The individual, the system, and medical error

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A then chairman of surgery was eating lunch in the faculty dining room when he accidentally ingested eggs, to which he had been violently allergic all his life. He developed some minor laryngeal oedema which made him lose his voice but there was no respiratory distress. A close friend and colleague who was at the table performed the Heimlich manoeuvre (not noted for its success at treating allergic reactions). It was the characteristic activist performance of a great surgeon. A cardiologist also at the table left and returned a bit later with an ECG machine, also not noted for its effectiveness in treating egg allergies. I was that person, and I was admitted to the coronary care unit where the very first meal I was served contained eggs.

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Key points

In the USA, medical error is estimated to be responsible for 44–100,000 deaths/yr at a cost of $29 billion.

Of adverse events in anaesthesia, 70% have been attributed to human error.

The model of error applicable to the medical environment focuses on the system as well as the individual.

Reduction in patient morbidity and mortality requires a blame-free culture.

Simulation may be a useful tool to reduce the incidence of adverse events.

No one could deny that, despite our best efforts, errors in medicine occur. This article discusses how prevalent errors are, why they occur and how we can act to reduce them. Medical errors result in death, permanent disability and suffering. Error is an unintended act (either of omission or commission) or one that does not achieve its intended outcome. The Institute of Medicine found that medical errors kill almost 100,000 Americans per year and are responsible for 1 million injuries. This would make error the 8th commonest cause of death in the hospital population and it is estimated to cost $29 billion per year.

The magnitude of this problem has long been recognised. The benchmark studies in the area of medical error were from the USA and Australia. The USA study found levels of adverse events to be 3.6%. However, it was designed according to a legal policy model, so injury that warranted compensation was a prerequisite. The Australian study found adverse events in 17% of patient episodes. In the UK, a retrospective study of two acute hospitals in the Greater London area found that 11% of patients suffered adverse events. One-third of these events were fatal or disabling.

Why is the incidence of medical error so high?

Reporting systems

The idea of reporting adverse events has long been adopted in industry. In aviation, the establishment in 1975 of a confidential reporting system for accidents and 'near-miss' events with no blame attached has been highly successful. Development of reporting systems in anaesthesia and other medical specialties has followed. Reporting may alert the anaesthetist to errors and stimulate discussion at a local level, as well as in national confidential enquiries. These provide us with a large database of medical error. However, while a reporting system can identify errors, it will only effect change if new systems are put in place to prevent errors recurring.

Under-reporting of adverse events has been estimated to be of the order of 50–96%. The reasons for this include failure to recognise error, the attitudes of colleagues and management, and the lack of true confidentiality. Our reporting systems will only be effective in a blame-free culture where they are perceived as fair, confidential and produce a positive change in patient management. We should value the 'near-miss' and appreciate its importance in accident prevention.

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Fear of litigation

In the last decade, criminal charges of manslaughter against doctors have increased 8-fold. It is unlikely that doctors have become more dangerous; it is the climate in which we work that has changed. While criminal charges against the medical profession are few, they continue to be high profile. However, the vast majority of litigation is civil and costs the NHS a considerable sum.

Clinical negligence is on the public agenda. A recent National Audit Office report found that clinical negligence claims took on average 5 years to settle. The cost to the NHS for 1999–2000 was £400 million with legal costs being greater than damages in 44% of cases. Currently, the figure for liability stands at an estimated £4.4 billion. The threat of legal action may make it difficult to admit to error. Investigation of an adverse event may appear personal, result in suspension, affect career progression and result in criminal prosecution. These factors may lead us to operate a system of concealing mistakes to protect ourselves.

Ingrained attitude to error

Our current attitudes to our own errors and those of our colleagues may be responsible for their perpetuation. When an error occurs it may be seen by ourselves and colleagues as a personal failure, even when beyond our control. This can take a toll on an individual and may be an isolating experience accompanied by feelings of guilt and fear. An individual doctor may learn from such an experience. However, unless the experience is shared with colleagues, there will be no wider benefit. There is often difficulty in telling the truth. It may be seen as an unnecessary unkindness to the patient or, alternatively, an unnecessary kindness to the legal profession. We may fear the patient's reaction to our admission of fallibility. This attitude is evident even as far back as Hippocrates: 'treat patients calmly and adroitly...concealing most things from the patient'.

Although it is inevitable that we will commit errors ourselves, we are loath to confess to such a 'weakness' and we may be critical of the errors of others.

