Error modelling in anaesthesia: slices of Swiss cheese or shavings of Parmesan

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Accidents in complex systems occur through the concatenation of multiple factors; each may be necessary, but only when all are present are conditions sufficient to produce an accident. In 1990, James Reason, then a professor of Psychology at the University of Manchester, provided a crucial contribution to this idea by proposing a ‘model’ of how accidents could be seen as the result of interrelations between real time ‘unsafe acts’ by front-line operators and latent conditions. Holes can appear in multiple levels of the system. When these holes line up, as in multiple slices of Swiss cheese, an accident can occur. A key facet of this model is the suggestion that by preventing any one hole in the Swiss cheese, the eventual adverse event could have been prevented.

The Swiss cheese model has been further developed and explored in other complex high-risk industries, including aviation, nuclear power, and, increasingly, healthcare. For example, the 2002 Überlingen plane crash involved the midair collision of a cargo plane and a passenger jet at 35 000 feet. Reviews of the circumstances leading up to the collision identified numerous ‘holes’ involving the International Civil Aviation Authority, the air traffic control organization and culture, and pilot training. These holes included aspects of workload, workflow, training, equipment, and communication.

Multiple checks of patient identification and the surgical checklist are designed to prevent wrong site, wrong side procedures. A risk of utilizing the Swiss cheese model is the thought that any single error, in this process, can be mitigated by the protective actions of the system, other personnel within the system, or both. Obtaining consent for a procedure on the ‘wrong’ side will be corrected by marking the site, and other checks along the surgical pathway. If the system prevents poor practices contributing to adverse events, pressures to change may be resisted.

In healthcare, though, a large numbers of errors are unredeemable. Many of these errors may decrease the probability, or even possibility, of an optimal outcome.

A safe blood transfusion service involves numerous checks at multiple levels. However, some of the key steps in the process are not able to be prevented, identified, or corrected by other parts of the system. A significant deviation from procedure may be unrecoverable. A mislabelled specimen may only be salvageable if the patient is known, by the laboratory, to have a different blood group. Failure to adequately check the blood and patient documentation, at the time of administration, may only be discovered after an adverse effect has occurred.

A recent report outlined the consequences of a delayed diagnosis. After 18 months of treating a plantar wart, a biopsy diagnosed a melanoma. In court, the plaintiff was unable to prove, on the balance of probabilities that the delay contributed to the development of distant metastases. However, it makes biological sense that a significant delay in diagnosis could lead to an increased possibility of metastatic spread.

A similar case involved a 6-yr-old girl, who, in 1990, developed headache and drowsiness. Two weeks later, during a second hospital admission, she became drowsy, with non-responsive pupils. A CT scan revealed a brain tumour. The trial judge held that it could not be proven that the delay had caused Ms Tabet’s brain damage, but found that negligence made a 25% contribution towards her ultimate brain damage. He held that she was entitled to damages for the lost chance of a better medical outcome. That chance was assessed as a 40% chance of a better medical outcome, and

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she was awarded 40% of 25% of her overall damages. After appeals, this was overturned. In 2012, in Tabet vs Gett, the Australian High Court found that a decrease in the probability of a good outcome was not sufficient to enable a finding of medical negligence. Before this decision, loss of a chance cases were often difficult to defend. Experts could state that anything is possible and under a loss of chance regime, the simple assertion of such a possibility was enough to see the awarding of damages.

Many clinicians decry the trend towards defensive medicine. *What do I need to do to reduce the chance of me being successfully sued?* This can lead to unnecessary investigations and procedures, at increased cost, and the introduction of other risks to the patient. It has not necessarily led to better patient outcomes. The High Court finding could be interpreted by clinicians as setting the standard of medical practice to one which avoids demonstrable patient injury, rather than one which awards the patient the best possible chance of achieving the therapeutic goal, while minimizing the chance of an adverse outcome.

In anaesthetic practice, we are exposed to impediments to effective and efficient workload and workflow, to issues with training, unfamiliar or ‘broken’ equipment, and communication. Each of these may lead to a decrease in the chance of an optimal patient outcome. Some of these negative factors are demonstrable and measurable, much to the lawyer’s benefit, while others are not. But they may be no less significant to patient outcome.

Poor central venous catheter insertion practices may contribute to a central line bloodstream infection, which cannot be overcome by careful sterile dressings. Prolonged and inadequately treated hypoperfusion, insufficient to cause an attributable injury such as a cerebrovascular or cardiovascular event, may be enough to cause some impairment of renal or other vital organ function. Once this event has occurred, there is a decreased probability of an optimal outcome.

Every time a substandard practice or adverse incident occurs, we shave a piece from the patient’s whole, or at least the patient’s potential, subject to the patient’s current illness and co-morbidities. As with a block of Parmesan cheese, with each shave—no matter how small—we remove from the whole. In doing so, we decrease the chance of optimal patient outcome. Importantly, each of us, as healthcare providers, has a cheese knife, and many of the small shavings that we take cannot be repaired or replaced by another.

The Swiss cheese model is useful as an explanation of many tragic outcomes, and facilitates the design of defences against this. The Parmesan cheese model may be a better representation of the clinician’s responsibility in routine patient care and the importance of minimizing any deficiencies in our day-to-day practice.

### Declaration of interest

None declared.

### References

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### Perioperative management of diabetic patients: new controversies

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The prevalence of diabetes mellitus (DM) is increasing rapidly. In 2011, it was estimated that 366 million people worldwide had DM with a projected increase to 522 million by 2030. Diabetes is one of the most common non-communicable diseases...