

Quality, safety, and outcomes in anaesthesia: what's to be done? An international perspective

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Abstract

This article reviews some of the key topics and challenges in quality, safety, and the measurement and improvement of outcomes in anaesthesia. The topics were selected based on the perspective of an individual with quality and safety expertise and recent experience of the specialty in both the UK and USA. The review does not seek to be exhaustive or systematic, but to highlight current areas of concern and potential solutions. The topic is subdivided into sections where the system of health care is viewed from different levels. These levels are as follows: the microsystem or patient and individual clinician perspective; the meso or hospital perspective; and the macro or government and policy perspective. Topics covered include medication safety, changes in approaches to patient safety, payment reform, longer term measurement of outcomes, large-scale improvement programmes, the ageing population, and burnout. The article begins with a section on the success of the specialty of anaesthesia in improving the quality, safety, and outcomes for our patients, and ends with a look to future developments, including greater use of technology and patient engagement.

Key words: anaesthesia, general; patient safety; quality improvement

Reflections and celebrations

In the 25 yr since the gaining of the Charter to form the Royal College of Anaesthetists (RCoA) in March 1992, the specialty has come a long way. In the previous 25 yr, there had been incredible innovations in anaesthesia, such as the introduction of enflurane, isoflurane, propofol, the laryngeal mask airway, and pulse oximetry. The breakthroughs and developments from 1992 to 2017, although perhaps not so dramatic as those that occurred between 1948 and 1992, reflect the maturity of anaesthesia as a specialty. Work is focused on continuous improvement, a better understanding of patient outcomes, and delivery of the highest quality of care through education and training, research, audit, incident reporting, and the setting of standards.

Although there are still many challenges that the specialty must meet, some of which are discussed in this article, on the

25th anniversary of the RCoA it is important to pause, reflect, and celebrate how much has been achieved as a profession. The death rate from anaesthesia alone, while once feared, is now extremely low;¹ 0.06% for general anaesthesia deaths reported in the 5th National Audit Project (NAP5). There are now standards and systems in place for continuous quality improvement.²

The year of the Charter of the RCoA, 1992, was a challenging year in the UK; the Irish Republican Army (IRA) were active, the Manchester city centre bombing occurred, and the Chancellor announced a reduction of interest rates for the first time in 4 yr to 8.8%! In the world of anaesthesia, the publication of the 1991/1992 NCEPOD report, which then stood for the National Confidential Enquiry into Perioperative Deaths,³ highlighted concerns that have preoccupied the specialty for the last 25 yr;

the lack of dedicated emergency theatres, adequate postoperative recovery and intensive care bed provision, insufficient staff and inappropriate night-time operating by unsupervised junior and locum doctors, inadequate preparation of emergency patients, excessive fluid administration, inadequate use of non-invasive monitoring before and during induction of anaesthesia, and continued issues with some surgeons performing operations with which they were not familiar (Table 1). In many of these areas, significant improvements have been made, such as the provision of dedicated emergency theatres⁴ and the use of monitoring during induction. In others, such as intensive care bed provision, the UK still faces challenges⁵ and lags behind many other developed countries.

Anaesthetists have always been leaders in patient safety, perhaps because of the immediacy that an error can bring. Hospital care is still hazardous for patients,^{6,7} but anaesthesia for ASA physical status I and II patients undergoing day case surgery is one of the safest and reliable procedures that a patient can have. A population study by Li and colleagues⁸ of anaesthesia-related deaths in the USA between 1999 and 2005 showed a death rate related to anaesthesia of 8 per million hospital surgical discharges, taking deaths directly related to anaesthesia into the ultra-safe zone, a term used in the definition of system safety.⁹ As a specialty, anaesthesia has relentlessly driven up standards by seeking out harm, studying and understanding it, and implementing change to improve. However, improvements in perioperative safety have been greatest in the developed world, and although outcomes have improved overall worldwide, there is a need for greater application of evidence-based practice in the developing world.¹⁰