Productivity pressure

We are under increasing time pressure from a number of directions and perceived delays in operating lists are considered inefficient. Cancellation of surgery for pre-operative optimisation can cause inconvenience to both patient and surgeon, and we may bend rules to proceed. The current trend for day-of-surgery admission will only increase time pressure, making it difficult to comply with the ideals of pre-operative assessment without delaying the list. The system is encouraging short cuts and violations of rules that exist to ensure patient safety. Many industrial catastrophes, including Chernobyl, have occurred in part due to this pressure to 'produce'.

Lack of protocols and regulations

Lack of protocols and standardisation of tasks and equipment may lead to increased rates of adverse events. Protocols for anaesthesia and machine checks aim to ensure consistent standards. However, it is important to recognise that while protocols and guidelines are good safety mechanisms, they can, in excess, prove equally as damaging as the under-regulated environment. In order to get the job done, an individual may be forced to select which rules to follow and which to discard. In this way, excessive protocols may encourage a culture of rule violation. Once established, protocols may be accepted as the standard of practice. Any breach of protocol may then be perceived as negligence, resulting in legal claims. Finally, the scope of human error is unlimited and we can only make protocols for events that we can predict.

How does medical error arise?

Unfortunately, medical error is not simply due to equipment failure. In one study of anaesthetists, only 4% of the incidents with adverse outcomes were due to equipment failure. Human factors play a much greater role.

Human error

Analyses of adverse events in anaesthesia have demonstrated that 70% are contributed to by human error and are therefore potentially preventable. Professor James Reason has contributed much to the field of cognitive psychology related to error. He concludes that error is a by-product of our normal mental processes. We store experiences in the brain to call on at a later date. These are termed schemata and are activated by conscious thought or sensory input and are called on automatically, allowing continued subconscious processing. This mechanism is very fast and explains how we can act on 'auto-pilot'. However, this storage, while allowing rapid recall, is a far from an exact representation of events and we may make approximations with the limited data

available. Conscious thought is a much slower process. It is more accurate than subconscious thought, but not sustainable for long periods of time and deteriorates under stress.

The widely accepted classification by Reason divides error into three categories. The first and most frequent is 'skill-based' error; activity is subconscious and the individual carries out an unintended action as stronger schemata take over. These errors are usually recognised. Contributing factors include tiredness, stress or boredom. This is how one pours orange juice onto one's cornflakes. These hiccoughs in normal subconscious functioning are also called 'slips'. Another skill-based error is a 'lapse', where one fails to carry out an action because of a distraction.

The second category is 'rule-based' error in which the mechanism of error recognition and application of an appropriate and effective action fails. In this situation, we may apply either the wrong rule or an inadequate rule to a given situation, classically a misdiagnosis.

The third category is 'knowledge' error which occurs because of incorrect or incomplete information and the loss of appropriate situation-awareness. Error at this level occurs due to resource limitations, or incomplete or incorrect information. Professor Reason refers to both rule-based and knowledge-based errors as 'mistakes'.

Table 1 The three forms of error with examples

Skill-based	
	Drug errors
	Forget to switch ventilator on
	Forget to hand ventilate
Rule-based	
	Volatile not turned off during arrests
	No anaesthetic machine check
	Failure to implement ACLS guidelines
	Inadequate recall of management guidelines for anaphylaxis
Knowledge-based	
	Situational awareness failure (e.g. blood loss)
	Not comprehending significance of a clinical indicator (e.g. temperature)
	Not projecting course of situation such as anaphylaxis

Systems error

An alternative to looking for human failing in adverse events is a systems approach to error. The system approach encompasses the entire process of anaesthesia and acknowledges the interrelationships between humans, the tools they use, and the environment in which they work. Working conditions and schedules that lead to fatigue, production pressure and loss of control over work can all predispose to errors. The ability of the operating room team to work together can avoid and contain errors.

Professor Reason postulated that we work in an environment that has within it a number of safeguards to prevent errors. The pre-operative assessment, consent form, anaesthetic machine check, oxygen failure alarms, and regulation of opioid medication postoperatively are all examples of how patient management is routinely safeguarded. However, it is not possible for any of these safety mechanisms to be absolute. Each level of defence is vulnerable; however, when a hole in it develops, the propagation of the error should be preventable at a subsequent level. It is when these 'holes' line up, level upon level, due to a series of circumstances, that adverse outcomes are produced. We should aim to identify these 'holes' in order to strengthen defences against errors.

