The three ages of patient safety: moving towards resilient anaesthesia practice

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Summary

This lecture will outline recent developments in safety science. It describes the progression of three 'ages' of safety, namely the 'age of technology', the 'age of human factors' and the age of 'safety management'. Safety science outside healthcare is moving from an approach focused on the analysis and management of error ('Safety-I') to one which also aims to understand the inherent properties of safety systems which usually prevent accidents from occurring ('Safety-II'). A key factor in the understanding of safety within organisations relates to the distinction between 'work as imagined' and 'work as done'. 'Work as imagined' assumes that, if the correct standard procedures are followed, safety will follow as a matter of course. Staff at the 'sharp end' of organisations know, however, that to create safety in their work, variability is not only desirable but essential. This positive adaptability within systems, which allows good outcomes in the presence of both favourable and adverse conditions, is termed resilience. We argue that clinical and organisational work can be made safer not only by addressing negative outcomes but also by fostering excellence and promoting resilience. Some specific tools activities to promote safer practice in anaesthesia are presented, and the role of the Helsinki Declaration for Patient Safety in Anaesthesiology included.

Introduction

Optimising patient safety is a goal of healthcare. Much has been spoken and written about it and it is well established as a core activity of all those working in healthcare systems. This has not always been the case: historically error and harm from healthcare was an accepted risk of treatment. However, as standards of treatment and care have improved, this acceptability was questioned and refuted and the patient safety movement born.

This article summarises the evolution of safety science, describing historical approaches and recent concepts in safety, and how they affect the people working within the healthcare system. It introduces some of the models we use to explain safety-related work, and the way we view the system as a whole and gives examples of tools and techniques to apply in practice. It does not aim to be a systematic review [1] but instead reflects the authors' (at times partisan) interpretation of the research literature and reflection on clinical and organisational experience. Its purpose is to give the reader an insight into the evolution of the current approach to patient safety; an appreciation of some of its limitations and an account of some of the newer concepts, and the ways they can be applied in their everyday safety work.

The three 'ages' of safety

Hale and Hovden have traced the development of safety by describing three 'ages of safety', namely 'the age of technology', 'the age of human factors' and 'the age of safety management' [2]. In the first age, it was technology that posed the main threat to safety. This was partly because machines were inherently unreliable and dangerous, but also because people had not yet learned to identify and avoid the risks this posed. This age is generally held to have begun around the time of the Industrial Revolution (c. 1770), but extended well into the 20th century; both Heinrich's seminal book on industrial safety in the early 1930s [3] and the development, in the 1950s and 1960s, of a number of methods of analysing risks within technological systems, are firmly part of this view of safety. Accidents in the first age of safety were attributed to breakdown, failure and malfunction of machinery. The models used to describe and explain accidents have evolved in parallel with the changes in safety thinking typified by the three ages above. The Domino model, proposed by Heinrich in the 1930s [3], where a set of domino pieces

falls, each knocking down the next, exemplifies simple, sequential, linear causality. Within this paradigm, event analysis is geared towards finding the step, or component, that 'failed'. Although simple, this model guided risk management well into the 20th century, and gave rise to many sophisticated prospective analytical techniques such as Hazard and Operability Studies (HAZOP) and Failure Modes and Effects Analysis (FMEA). Such prospective approaches are fruitful and have also been applied to healthcare, as in a previous study which attempted to identify points in the perioperative pathway where safety could be enhanced [4]. These were used to try to anticipate the likelihood and severity of possible points of failure or malfunction in industrial systems, so that procedures and 'fail-safes' could be put into place to deal with possible hazards and prevent accidents. Although they focused on the technology rather than the humans operating it, they were applied even to complex mechanical systems such as power plants and led to considerable advances in safety in their time.