The RCoA has actively driven standards up with a pursuit of excellence and a quest to make care better for patients. Confidential enquiries, such as NCEPOD¹¹ and the Maternal Morbidity and Mortality reviews,¹² have examined themes, found areas for improvement, and then delivered better care through education, training, and constant review. The RCoA is leading the way in accreditation of departments, and programmes for excellence, such as Anaesthesia Clinical Services Accreditation (ACSA).¹³ The National Audit Projects (NAP)¹⁴ and now the Sprint National Anaesthesia Projects (SNAP)¹⁵ have generated information on large numbers of patients, giving further truly evidence-based insight into deficits in care and the incidence of problems.

The specialty of anaesthesia and intensive care medicine has 'changed the conversation' in the care of sick patients. Not that long ago, a prolonged stay in the intensive care unit (ICU) might well lead to a complication, such as a central line infection.¹⁶ Now this is so unusual, after focused safety

programmes,¹⁶⁻¹⁷ that we count days between infections as the incidence rate in high-performing units is too low to calculate.^{17,18} Data from safety programmes, such as the Scottish Patient Safety programme and the South West of England Quality and Patient Safety programmes,^{18,19} show that it is possible across large populations and large numbers of hospitals to go for weeks and months without a central line infection occurring. Internationally, anaesthetists are pioneers and leaders of the patient safety movement.²⁰ However, after the celebration of what has been achieved must come reflection on what is to be done now and in the future to improve safety, quality, and outcomes continuously.

System thinking

As a means of providing structure to this topic, an approach was organized by thinking of the many influences on health care as a system, including political and economic drivers at a macro level, the interactions of multiple small units at a meso-system level (for example, in a hospital), and the patient-centric building blocks of clinical care, the microsystem. A microsystem can be defined by the interactions of a set of providers, support workers, and a population of patients in a defined location.²¹ The challenges to delivering high-quality care for excellent patient outcomes are different depending on the level of the system worked in, but they all interact and significantly influence each other (Fig. 1). The topics discussed in each section are illustrations of challenges and solutions at each level; they are not exhaustive, but have been highlighted by recent international expert consensus.²² The topic of measurement for improvement was covered in a recent *British Journal of Anaesthesia* editorial²³ and so will not be discussed further, but the other issues raised by the expert group are discussed in this article.

Micro-system challenges and potential solutions

The micro level is where interactions occur directly with patients. For example, a high-profile challenge for anaesthesia is medication safety. A recent major study by Nanji and colleagues²⁴ found that 1 in 20 perioperative medication administrations, and every second operation, resulted in a medication error, an adverse drug event (ADE), or both. Fifty-one of the 153 medication errors detected led to a 'preventable' ADE; for example, giving penicillin to a patient with a known penicillin allergy, or administering a large remifentanyl bolus, resulting in bradycardia and hypotension. More than one-third of the errors led to

Table 1 Then and now: recurring themes in resource allocation and recommendations for perioperative practice since the 1990s^{3,4}

| Resource allocation | Medical practice recommendations |
|--|--|
| Twenty-four-hour access to fully staffed operating theatres | Pathways to facilitate the delivery of optimal emergency surgery |
| Twenty-four-hour access to pathology and radiology reporting services | Safe and structured handover of care |
| Critical care beds provision | Pathways for the care of unscheduled surgical patients and timely management of sepsis |
| Adequate staffing, with consultant-led care and supervision of juniors | Multidisciplinary reviews of processes and patient outcomes (morbidity and mortality meetings) |

