

Rethinking healthcare as a safety-critical industry

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Abstract. The discipline of ergonomics, or human factors engineering, has made substantial contributions to both the development of a science of safety, and to the improvement of safety in a wide variety of hazardous industries, including nuclear power, aviation, shipping, energy extraction and refining, military operations, and finance. It is notable that healthcare, which in most advanced societies is a substantial sector of the economy (eg, 15% of US gross domestic product) and has been associated with large volumes of potentially preventable morbidity and mortality, has heretofore not been viewed as a safety-critical industry. This paper proposes that improving safety performance in healthcare must involve a re-envisioning of healthcare itself as a safety-critical industry, but one with considerable differences from most engineered safety-critical systems. This has implications both for healthcare, and for conceptions of safety-critical industries.

Keywords: Health care, safety

1. Introduction

Healthcare activities comprise a substantial portion of the domestic economy of most advanced countries (eg, approximately 15% of GDP in the US). In addition, it has been associated with a considerable public health burden of mortality and morbidity, with ‘defect rates’ ranging on the order of 10^{-2} in multiple studies [2,3,5,19,22,24]. Despite this, healthcare has not commonly been considered a safety-critical industry, while other activities (commercial aviation, nuclear power, rail transport, energy extraction) have been so viewed [2,15], despite lower total and per exposure burdens of injury. In this paper, we take a macroergonomic viewpoint to argue the case for viewing healthcare as a safety-critical industry, and discuss how that might change the ways in which we view healthcare activities; in addition, we further argue that developing such an understanding would expand and enhance our concept of safe performance in safety-critical domains in substantively important ways.

2. Healthcare and ‘safety-criticality’

It would be disingenuous to assert that healthcare should be considered as just another specific instance of a safety-critical industry based on the total number of people killed or injured annually. After all, motor vehicle transport is generally accepted to bear some risk, but is nonetheless not considered safety-critical in the sense that, say, nuclear power is, even though there are many more motor vehicle deaths than nuclear power deaths each year.

2.1. How healthcare differs from other safety-critical domains

Quite obviously, healthcare has striking (but superficial) differences from other safety-critical domains. The concept of safety-criticality originally evolved from two orthogonal properties, mass and dread. Mass casualty events (eg, Bhopal, Air France 447 [20]) in which large numbers of people are killed or

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injured almost instantaneously, capture the public imagination in ways that an equal or even larger burden of injury spread over a large number of small episodes, does not. Because healthcare risks lead to injuring only small numbers of people in any single event (typically, only one), they do not draw the attention (or resources) associated with mass injury events; in addition, because of their small scale, there is a tendency to view them as amenable to simple exhortations (such as, “Be more careful – if only he had noticed, *etc*”) that would not be considered in large scale events.

Second, many adverse events in industries commonly considered safety-critical are associated with feelings of dread, related to impressions of loss of control, unwilling participation in risks, and differential distribution of risks and benefits. While some healthcare accidents may be viewed with dread (*eg*, wrong patient amputations), the vast majority of system-induced adverse events are superficially indistinguishable (or at least ambiguously differentiable) from natural events. In this vein, Gaba has pointed out that every human being is destined to die, and that most of those deaths will occur in some proximity to healthcare [6], creating a fundamental ambiguity about the proscribed events that does not arise in other endeavours (perhaps excepting military operations). So to a large extent, deaths and disabilities in healthcare settings are typically viewed as normal and even expected events, in ways that deaths and injuries in aviation, or nuclear power, are not.

2.2. How healthcare must change if viewed as safety-critical

In addition to the numerous, small technical changes in the organization and performance of clinical work that a safety-critical understanding will require, global changes will be needed in two fundamental areas: culture and science.

2.2.1. Culture

Quality, safety, and other dimensions of performance have traditionally been viewed in healthcare as properties of the individuals in it, and improvement activities have accordingly been focused on the modalities of selection and training. While no one would deny that selection and training are not important, the healthcare work force is already highly selected and intensely trained, so these modalities are close to their maximal effectiveness, and there is little to be gained by further investment in them. In addition,

the highly selective entry processes and intense training (particularly in post-graduate residency experiences) tend to promote the development of narratives of individual heroism – that extraordinary performance is achieved by extraordinary individuals doing extraordinary things [4].

However, adopting a safety-critical view must necessarily change this narrative, to one that emphasizes the role of a complex sociotechnical system comprised of people in multiple roles, and their social and technical artefacts. Although the patient safety movement has adopted the rhetoric of systems thinking [11], the rhetoric has not yet become the reality in healthcare. This is illustrated by the observation that the dominant narrative in discussions of patients safety is still one of extraordinary people doing extraordinary things, (*eg*, overcoming complex, broken systems to achieve safe performance despite the problems arrayed against them) [4].

