Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Parallels between our response to COVID-19 and approach to patient safety

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Summary

The response to the COVID-19 pandemic and the approach to patient safety share three important concepts: the challenges of preventing rare events, use of rules, and tolerance for uncertainty. We discuss how each of these ideas can be utilised in perioperative safety to create a high-reliability system.

Keywords: COVID-19; patient safety; rare events; high reliability; controlled safety; managed safety; uncertainty

History does not repeat itself, but it does rhyme.

Attributed to Mark Twain

In early 2020, the world was caught off guard by a novel coronavirus. Regardless of the mechanism of origin, history suggests that we should not have been surprised that we would be confronted with another viral pandemic. In fact, if anything should have surprised us, it is that a viral pandemic did not happen sooner given the current extent and ease of international travel. Early warning signs were present. An influenza pandemic struck the world more than a century earlier, resulting in hundreds of millions of infections and tens of millions of deaths. In the previous 20 yr, several respiratory pandemics occurred, two of which were caused by coronaviruses: severe acute respiratory syndrome and Middle East respiratory syndrome.

In an attempt to explain these warning signs, we can turn to the work of Barry Turner.[1] Originally published in 1978, *Man-Made Disasters* is credited as being amongst the first to examine the organisational causes of disaster.[1] In the foreword, Diane Vaughan discusses Turner's core idea of 'failures of foresight'. Disasters are not sudden cataclysmic events; rather, they are processes. We may witness the outcome on a specific day, but what caused that day to occur was incubating for years or even decades. During this incubation period, there were warning signs that were misinterpreted or ignored. Inattention to these signs is antithetical to the practice of high reliability to which healthcare aims to achieve. The response to the COVID-19 pandemic and the approach to patient safety share three important concepts: the challenges of preventing rare events, use of rules, and tolerance for uncertainty.

Challenges of preventing rare events

Catastrophes are fortunately rare, which is both a blessing and a curse. Although their infrequency prevents greater harm from occurring, it also impedes learning from mistakes and preventing recurrence.[2] A lack of catastrophe does not equate to safety, whether it is 100 yr without a pandemic, 87 shuttle launches between the *Challenger* and *Columbia* losses, or thousands of surgeries without a wrong-site operation. One must give great caution to interpreting zero numerators, as they have a qualitative impact far more than their quantitative value.[3] The two main challenges of preventing rare events are relying solely on outcome measurement and a lack of learning at the organisational level.

Let us first consider the catastrophe of wrong-site surgery. Based on data collected before the widespread adoption of the WHO safe surgery checklist, the incidence of wrong-site surgery was estimated to be one in 76 000–174 000 operations.[4] For a hospital performing 10 000 operations each year, this equates to about one occurrence every 7–17 yr. When a patient was unfortunate enough to suffer one, the organisation would be forced to re-evaluate its practices and develop a mitigation strategy. If it judged the success of its mitigation strategy solely by measuring the outcome, that is, not having a wrong-site surgery, the organisation could easily be lulled into believing that the changes were successful.

For events that are rare, measuring outcome alone is not informative if changes have successfully addressed the problem, as statistically the chances of another event occurring are unlikely for many years. For the scenario of wrong-site surgery, we must also measure the adherence to each of the processes implemented to make this rare but catastrophic event even less likely to recur. Such processes include how the correct site is indicated, ensuring that radiographs are available and reviewed before incision, and that the surgical time out is completed as designed.

The second challenge in the mitigation of infrequent events is that individuals who were around to learn the lessons from the previous occurrence may not be around when it happens again. The individuals managing the pandemic of 1918 were obviously not around to lend their expertise to those managing

COVID-19. This emphasises the importance of learning from an event and then embedding it within the intelligence of the organisation (or nation). Individual knowledge is fleeting; people change jobs and retire, and outsourcing occurs. Of course, this can also affect organisational learning, as later generations do not see the rationale behind the processes and are tempted to change them. In such cases, it is wise to consider the principle of Chesterton's fence, which, interpreted simply, advises one not to tear down a fence that seemingly has no purpose until it is fully understood why it was erected in the first place.

Use of rules

Organisations often use rules, standard operating procedures, and policies to transmit knowledge. Amidst a growing body of evidence, countries around the world transmitted their knowledge of how to mitigate COVID-19 spread by mandating mask wearing. The ire began almost immediately; outright refusal to comply and attempts to bypass the rules were widespread.

The safety of a complex system comprised two components: controlled safety and managed safety.[5] Controlled safety is the aspect that is achieved through rules, regulations, policies, and procedures, whilst managed safety is achieved through workers using their adaptive expertise to meet the challenges of novel problems. Consider an example from aviation: the strict, rule-based method of preparing an aircraft for take-off is an example of controlled safety. Ditching the aircraft in the Hudson River after experiencing a double-engine failure is an example of managed safety. Controlled safety established rules for patient care early in the COVID-19 pandemic regarding use of personal protective equipment and ventilator management. The adaptive expertise of clinicians to meet the unprecedented challenges of the pandemic (managed safety) resulted in the development of decontamination techniques for N-95 mask reuse, 3D printing to retrofit and adapt snorkel masks for respiratory filters,[6] and innovative designs for mechanical ventilators that could be mass produced quickly and used on more than one patient during times of surge.[7,8]

Controlled and managed safety align closely with the safety management concepts of Safety-I and Safety-II, respectively. The focus of Safety-I is ensuring that as few things go wrong as possible with the principle that adverse outcomes have identifiable causes that can be eliminated once they are identified (e.g. adding or modifying an element on a checklist).[9] The concept of Safety-II views humans as sources of flexibility and resilience, which is especially important in complex and dynamic systems, such as healthcare.[10] An ideal safety system involves a balance of both controlled safety and managed safety, of both Safety-I approaches and Safety-II approaches to safety management.

