could be specifically and usefully applied to the training of young, inexperienced doctors in an attempt to reduce the frequency of medication errors.

## THE DRILLS OF LEARNING TO FLY

In proposing that aspects of aviation training could, with advantage, be adapted for training inexperienced doctors in error avoidance, I briefly describe some aspects of *ab initio* pilot training and show that, in many instances, close parallels can be drawn between training at this level in aviation and in medicine. Before my initial flight, my Royal Air Force instructor warned me that there were only two kinds of pilots: old pilots and bold pilots, but there were no old, bold pilots. He suggested that the aircraft should always be regarded with care and respect, echoing Professor Sir Derrick Dunlop, who used to implore us to use modern drugs – 'those therapeutic thunderbolts of Jove' as he called them – with care and trepidation. 'Show me a drug without side effects,' he would urge, 'and I'll show you a drug without any effect.'

My instructor had been a fighter pilot who survived the Second World War. He warned me that, in peacetime, most aviation accidents resulted from pilot error, usually a combination of inexperience, stupidity or a failure to complete all the safety checks. So, with several similar aircraft parked in the dispersal area, rather like patients in a ward, I was told always to check carefully the identity of the aircraft to which we had been assigned and to confirm this with the ground crew. Taking off in an aircraft that has not yet been refuelled usually results in an unexpectedly short flight with an abrupt ending. With the identity of the aircraft confirmed, he led me through my first pre-flight inspection – an external examination of the entire machine to look for minor damage or a cover left in place over the pitot tube; damage to the tyres, navigation and landing lights; impaired movement of the ailerons, elevators or rudder; or damage to the canopy and windshield, and so on.

This stage is familiar to anaesthetists who start their day with a check of the functioning of the anaesthetic machine

and monitoring equipment, available drugs and back-up supplies. In medicine, this would be paralleled by an identity check of the patient, confirming with a nurse or other member of the ward staff that they and the patient were aware of the treatment or procedure to be undertaken; confirmation, if relevant, that the patient had or had not received food or other drugs recently, and a check that the necessary equipment for any procedure, say a lumbar puncture, intravenous or intrathecal injection, was complete and ready. Ideally, a senior colleague would be present to guide, spot omissions and confirm each stage as completed.

### CHECKS WITH EVERYTHING

Everything in aviation follows a check-list to ensure that nothing is overlooked: anyone who has boarded a commercial passenger aircraft has probably noticed the two pilots in the cockpit performing the pre-flight checks, one calling out from the flight manual each check-list item and watching while the other checks or performs the task. These flight manuals are massive, weighty tomes that are prepared by the aircraft manufacturer, agreed with the relevant Civil Aviation Authority and continually updated during the life of the aircraft. For large, sophisticated commercial aircraft, these manuals are too comprehensive to be learned by the pilots, hence a colleague is required to read out the checks.

For a novice pilot starting on relatively unsophisticated aircraft, pilot's notes, containing all the check-lists, performance data and information pertaining to flying that particular aircraft type, together with the procedures to be followed in an emergency, are prepared by the manufacturer and promulgated by the Air Council. Also continually updated, these 50-page pilot's notes are mandatory reading, the check-lists learned by rote and never forgotten.

Pilots have one immense advantage over their medical colleagues in that they can, and regularly do, practise the recovery techniques and manoeuvres to be used in getting the aircraft safely back on the ground from various emergency situations. In medicine, it is not acceptable to fake an emergency in a patient simply to practise a recovery technique. Of course, it is not possible to provide a completely successful solution for every conceivable eventuality, and I can still quote the understated recommendation for dealing with engine failure over water – ditching:

'Owing to the fixed undercarriage it is expected that the ditching behaviour will not be good, and it is recommended that the aircraft be abandoned rather than ditched.'