The limitations of the focus on technology as the source of accidents were illustrated by the disaster at the Three Mile Island nuclear plant in the United States in 1979. During the preceding 20-30 years, there had been some attempts at scientific study of the interplay between humans and technology, but these had focused on efficiency and productivity rather than safety. In comparison to technology, humans 'came to be seen as too imprecise, variable and slow'[5]. The Three Mile Island incident evolved after a minor mistake during routine maintenance; the operators in the plant's control room interpreted conflicting instrument readings in a way that allowed them to apply standard operating procedures in an attempt to correct the problem. However, this interpretation was incorrect and made the situation worse. Only when, some hours later, a new technician was called in to the control room, was the situation correctly re-interpreted and a much more serious outcome averted. This incident struck a blow to the notion, supported implicitly by the domino model of accident explanation, that all possibilities of failure could be predicted, or managed by predictable means. Further, it also became generally accepted within the safety science community that it was no longer possible to ignore the role of people in complex systems. To promote human reliability, the aim became to reduce the human contribution to the processes of care to a minimum, by standardising and improving basic processes and automating as much work as possible [6].

However, there are a number of problems with this approach, especially as applied to healthcare. Many things cannot, or should not, be standardised (see below). Automation is helpful in some aspects of care, but unnecessary or even desirable in others. More importantly, however, is the logical consequence that human reliability carries with it its opposite, human unreliability. And, whilst technology can be thought of as morally neutral (it is a nonsense to suppose, for instance, that a machine might deliberately malfunction), as humans carry the power of agency, meaning and intention can be ascribed to their actions, and with them the possibility of blame. Thus, the idea that humans play a part in systems of safety as well as machines introduced both the concept of human reliability (to complement mechanical reliability) but also gave pride of place to human error as an explanatory factor in accident analysis. The enduring legacy of the second age of safety is thus the possibility of castigation, victimisation and admonishment as humans are blamed for their 'mistakes'.

This new view of safety needed a better explanatory model, and the 1980s saw the publication of Reason's 'Swiss cheese' model [7]. This represents events in terms of composite linear causality, where adverse events can be attributed to combinations of active failures (unsafe acts) and latent conditions (hazards). The types of conditions influencing safety include team and organisational factors as well as individual personality and behaviour, but the model is still inherently linear; investigation of accidents still assumes that it is possible to work backwards and identify causative features. Using this model, a substantial amount of effort has been devoted to looking back once accidents have occurred to try to understand how the accident came about and help prevent re-occurrence. This approach was taken up in aviation and subsequently adopted in healthcare, both across the NHS and in anaesthesia [8-10]. A typical approach is depicted in Box 1.

Box 1 Typical approach to accident investigation

A typical approach to accident investigation looks like this:

- Wait for something to go wrong
- Establish what happened
- Attribute actions to people
- Establish the root cause
- Make changes to systems so accident does not recur

However, within 10 years or so (towards the end of the 1980s) it became clear that, whilst the inclusion of human elements was necessary, it was not in itself sufficient to give form to a model which could explain accidents in complex organisational systems. The resulting attention given to broader safety management systems led to the name given to this 'third age'. A move away from the probabilistic assessment of possible risks, and from the linear backward search for contributing or causal factors in accidents, was accompanied by a trend towards understanding organisational culture and processes in addition to technology and human behaviour. The relationships between individual human beings, the technology the use and the organisational setting they work within, together make up complex socio-technical systems.

The transitions between the first and second, and especially between the second and third, ages have not been clear cut. As Hollnagel noted in 2014, 'the practices of risk assessment and safety management still find themselves in the transition from the second to the third age' [5] and indeed elements of all three ages may co-exist. We should also note here that the three ages of safety, having first been described in 2001, are retrospective constructs that aim to make sense, and possibly over-simplify, history. Nevertheless, we believe they offer a useful perspective.

From 'Safety-I' to 'Safety-II' and two views of 'work'