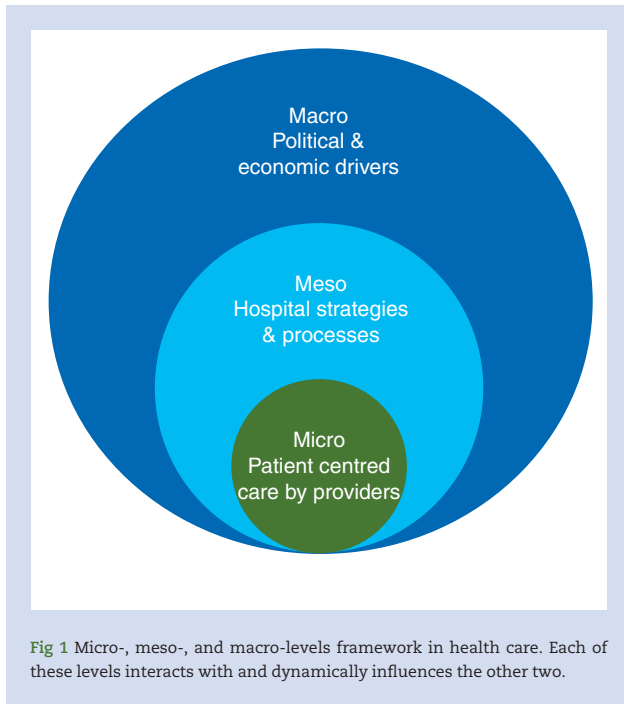


Fig 1 Micro-, meso-, and macro-levels framework in health care. Each of these levels interacts with and dynamically influences the other two.

patient harm and the remaining two-thirds had the potential for harm. This is the largest observational study of anaesthesia-related medication events to date. The study was done in a major Boston teaching hospital, which already had electronic anaesthetic records and a bar-code-assisted labelling system in use to scan the medication, which provided a label and gave audio and visual feedback of drug name and concentration. In addition, this hospital has noted experts on medication safety. This was a relatively high number of errors given the advanced safety features in place, including feedback on the drug chosen. As bar coding was in use in this study, further work is required to gain a better understanding of exactly how it is used in the real world and why workarounds may occur.^{24–26} In addition, in this study the medication error rate was only what was recorded in the operating theatre. There is added challenge in ensuring that patients are prescribed the correct medication as they move through their perioperative course. Many patients are now on more than five medications, putting them into a high-risk category²⁷ for medication error.²⁸ Reductions in medication errors in other patient care areas have occurred because error rates were systematically measured, errors were categorized to determine their root causes and potential for harm, and solutions were designed and implemented.²⁹

Patient safety programmes and measurement of harm

There have been marked successes in reduction in patient harm through measurement and targeted improvement programmes. Under the Affordable Care Act in the USA, many safety metrics are subject to mandatory reporting, which may seem onerous, but the approach has delivered genuine improvements, such as a 49% reduction in catheter-associated bloodstream infections and a 28% reduction in catheter-associated urinary tract infections.³⁰ Likewise, the relentless drive in the UK on measurement and reporting aligned with hand washing campaigns has decreased infection rates.³¹ However, thought leaders suggest

Table 2 National Patient Safety Foundation recommendations (2015)³⁴

| |
|--|
| Ensure that leaders establish and sustain a safety culture |
| Create centralized and coordinated oversight of patient safety |
| Create a common set of safety metrics that reflect meaningful outcomes |
| Increase funding for research in patient safety and implementation science |
| Address safety across the entire care continuum |
| Support the health-care workforce |
| Partner with patients and families for the safest care |
| Ensure that technology is safe and optimized to improve patient safety |

that there is a sense that some momentum has been lost in the world of patient safety.³² Much of what was the focus of the original safety programmes, such as 'Patient Safety First', is now standard care.³³ The US National Patient Safety Foundation published a report in 2015 on accelerating patient safety 15 yr after the seminal 'To Err Is Human' report, which drew attention to the harm rates in hospitals. The recent report calls for the establishment of a total systems approach and a culture of safety, with a call for action by government, regulators, health professionals, and others to place higher priority on patient safety science and implementation^{34–36} (Table 2 and Fig. 2).

These thoughts were echoed in the UK by The Health Foundation with their report on 'Continuous improvement of patient safety 2015',³⁷ which also called to: (i) develop a culture and system of learning; (ii) improve safety across all care settings; and (iii) manage safety proactively.