The use of rules remains an essential part of safety strategy. They serve to make safety processes visible and can be communicated, reviewed, and understood. Rules also have limitations. Human factors either directly cause or contribute to the majority of traffic accidents. Laws exist prohibiting speeding, tailgating, driving under the influence, and so on. Simply having rules does not guarantee compliance, as we are all aware that these traffic infractions continue to occur. More rules may increase liability, as the more rules an organisation has, the more likely that at least some of them are not being followed. Unfortunately, many hospitals have yet to realise that more rules do not translate to a safer system. Rules, therefore, are *necessary* but *insufficient* as a safety strategy.

When rules are viewed as a hindrance to efficiency, people sometimes resort to bypassing them or taking shortcuts. Whilst these 'workarounds' occasionally uncover a better method for getting the task done, more often they circumvent an established process for one that has not been properly vetted. This typically occurs when the importance of a rule and the risks involved are not fully appreciated. More important than knowledge of a rule's existence is knowing the 'Why?' behind the rule. A fascinating story of the importance of understanding the why was told by Captain Chesley Sullenberger. He stated that pilots of his generation could quote all the major seminal accidents of the past half-century by how the recommendations changed equipment designs, procedures, and training. Almost everything that pilots know and every rule that they follow they have because someone, somewhere died to provide that knowledge, so pilots dare not forget and have to relearn those lessons.[11]

Imagine in healthcare if we approached rules the same way. What if we could quote the major accidents and incidents at our own healthcare facilities and how they changed the way we do things? What if we viewed rules not as a hindrance but as a reminder of the knowledge that was given to us by someone who had been harmed? The story is crucial to the acceptance of the rule. Some of the most ardent COVID-19 sceptics were only convinced when they experienced first-hand the story of how it affected someone they knew.

Tolerance for uncertainty

The emergence of COVID-19 challenged the world in a way that has not been experienced in generations. The novel infectious disease was met with great uncertainty: uncertainty about how the disease was spread, the best preventative measures, and its treatment. Initial recommendations were later rescinded and changed, creating a great deal of confusion and scepticism regarding their replacements.

Uncertainty is pervasive in healthcare, regarding the disease process accounting for a patient's symptoms, the most accurate diagnostic test to order, or the best therapeutic options. Rather than being spurned, uncertainty should be viewed as a vital and essential component of the process of diagnostic safety: achieving a timely and accurate explanation of the patient's problem.[12] When we stop perceiving uncertainty as a threat, we can then challenge the biases and rules of thumb that contribute to our immediate initial impression. By retaining a degree of uncertainty when faced with a clinical presentation, it forces us continuously to challenge our hypothesis, circumvent overconfidence, and arrive at a better decision.[13]

The same benefits of retaining uncertainty can be realised in our approach to other safety improvement initiatives. Just as we approach a diagnostic hypothesis, we should continuously challenge our impression of the causes of safety issues and whether our improvement efforts are effective and sustainable. Hubris in any area of safety limits our ability to accurately assess risk and potential for harm.

We have utilised what the world experienced with COVID-19 as a springboard to discuss several safety-related topics relevant to the practice of medicine. The challenges of managing infrequent events include measuring the success of mitigation techniques and overcoming the barriers of organisational learning. Rules are necessary as a safety strategy, but consideration must be given to circumstances that may require adaptive responses by frontline workers. One of the keys to ensuring rules are followed is verifying that the story behind the rule is well known. Finally, uncertainty should be embraced rather than shunned. We need to accept the fact

that because of the nature of our profession, we must make decisions based on imperfect data and limited knowledge, and that alterations in plans are often necessary.

Declarations of interest

The authors declare that they have no conflicts of interest.

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Potential responses to remifentanil supply shortages

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Summary

Rapid elimination of remifentanil facilitates application of intense opioid effect during general anaesthesia whilst maintaining prompt emergence. Interruptions in remifentanil supply mean clinicians must relearn titration of pharmacokinetically longer-acting opioids to achieve appropriate levels of opioid effect whilst maintaining acceptable recovery times. Opioid-free anaesthesia is achievable for many minor and intermediate surgical procedures for which remifentanil might have been used previously.

Keywords: alfentanil; pharmacodynamics; pharmacokinetics; propofol; remifentanil; supply chain

Anaesthetists can manage without remifentanil—but it's annoying!

Remifentanil was introduced in the 1990s and is now widely used as the opioid component of balanced anaesthesia and intensive care sedation and for obstetric analgesia. Two decades of clinical experience and the availability of remifentanil at reduced cost from generic manufacturers place it at the centre of contemporary anaesthetic practice, especially when total intravenous anaesthesia (TIVA) is used. Intermittent interruptions to the supply of remifentanil have been reported internationally, including the UK[1] and the USA.[2]