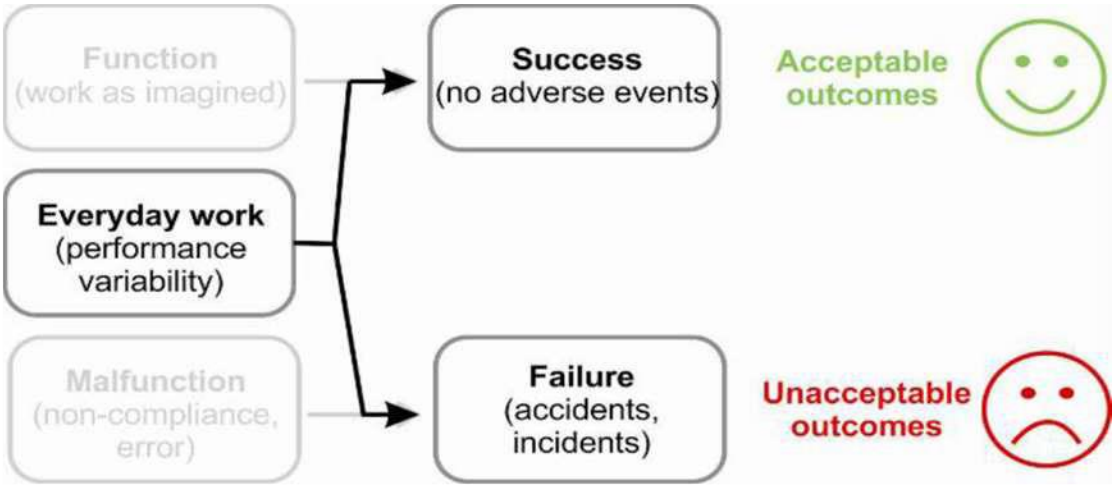
The focus in the third age of safety is more on trying to understand and strengthen the everyday features of work within complex sociotechnological systems which keep them safe most of the time. This is the dominant paradigm in what Hollnagel has termed 'Safety-II', in comparison to 'Safety-I', where the focus is essentially on errors and how they have arisen [5].The system property promoting the maintenance of safety has been termed *resilience*, and is well defined by Hollnagel as 'the ability to succeed under expected and unexpected conditions alike, so that the number of intended and acceptable outcomes is a high as possible' (p.134) [5].

Hollnagel went on to articulate the concepts of 'work as imagined' and 'work as done' to describe two contrasting ways of understanding work [5]. Work as imagined is defined by the rules and standards outlining the way things should work, and represents how designers, managers, regulators and authorities believe work happens, or should happen. 'Work as done', on the other hand, describes the work as carried out by 'front-line' employees as the 'sharp end' – in the case of healthcare, clinicians who interact with patients. Those who work at this level know that, although protocols and guidelines have their place, work is only possible by continually adjusting what you do, and that this sometimes means improvising and working outwith the 'rules'. This variability in performance is necessary partly because of the inherent unpredictability of much healthcare work, but also sometimes because of the very organisational conditions created by those at the 'blunt end', often by the policies they have produced, or the way in which they view work. We suggest that the work as done/work as imagined model helps to explain why there are contrasting (and sometimes conflicting) views about how safety should be managed in healthcare organisations.

Taking a work-based view of accidents, each step of the investigation model in Box 1 can now be seen to be at best limited in its usefulness, and at worst fundamentally flawed. Waiting for something to go wrong risks unnecessary harm if the problems within the system can be detected before they cause an accident. Finding out what happened (typically by root cause analysis, which is now well embedded into the NHS) often focuses on the 'first story'; that is, establishing the 'facts' and the timeline linking them. This is essential, but gives an account of events that is incomplete without the meanings given to them by the people concerned, and an understanding of why they acted as they did [11]. The third step, that of attributing actions to people, is the

most dangerous. This can very easily stray into the allocation of blame, and this is bad for safety in general as humans need to feel safe to be safe (and act safely) and a punitive culture will discourage reporting of error and its balanced discussion. Furthermore, safety investigations often stop as soon as human error has been identified as a causative factor. Attributing actions to one individual is undesirable, as noted above, but also closes off further investigative possibilities which might go deeper into organisational function, norms and behaviour. The fourth element, finding the root cause, is problematic as the 'root' may never actually be reached, but it is also logically asymmetrical [12]. This is because, although it is possible to argue that every cause must have an effect, not every event has an identifiable antecedent, let alone whether this can be considered causative (reverse causality). The final step, that of 'fixing' the system so that the accident does not happen again, ignores that fact that the system usually operates successfully most of the time in preventing the occurrence or propagation of accidents and so, in that sense, does not need 'fixing'. Safety at its simplest becomes a matter of procedures, and compliance with them. Means of repair such as recommendations and guidelines very much demonstrate a reinforcement of 'safety as imagined' and often do not mean much to those on the 'front line'. Further, large enquiries offer a large number of recommendations which are naively assumed to be independent but which in practice may be mutually contradictory. However, the strongest indictment of the 'fixing' approach is that is implies a binary view of work and outcome, namely that correctly functioning systems (and the humans within them) do not lead to adverse outcomes, which can only come about through malfunction or error. [13]. This is an oversimplification of work; as we argued above, responsiveness to changing needs and circumstances is essential to get the job done. Usually, this performance variability helps produce the right outcome. Sometimes it may contribute to an unacceptable outcome. This is illustrated in Figure 1.