The new approach to patient safety therefore appears to be much less about individual projects, and much more about changing the culture and truly creating systems that support the reliable delivery of care.

Meso-level challenges

A collection of interrelated microsystems that provide care to a shared population of patients (for example, cancer, cardiovascular, obstetrics) can be referred to as a mesosystem . . . One role of the meso-system is to actively guide the dialogue between related microsystems to achieve desired outcomes for patients.²⁰

The study of quality and outcomes has been placed into the meso-level lens in this review. In the past, outcome measurement at the hospital level has focused primarily on outcomes within a 30 day window of the primary event or admission, such as mortality, re-admissions, and length of stay. Michael Porter, the Harvard Business School Professor, in an important article,³⁸ drew attention to the fact that these outcomes are not what matter most to patients. Obviously, being alive or dead is key, but beyond that for most types of elective surgery patients want to get back to their previous level of health or better, and there must be a greater focus on patient-centric outcomes. Patient-reported outcomes and quality-of-life evaluations are deservedly receiving greater focus.³⁹ Indeed, they have led to questioning the appropriateness of previously common procedures in the assessment of treatment pathways,⁴⁰ in surgical options,⁴¹ and adaptation and improvement of surgical procedures.⁴²

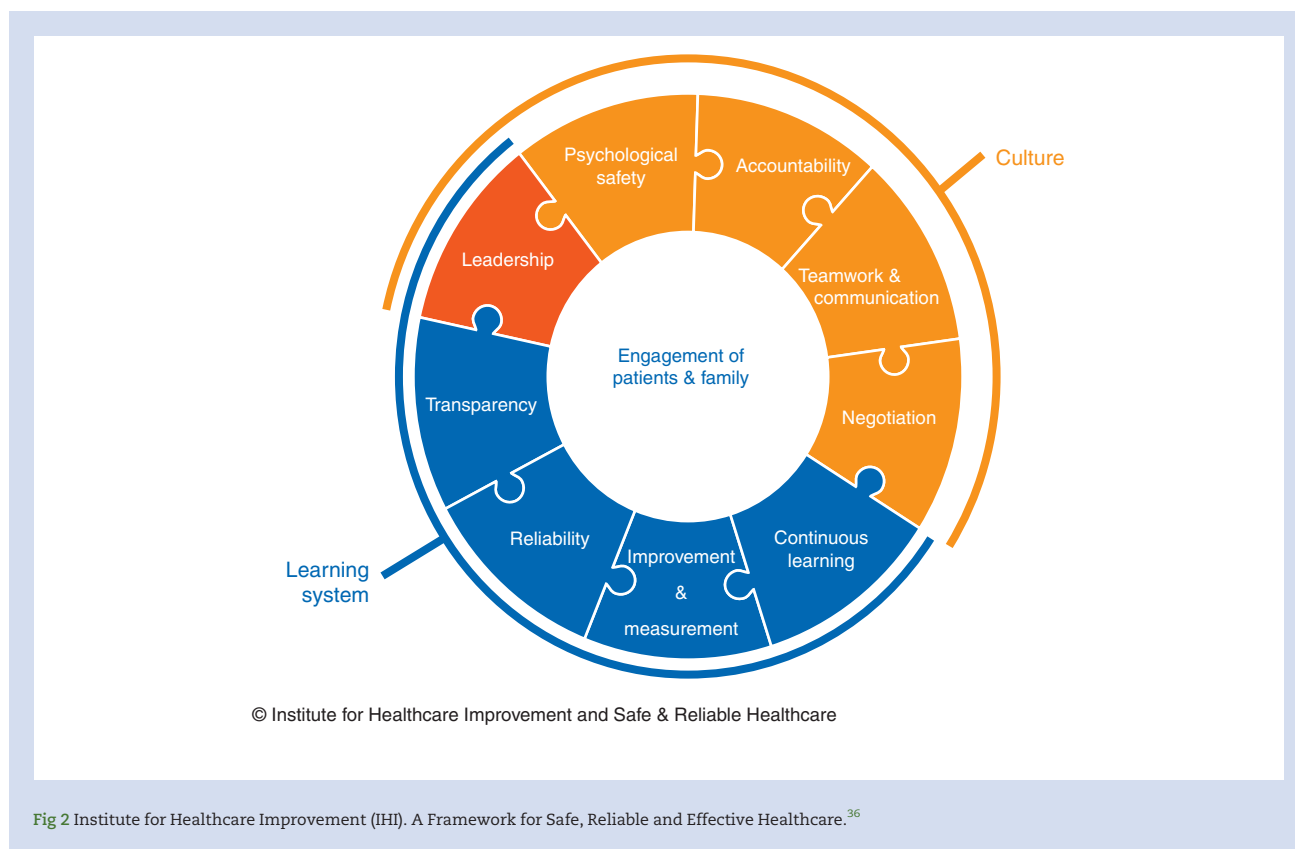


Fig 2 Institute for Healthcare Improvement (IHI). A Framework for Safe, Reliable and Effective Healthcare.³⁶

As the specialty of anaesthesia moves towards perioperative medicine and a greater involvement in the whole patient pathway, we must evaluate its impact on all outcome measures. The association between surgeon volume and outcome is well established,⁴³ but anaesthetists have not generally been held accountable for longer term outcomes, such as re-admission rates. However, a recent study⁴⁴ demonstrated increased re-admission in low-volume anaesthesia centres. When anaesthetists did the procedure only occasionally, patient outcomes were poorer. As a specialty, this type of data should be welcomed as it shows that expertise and experience generated by a sufficient caseload are as applicable to anaesthetists as they are to surgeons. There are other important points about this paper for future outcome studies. First, a large data set was used to explore outcomes for relatively low-volume procedures, which is hard to do effectively at an individual hospital level; 3500 patients were collected during 5 yr. Second, the association with re-admission and occasional patient outcome was shown not only at 30 days, but also at 90 days.