2.2.2. Science

Healthcare professionals view their work as a science, or at least as scientific. Their training inculcates in them a strong commitment to the positivist, rationalist view of science growing out of the Enlightenment, and unfortunately does not provide them the tools to understand the literature of other disciplines that do not share this philosophical underpinning [10]. The positivist view is so strong that many health professionals cannot even imagine that alternative worldviews might be possible, much less that they could be useful. Thus they are often distrustful of many of the insights and methods of the safety sciences in which the assumption of a worldview is important, and indeed in which the cultivation of a variety of viewpoints are seen as valuable and potentially enlightening. (For example, results from psychology, social psychology, macroergonomics, resilience engineering, organizational behaviour, or even education have been viewed with suspicion or even disdain because they do not fit easily into the positivist framework claimed as the only conceivable source of truth in movements such as ‘evidence-based medicine’ [18]). This problem is manifested in two ways: in addition to dismissing potentially useful modes of scientific inquiry, resources and energy are wasted by being diverted into non-productive approaches toward improving the safety of care processes (*eg*, counting and classifying adverse events, developing large databases of events that discard narrative and context) [1], linear analyses of single, isolable factors

instead of analyses appreciating reciprocal causation, endogeneity, and equifinality [7,8,14].

2.2.3. *Engineering design*

Finally, rethinking healthcare as a safety-critical activity will require a substantively enhanced role for engineering in the design of devices, procedures, and organizations. While health care has periodically issued calls for greater partnerships between healthcare and engineering professionals [11,16,21], these calls have resulted more in ‘intersections’ (in which systems engineers are called in late to sprinkle magic ‘engineering dust’ on an activity already well underway) than in ‘collaborations’ – substantive, long-term partnerships [13]. Fundamental, structural changes (imagine shifting the US federal patient safety research portfolio from the Agency for Healthcare Research and Quality to the National Science Foundation) may be required to effect this change.

3. Safety-criticality and healthcare

In addition to changes in healthcare, the exercise of viewing healthcare as a safety-critical industry should bring some fortuitous changes to our understanding of the properties of these industries. Just as moving healthcare into the domain of safety-critical industries changes the ways in which we understand healthcare, it will also change the ways in which we understand and deal with safety-criticality.

3.1. *Feed forward vs feed back guidance*

Because the first industries treated as safety critical tended to be those in which there was a detailed, fundamental understanding of the mechanisms underlying the phenomena of interest (think of aviation, or nuclear power), the dominant method of addressing safety in these domains has been via feed-forward, prescriptive control – an enumeration of proscribed events, and the institution of barriers and other means of control to prevent those events, or their immediate precursors. Although this approach is amenable (and has had some success) in circumscribed areas of healthcare, it has not found broad applicability in that field (although its intellectual appeal – the wish that this sort of rationalist control could be imposed and would be successful, is admittedly great, and resonates strongly with the general positivist thinking in healthcare).

However, such a fundamental understanding of the processes at work in the care of illness and injury is lacking in healthcare. In addition, clinical work is strongly characterized by profound uncertainty, ambiguity, contingency, context, constraints, and competing goals – clinical work is probably the quintessential ‘open system’, in which “things that never happened before happen all the time” [23]. In such settings, prescriptive guidance will inevitably be underspecified, and opportunistic actions will rise in importance in comparison to following standard procedures. Unfortunately, this will resonate unfavourably with the narrative of heroic individuals, and so will be a difficult area to resolve in redefining healthcare as safety critical.

3.2. *Resilience and organizational slack*

The traditional approach to safety-criticality in most other industries has revolved around reducing variability, and concomitantly enhancing process efficiency. In closed (or relatively well-defined) settings, this approach has been fairly successful. But, researchers have raised concerns that decreasing the variety of tools, procedures, and approaches to problems might improve performance under normal, within-design-base conditions, but degrade it under off-normal conditions. Since off-normal conditions are almost the norm in some areas of healthcare (consider emergency department operations, or trauma surgery), and off-normal conditions do occur even in the most well understood industries, the field of resilience engineering has developed to explore ways of enhancing a systems ability to respond effectively to the unexpected and still accomplish its fundamental mission [9]. In essence, these issues are expressed in two differing views of reliability: the traditional view is anticipatory and equates reliability with invariance; the alternative view is resilient, and equates reliability with the ability to respond effectively. These views are not necessarily mutually exclusive (*ie*, organisations can adopt the anticipatory model but simultaneously understand it is incomplete and support “partisans of the neglected perspective” to maintain procedures and resources supporting resilient response) [17].

4. Conclusion

This essay has argued, from a “big picture” point of view, that re-conceiving of healthcare as a safety-

critical activity should have salutary effects on both healthcare as an industry, and on our understandings of safety-critical work. There are obvious challenges and potential pitfalls to this approach, but the record of performance of current efforts to improve healthcare safety suggest that new thinking is required [12].

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