This was not a manoeuvre that we routinely practised! After the pre-flight checks have been completed satisfactorily and once the pilot is strapped in the cockpit, 'FUEL ON, BRAKES ON, THROTTLE CLOSED, SWITCHES OFF' is indicated and confirmed with a thumb down to the ground-crew colleague on the left. Only after confirmation that no one is lurking near the propeller does the pilot move to thumb up, 'SWITCHES ON, CONTACT and START UP'. Further checks on oil pressure and temperature, magneto drop, radio, instruments and compass are followed with permission to move coming from the air-traffic controller, but taxiing does not start until the ground crew indicates that the path out of the dispersal area is clear. So many checks involving colleagues on the ground or in the control tower and all before the aircraft has even moved. No matter how routine or mundane a procedure might appear, novice pilots call out audibly for the instructor to hear each check as it is performed, and we were encouraged to call them audibly even when flying alone. So ingrained does this become that a senior Group Captain friend, while flying solo to evaluate an update to the in-flight fire drill procedure for his nuclear bomber, found himself calling out, as the first check, to his non-existent co-pilot: 'Warn the crew.'

### THE SAFEST FLIGHT

Paradoxically perhaps, instructors identify a pilot's safest flight as the first solo. After approximately ten hours' flying successfully with an instructor, the novice knows that the first solo cannot be far away, but this is not discussed. In my case, as we came to the end of a regular, routine flight the instructor climbed out of the aircraft saying 'Off you go. One circuit only, I'll be watching.' With no time to be anxious and concentrating hard, no novice will omit a check and everything will be done by the book, as taught. It is only after this, as experience and confidence grow, that corners may be cut and errors introduced. Consequently, to restrain the ego and control the hubris with a dose of humility, the next flight after the first solo is always once again with the instructor, and all pilots, regardless of status, undergo annual evaluation and recertification checks on the different aircraft types that they might fly.

The parallels with medicine are close and obvious: The inexperienced doctor will have watched the various procedures being performed by senior colleagues on a number of occasions, perhaps even performed some of them under direct supervision and guidance, but the first time alone is always intimidating. Unlike the novice pilot the physician knows when his or her first 'solo' is going to occur, so there will be time for anxiety and doubts to creep into the mind. As the moment approaches there will be a concomitant increase in nervousness and tension, or perhaps even a degree of overconfidence in a bold resident – ideal circumstances for something to be

**TABLE 1** Medication notes, based on pilot's notes**CHECK-LIST OF THE FIVE RIGHTS****The Right Patient**

- Check and confirm patient identity.  
*Beware of similar names, e.g. Johnson, Jonson, Johnston, Johnstone.*
- Confirm with the patient the proposed treatment or procedure.  
*If surgical, confirm patient's understanding of what is to happen.*  
*Confirm organ or side of procedure, as relevant.*

**The Right Drug**

- Check and confirm the identity of the proposed drug.
- Check the formulation, tablet, capsule, sublingual, oral solution or for injection.
- Check for patient–drug incompatibility, e.g. penicillin allergy.

**The Right Dose**

- Check the dose, dilution or concentration of the proposed drug.  
*Have calculations confirmed by a colleague.*
- Check all concomitant medications for potential drug–drug interactions.

**The Right Time**

- Check timing of drug administration with reference to food/fasting.

**The Right Route**

- Check the ampoule, if relevant, for discolouration or contamination.  
*If intravenous injection check ease of venous access.*  
*If intravenous infusion check patency of indwelling line and drug compatibility with the infusion solution.*  
*If intravenous check rate of injection of infusion.*

**IF IN DOUBT THEN SEEK CLARIFICATION**

overlooked or omitted. Even if the procedure is accomplished successfully, it might be useful to adopt the pilot drill and have the next procedure performed under supervision again.

**MEDICAL CULTURE AND ADAPTATION**

That flying is widely regarded as being the safest way to travel is almost certainly a result of the instruction, training and the regular re-evaluation given to pilots and their colleagues on the ground, whose importance is acknowledged by the pilots themselves. Human performance and function cover a wide range, and while it is unlikely that errors will ever be totally eliminated, all the training, check-lists, safeguards and assistance from colleagues can reduce the frequency of these errors and mitigate their consequences. The culture of medicine does not encourage admission of error or fallibility, and failure is always an orphan, especially when colleagues in

the legal profession seem keen to expand the role of litigation towards that stage in the US, where a successful suit against a physician is regarded by the plaintiff as a 'pension plan'.