The collection of longer-term outcome data is now becoming more routine. The second National Emergency Laparotomy Audit (NELA) report has outcomes at 90 days,⁴⁵ and the European Surgical Outcomes Study (EUSOS) and the International Surgical Outcomes Study (ISOS) studies^{46 47} collected longer-term outcomes. However, although there is work going on to improve mortality for patients undergoing high-risk surgery,⁴⁵ we know little about the quality of life of survivors. Outcomes must be measured routinely at a number of different levels, including patient experience and quality of life, especially for high-risk surgery.^{23 48} Long-term outcome studies are producing fascinating insights into our practice of anaesthesia.

An example from the Royal Marsden Hospital showed increased survival over time for cancer patients, with and without metastases, who received total i.v. anaesthesia compared with those who received inhalation anaesthesia.⁴⁹

The concept of 'bundled care' has been big news in the USA for the past few years.⁵⁰ This is an episode-based payment where hospitals are reimbursed for the expected costs of a defined episode; the catch is that the hospital is held accountable for all costs of care for 90 days after the index surgery, whether or not related to the original episode. The idea developed from the US health care system Geisinger, which offered a 'ProvenCare' model and included best practice, patient engagement, and all costs for 90 days after cardiac surgery.⁵¹ The first major widespread programme in the USA has been the 'Comprehensive Care for Joint Replacement'; early reports show benefits, with a reduction in cost, decreased length of stay, better mobility, more patients going directly home, and decreased re-admissions at 90 days for patients who had a bundled approach for joint replacement compared with those who did not.^{52 53} What the bundled care approach brings is a financial necessity to see what really happens to patients after surgery and to understand the complications and problems that arise in the extended postoperative period. In some ways, this has been an accelerated lesson in perioperative medicine for administrators and surgeons, which incentivises and empowers providers to innovate and coordinate care better. The programme is now available for 48 types of care; other surgical procedures include hip fracture and coronary artery bypass surgery, and medical conditions include acute myocardial infarction, cellulitis, and chronic obstructive pulmonary disease. Whether this programme remains in its current form under the new Secretary of