Figure 1 Relationship between performance variability and outcome



It then becomes possible to posit a revised investigation model (Box 2).

Box 2 Revised accident investigation model

- Needs to go beyond the 'first story'
- Not necessarily linear - multiple, interacting variables
- Understand why previous similar actions went well – examine everyday activities and
- potential 'rescue points'
- Strengthen the system to promote things going well

'Problem areas' in patient safety

Studying patient safety, and applying its scientific principles to practice, is complicated. Here we deal with four particular factors which contribute to this. The first is the ambivalent role of human beings in safety. On the one hand, humans bring variability and uncertainty, and hence can be thought to increase the risk of error. On the other, as in the Three Mile Island incident above, they also act to promote safety. Human variability is what permits us to improvise and try new responses to newly encountered situations and is therefore desirable. As Vincent notes, there are two broad approaches to this issue, which fit neatly with the 'Safety-I' and 'Safety-II' approaches respectively [6]. One is to simplify, standardise and automate; in the other, enhanced safety comes about not through minimising the human contribution but on understanding how people think about, and respond to, the risks in their work, overcome hazards and, in effect, 'create' safety.

The second is related to this, and deals with the advantages and disadvantages of standardisation. In a short but brilliant recent article, Wears explored the complexities behind the common and deceptively simple call for greater standardisation in healthcare [15]. The benefits of standardisation are, in a sense, obvious in many settings. Of particular relevance to safety, they promote routinisation, which in turn allows the freeing-up of 'attentional resources, diverting them from mundane to truly complex or pressing issues' [16]. Wears goes on to delineate five problematic aspects of standardisation, especially in healthcare. These include: its philosophical basis rooted in old-fashioned 'production line' industrial processes; its tendency to ignore existing practices, albeit without the formality and documentation usually preferred by managers (see, for instance, our previous work on recovery room handovers [17]); and the fact that 'standardisation' can be psychologically and organisationally comforting even if it is ineffective [15]. (One need only refer to recently published articles within the medical literature to see that the debate as to what extent standardisation and protocolisation are effective is continuing unabated [18-21]).

Even within industries where there are formally established safety practices such as aviation and the offshore oil industry, practical skills, support from colleagues, the creation of 'performance spaces', and flexibility in problem solving (all rooted in the informal elements of work) are important in maintaining safety [22].

The third problem area is transferability. Ideas from safety science have been applied to healthcare, and have much to offer, but there are a number of difficulties in transferability. First, safety is rightly seen as only one dimension of healthcare quality [23]; as in industry, timeliness, efficiency and customer focus ('patient-centred care') are also important. However, effectiveness and equity of care must also be included in healthcare quality [23]. Second, although patient safety is a clinical and policy priority, the ideas and principles outlined above can be quite abstract, and it may be that this presents difficulties for healthcare staff. Perhaps for this reason, there is often a rather reductionist feel to many patient safety initiatives in healthcare. For instance, substantial resources are expended on preventing and managing healthcare-associated infections (the UK Government having made rates of infection by certain organisms one measure of the quality of care in hospitals), and the World Health Organisation surgical checklist, whose use has been mandated in the UK NHS, but unless the underlying principles and ideas are fully understood, there is a risk that patient safety will be seen superficially, as a series of single issues, without an appreciation of the importance of culture.