Our medical culture is also extremely hierarchical, with the senior consultant holding sway and the other staff assembled in serried rank. Changes are afoot, but it would be foolish to expect a seismic and sudden shift of personality traits or changes in the culture. Accepting the concepts of CRM or even *ab initio* pilot training will be alien to some and will antagonise others; will be interpreted as a criticism of current teaching methods or as an attempt to subvert the present training; or will simply be dismissed, while pointing out that even an acceptance of pilot training drills will not solve all the problems.

It may also be difficult for certain colleagues to accept that evaluation of an error must involve a non-punitive approach if all the relevant facts are to be uncovered. Medical advances have always rightly been adopted slowly and cautiously, with modern medicine demanding evidence-based proposals, and we should not forget that Semmelweis had difficulty in gaining acceptance for his seemingly obvious concepts of hand-washing and basic hygiene when seeing obstetric patients. My proposal, aimed specifically at reducing medication errors by inexperienced doctors, has no current evidence base beyond those concepts of CRM that have made the transition from aviation to medicine,<sup>16</sup> but I take encouragement from Abraham Lincoln who, when asked to pass judgement on a new book, said: 'People who like this sort of thing will find this is the sort of thing they like.'

**INTRODUCING THE PROPOSAL INTO PRACTICE**

Alas, divine forgiveness is not in our remit, but it behoves us all to establish procedures that might prevent or mitigate the more egregious human medication errors. For many doctors, writing a prescription will be their major, or only, therapeutic intervention, yet recent authors<sup>3,4</sup> have pointed out that medical students now spend less time learning pharmacology and pharmacological concepts, and less time on the wards and more time in tutorials, than did their predecessors, so that the principles of safe prescribing may be in danger of being overlooked or forgotten. Clearly, if there is to be a reduction in the number and frequency of medication errors made by inexperienced doctors, then something is required in addition to the current systems.

A change in culture would be necessary at first, so perhaps it would be useful to expand the training of medical students by including the concepts of CRM, adapted to the environment of junior doctor prescription-writing and administration of medications. In this way the inexperienced physicians could be

encouraged to accept responsibility for their mistakes and be given the opportunity to discuss these with senior colleagues in a non-jeopardising and non-punitive manner. Rewarding people for reporting failures may seem counterintuitive,<sup>4</sup> but this has already proved successful in practice.<sup>8</sup> Secondly, inexperienced doctors must be encouraged to be more assertive, asking for clarification without challenging the instruction but clearing any doubt as to what is being proposed. The ubiquity of human error means that no one will escape making a mistake at some time, but errors become more likely and frequent with the degradation in human performance that accompanies stress, tension and fatigue, in medicine as in aviation, and this needs to be recognised and acknowledged.

The principles behind the *ab initio* training of pilots are simple: learn the check-lists by rote, call out each check as it is performed and check everything before any procedure or manoeuvre is started. Ideally a colleague (instructor or

ground crew) should monitor this checking. These, coupled with regular practice alone or in the presence of an instructor to point out and correct flaws or bad habits as they appear, provide the platform for a successful career in aviation. As Williams points out,<sup>4</sup> the training of nurses has long recognised drug administration as a high-risk area, giving rise to the 'five rights' (right dose, right drug, right patient, right time, right route).

A check-list, on the lines of pilot's notes, could be prepared and called medication notes, to be given to doctors at the start of their first appointment, to be learned by rote and repeated audibly to a colleague who would be overseeing the procedure. Regular follow-up and evaluation would also need to be established. As an initial approach I have provided a sample (Table 1), which will require further input and suggestions but might perhaps serve to start the discussion.

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### A FELLOW'S POETRY

For –

Enigma

Professor Alan Emery FRCP Edin has recently published a volume of poetry (*Poems*, Oxford Print Centre; 2007). Here are two excerpts:

Come back sweet love  
And return the light  
Which shone on my day  
And made all bright  
The things we once shared  
Before the dark night ...

With the path so clear  
Why am I so lost?  
I yearn for what I have  
And drinking yet thirst.  
With so much ...  
Why is there such grief?  
With so much ...  
Why is it so cursed?