Health in the USA remains to be seen, but it is thought likely that it will. This approach is not unique to the USA and has been successfully used in The Netherlands and Sweden. In Sweden, the approach saw a 33% reduction in complications after surgery and a 17% reduction in cost.⁵⁰

Coordinated safe care requires high-quality handovers, and there is growing evidence that this can make a significant difference across a continuum of care, not only to morbidity, but also to mortality. This should be an area for anaesthesia research to focus on during the next few years.^{54 55}

It will be no surprise if 90 day financial responsibility for patient outcomes after surgery becomes a norm in the UK. The UK should be well prepared for this multidisciplinary, collaborative, team-based approach to care coordination through our experience with 'enhanced recovery after surgery' (ERAS) programmes.⁵⁶ Initially developed in Scandinavia,⁵⁷ this is an approach not yet widely adopted in the USA.⁵⁸ It is currently seen as innovative and cost effective, and is attracting large grants, as in the recent award of a multi-million dollar grant to the Armstrong Institute for Patient Safety and Quality at John Hopkins University for the role-out of ERAS programmes in the USA.⁵⁹

Another important trend that is gaining ground internationally is large-scale quality improvement studies, with local teams working on quality improvement projects within their own hospital, but with the data gaining much greater validity through pooling multiple organizations at a national level. Examples of such studies are the UK emergency laparotomy Enhanced Peri-Operative Care for High-risk patients (EPOCH) study,⁶⁰ with results due out later this year, the Anesthesiology Performance Improvement and Reporting Exchange (ASPIRE) project based on the infrastructure of the Multi-center Perioperative Outcomes Group (MPOG),⁶¹ and the 'ABCDEF' bundle implementation through the ICU Liberation project collaborative in the

USA. This consists of 'Assessment and management of pain, Both spontaneous awakening and breathing trials for weaning, Choice of analgesia and sedation, Delirium assessment, measurement and management, Early mobility and exercise and Family engagement and empowerment'.⁶²

Macro level

At the macro level, major external factors that influence clinical performance and strategy must be considered. These factors can include economics, patient characteristics, social conditions, and technological changes. Two such factors that are dramatic and that challenge anaesthetists and intensivists in relationship to quality, safety, and patient outcomes, and that impact the specialty of anaesthesia both in the UK and worldwide, are the ageing population and the issue of burnout.

Ageing population

The first issue is the growing elderly population, and particularly, the oldest old or those >80 yr⁶³ (Fig. 3). This population change means that we are dealing with greater numbers of complex elderly patients who may have frailty and multiple comorbidities. Frailty identifies a lack of physiological reserve, increases with age, and is present in 40% of the >80-yr-old patients compared with 10% of patients at 65 yr.⁶⁴ Frailty is a significant factor in postoperative outcome and an independent predictor of mortality, morbidity, and institutionalization.^{64 65} A recent study using administrative data of 203 000 patients >65 yr⁶⁴ showed that a preoperative frailty defining diagnosis significantly increased 1 yr mortality, which was most marked for total joint arthroplasty. In this study, the immediate postoperative period was identified as a period of great risk, with the hazard ratio at day 3 extremely high for frail patients