The holes in the safety mechanisms within a system arise via two different routes. Firstly, there are 'active failures'. These are errors by a person. However, an adverse outcome is rarely due to a single error. The system also contains 'latent errors'. These are the 'accidents waiting to happen', the intrinsic flaws in the system that may come to light in a particular set of circumstances. Removing the individual will do little to reduce the chance of that error recurring. However, addressing the underlying latent errors in the system may prevent error and arrest its evolution.

What has been done so far to reduce error?

In order to be comprehensive, training in anaesthesia should include recognition and reduction of error. We should be teaching attributes that make a safe anaesthetist. The assessment process during training should incorporate assessment of safe practice in terms of error prevention, recognition and containment.

The role of stress in error evolution is important. Causes of stress are multiple, typified by lack of control, unpredictability of work and being pushed beyond real or perceived limits. There is a responsibility on doctors to recognise these factors in order to function safely and effectively. Working conditions and hours are also being addressed as tiredness has been accepted as a contributing factor in a number of high profile medical errors.

The availability of drugs and the social acceptability of alcohol, combined with stress, may lead to dependence. An Australian survey reported that 1.3% of registrars in anaesthesia suffered a drug abuse related problem during their training. The effects of alcohol and other drugs of abuse are a risk to

the doctor, the patients that they treat and their colleagues. A number of networks are in place to help the sick doctor (e.g. the Sick Doctor Scheme). All reports of substance/alcohol abuse should be taken seriously and investigated without delay as patient safety may be at risk.

Recognition of the magnitude of error in medicine and its cost to the NHS has resulted in the launch of The National Patient Safety Agency. Its aim is to produce a more 'blame-free' NHS where lessons from errors are shared. The agency has set up a system of identifying, recording and analysing adverse events with rapid feedback to medical practice. This agency will create a database of error that may help prevent future adverse events. A reform of clinical negligence law is also underway as the current system is not addressing the needs of NHS patients or staff.

We have much to learn from the aviation industry, which has also been forced to address the problem of human error in accidents. There are many similarities between pilots and anaesthetists. Most importantly, we are required to respond rapidly to a crisis and our response is closely coupled to the outcome. Both professions tend to overestimate their ability to function under adverse conditions, stress and fatigue. However, the two professions have differed in their reaction to errors. The aviation industry has made the assumption that error is inevitable and that the system needs to be able to absorb and protect against error. Standardisation and strict adherence to protocols have been paramount. Training and examination is undertaken repeatedly with the emphasis on safety.

The role of medical simulation

A simulator is a training tool that operates by replicating our working environment. Anaesthesia is utilising different levels of simulation. Part-task trainers and low-fidelity anatomical simulators such as those used for resuscitation training have a very important role to play. The next level of simulation is anaesthetic computer-controlled emergency situation simulation (ACCESS) and the Laerdal SimMan. These are 'intermediate-fidelity' systems consisting of a resuscitation manikin, a real anaesthetic machine with a ventilator and a computer to act as the routine anaesthetic monitor. Finally, the most realistic option is 'high-fidelity platform simulation' where the manikin 'lives and breathes'. Sophisticated software allows the manikin to be programmed with a variety of integrated physiological, pharmacological and pathophysiological profiles. To enhance realism, the simulator is situated in a modified clinical environment. The simulator can be used to practice for potential crisis events, to identify strategies to improve recognition and management of adverse events, and to improve skills in team working.

All three forms of human error have been observed in simulator training courses (Table 1). Video playback and debriefing help participants identify errors, such as failure of communication or loss of situation awareness, thus re-inforcing strategies to reduce them. In addition, systems errors can be identified, such as staff shortages, poor light, noise and unfamiliar environment. As a training device, the simulator develops awareness beyond current medical teaching by incorporating factors such as leadership, planning, management of available resources and interpersonal skills. It also promotes recognition of performance limiters such as stress. Acknowledgement of the role played by behavioural skills in the evolution of medical disasters may help to reduce the incidence of adverse events. Simulation may not only provide a valuable tool for training individuals and reducing human error, but it also provides an opportunity to study error under conditions of crisis rarely documented accurately in the theatre environment.

Conclusions

We are beginning to understand the reasons why doctors make mistakes. The current climate of blame and shame discourages learning from mistakes and should be replaced by exploration of the underlying factors which caused the error. The way forward to prevent and contain errors is in law reform, attitude change and training.

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See multiple choice questions 127–129.