Finally, safety science may be politically neutral, but its application is not. Notions of risk and safety have come to shape private and public discourse so powerfully that they are sometimes used towards ends which, on careful examination, have little bearing on safety *per se*. For instance, as Fischhoff has noted, couching problems in terms of safety may lead them to be taken more seriously within organisations, where people discover that 'whilst being disgruntled does not have legal standing, complaining about risks does [24]. It has also been argued that the notion of patient safety has been used as an instrument of governmental control; Yeung and Dixon-Woods refer to 'discourse creep' as issues within healthcare are redefined as safety problems to legitimise intervention and potentially limit professional autonomy [25]. Thus safety is closely

related to personal/professional identity and roles. In this context, it is worth noting that despite numerous initiatives to improve patient safety, we have little idea whether they have worked. Whilst Vincent has argued that this is because we lack the systematic measures to evaluate possible changes, it is also possible (though speculative) that it is more important politically for care to appear to be getting safer than for this to be achieved [26]. He and Amalberti have also more recently made the point that care envisaged by standards and guidelines and the care actually given to patients. They note that much care falls below 'ideal' levels envisaged by standards and guidleines, but point out that it is politically unpalatable for organisations (let alone governments) to admit this openly. However, they argue that this has two consequences for the management of risk. First, they note, 'it becomes very difficult to study or to value the many adaptive ways in which staff cope in difficult environments to prevent harm coming to patients'. Secondly, and more importantly, 'attempts to improve safety may not be targeting the right levels [or the organisation] or the right behaviours' [27].

Creating safety and promoting resilience

We suggested above that the key property of safe systems as understood within the Safety-II paradigm is their robustness in the face of error-creating conditions, or resilience. Resilience can be defined as the 'everyday performance variability that provides the adaptations that are needed to produce good outcomes both when conditions are favourable and when they are not'. Whilst this review has chosen not to focus on individual resilience, wellbeing and mental health (these are well dealt with elsewhere), like many, we believe they are related [28, 29]. We would simply point out that human performance is poorer if people are tired [30, 31] hungry, stressed, sad, or the victims or even witnesses of rudeness or coercion [32, 33]. Peoples' mental state also influences how they deal with the consequences of error. People need to feel safe to be safe [5] but we would argue that anaesthetists also need to feel safe to act safely; working within a system where individuals are punished for 'mistakes' does not create a good working atmosphere. They also need to feel that they can ask for help without being criticised [34] and need to feel able to raise concerns without being criticised [35]. As professionals, too, we need to learn to balance comfort with constant vigilance and 'intelligent wariness' without becoming over watchful [36]. A 'sixth sense' for safety [37], coupled with the conscientiousness to act on one's diagnostic hunches (whether clinical or organisational) are probably the two most important traits of the resilient professional. At whatever level we might look, however, the principle is the same; nurturing both individual and organisational resilience must be considered fundamental to the safe delivery of healthcare.

The Institute for Healthcare Improvement takes this one step further. In 2017 it published a White Paper describing a 'Framework for Improving Joy in Work' [38]. This paper sets out the link between the level of staff engagement and the quality of patient care, including safety. It references the 'burnout epidemic' affecting healthcare, citing the link between physician burnout and medical error [39]. Hypothesising that joy is the antithesis of burnout, it gives a framework of factors which facilitate joy, of which physical and psychological safety is one such factor (Fig. 4). These factors should not be considered as optional extras to our workplace but rather the starting point for ensuring staff can deliver safe, high-quality care. Fostering joy in work, or even just one aspect of it – psychological safety – can be a challenge when the language we use when we talk about safety is primarily negative. We discuss 'critical' incidents [10], 'error' [7], 'never' events [40-42] and colloquially the names of incident reporting systems have become verbs –; "I'm Datix-ing that". What is more significant is that we don't have a similar vocabulary for successful events. We have succeeded in developing our ability to describe human factors and non-technical skills, thanks to frameworks like the SHELL (Software, Hardware, Environment, Liveware, Liveware) model, Oxford NOTECHS and ANTS (Anaesthetist's Non-technical Skills) [43-45]. But regarding positive interactions at work, our tendency is, at best, to gratefully accept these and move on. Could we improve our safety culture by introducing some balance and also discussing "great catches" (a positive spin on the near miss), episodes of

excellence and “always conditions”? (https://humanisticsystems.com/ 2016/02/27/neverzero-thinking/)

This brings us to a definition of “safety culture”. The culture of an organisation is important as it is logical that the success of efforts to create safe systems is inherent on the behaviours which support them. The Health and Safety Executive quote The Confederation of British Industry’s description of safety culture as “the ideas and beliefs that all members of the organisation share about risk, accidents and ill health". [46]. Therefore, the description of the “ages” of safety above gives context to the current safety culture within safety-focussed organisations.

Healthcare is similar, and the subject of safety culture in healthcare was discussed at a Health Foundation roundtable event in 2013 with experts in the field of patient safety. The event report offers the following description:

“A safety culture in healthcare can be thought of as one where staff have positive perceptions of psychological safety, teamwork, and leadership, and feel comfortable discussing errors. In addition, there is a ‘collective mindfulness’ about safety issues, where leadership and frontline staff take a shared responsibility for ensuring care is delivered safely” [47,48]

We believe that a strength of this definition is that it highlights the conditions needed to promote resilience. The report goes on to suggest that an active approach to safety must be developed with a focus on the creating safety and not just identification of and measurement of harm.

Resilience and excellence – methodology and models

If we are to effectively manage our systems and create safety, it is logical that we must first properly understand how they work in order to recognise why problems occur. It is imperative therefore, that we measure quality and safety appropriately and accurately which, as mentioned previously [26] is arguably not currently occurring. Our traditional approaches to quantify safely (or risk) only tell part of the story; focusing on excellence in practice is also vital [49, 50]. To understand things fully, a different approach is required, one that ‘gets under the skin’ of how people behave within systems of work and digs deeper into how their interactions ‘create safety’.

This requires qualitative approaches [51-55] such as that used by the ‘Sign up to Safety’ campaign hosted by NHS England. The campaign focuses on improving safety by helping individuals and organisations create a ‘safety culture’, in the context of the limitations of the system described above (https://www.england.nhs.uk/signuptosafety) and to better understand what we need to enable us to work safely. The current focus of the campaign is to find ways to encourage conversations to occur about how ‘work is done’. If this can be done in a safe and supportive way, without fear of retribution when this deviates from ‘work as imagined’, then we can learn from these differences and use both examples of success and failure to improve.

With the definition of resilience above, how can we identify examples of everyday performance variability which contribute to good outcomes? If our current focus on safety captures only examples of when safety is lacking, in order to find and fix problems and generate further examples of standardised processes and policies, how can we learn from good practice?

A possible solution to this comes from many of the positive reporting systems emerging in healthcare. Initially described in Birmingham [56], the Learning from Excellence (LfE) initiative is designed to capture examples of individual good practice or the system working, despite challenging and variable circumstances. This appears to offer a simple but potentially effective approach to improving quality and safety. Pilot data suggest that rates of ‘best practice’ antibiotic prescriptions improved when positive feedback with Learning from Excellence reports and positive role modelling occurred [57]. In contrast to focussing on finding and fixing errors, this asset-focussed methodology is being used as quality improvement methodology in a Health Foundation funded project, Positive Reporting and Appreciative Inquiry in Sepsis (PRAISe) (http://www.health.org.uk/programmes/innovating-improvement/projects/positive-reporting-and-appreciative-inquiry-sepsis-praise). Other approaches and initiatives have also been reported [38, 58-63].

In anaesthesia, the Helsinki Declaration for Patient Safety in Anaesthesiology was launched in 2010 [64]. This offers a framework for anaesthetists to enhance safety in their practice. Specific simple measures for increasing safety include: the European Board of Anaesthesiology's recent recommendations for reducing medication error [65]; the 'Stop Before You Block' campaign to reduce the risk of wrong-site regional blockade [66]; the WHO Surgical Safety Checklist (recent work has helped our understanding of how to make it more effective in practice [67]), central line 'bundles' to reduce the risk of infection [68] and structured intra-operative and postoperative handovers [69].

Conclusion

The unspoken expectation is now that healthcare practitioners of every profession are to undertake three roles. The first is to undertake the clinical function they are engaged form whatever that might be. The second is to maintain and enhance patient safety in their own work, but also by intervening as necessary in the organisational systems they work within. The third is to seek out opportunities for improving quality and make sure that positive changes are made. We hope that our review has contributed to understanding how these roles intersect, and provided conceptual and practical tools for making sense of some of the demands of the politicised activity that is modern healthcare.

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