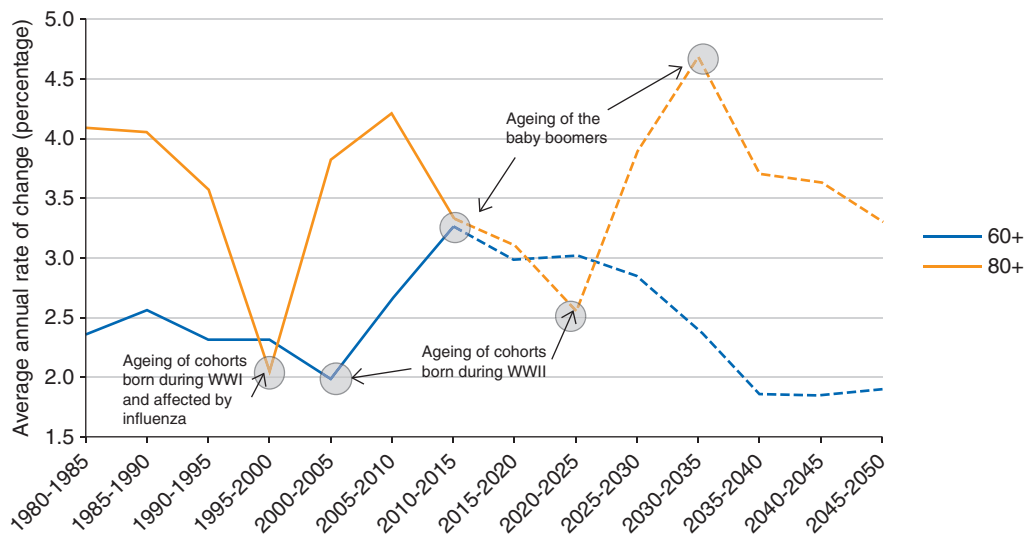


Fig 3 Average annual rate of change (percentage increase per year) of the global population aged ≥ 60 and ≥ 80 yr, from 1980 to 2050. Global trends in the growth rate of the older population reveal the powerful influence of major historical events in shaping the age composition of the world's population. Data source: United Nations (2015). World Population Prospects: The 2015 Revision.⁶³

compared with non-frail patients. With more outcome data of this nature, we are better able to provide preoperative counselling for patients, risk stratify patients, and work on modifiable factors.

After the 2010 NCEPOD 'An Age Old Problem' report of the care of older patients undergoing surgery,⁶⁶ a short-life working party was set up by the RCoA. One recommendation was to have specialists in geriatric or older persons anaesthesia, just as we have specialist paediatric anaesthetists, in every department. Co-management with care of the elderly physicians of older surgical patients has been shown to improve outcomes for patients with hip fracture.⁶⁷ A metric of the National Emergency Laparotomy Audit⁴⁵ is the percentage of high-risk older patients >70yr seen by a care of the elderly physician. Even in this patient risk group, whose mortality exceeds 20% at 90 days, only 10% of patients >70yr were seen by a care of the elderly physician.⁴⁵ In 2016, the American College of Surgeons (ACS) in conjunction with the American Geriatric Society issued guidelines on best practice for management of the geriatric patient.⁶⁸

One area of focus in the ACS guidelines is the prevention of delirium, and this is supported by separate guidelines from the American Geriatric Society.⁶⁹ Delirium is a very significant and common postoperative complication⁷⁰ that is associated with subsequent cognitive impairment⁷¹ and has been shown to be preventable in up to 40% of patients through simple measures.⁶⁸ Preoperative prehabilitation may have a role in reducing postoperative cognitive dysfunction and delirium.⁷² Later this year, the ASA will launch its 'Brain Health Initiative' to encourage departments of anaesthesia to take simple preventative steps to reduce perioperative confusion, postoperative cognitive dysfunction, and delirium, such as talking to older patients and their families about bringing in hearing aids and spectacles.⁷³

Burnout

Another major issue that most observers of health-care system performance are seeing and discussing in the literature is burnout. Burnout is a work-related syndrome involving emotional exhaustion, depersonalization, and a sense of reduced personal accomplishment that has reached epidemic levels, with prevalence near or exceeding 50%.⁷⁴ Burnout has a negative effect on patient care, professionalism, and self-care of affected individuals.⁷⁵ If staff are exhausted, their ability to empathize decreases, and patient safety is at risk. Evidence, although not strong, shows that poor well-being and moderate to high levels of burnout are associated with poor patient safety outcomes, such as medical errors and poorer quality care.⁷⁵ As the pressures on health care increase on what seems like a daily basis and staff struggle to cope, there is a real need to consider rest, well-being, and staff support.⁷⁶ Organizations such as the Mayo clinic in the USA are running physician wellness programmes to understand and promote physician well-being, provide resources to promote wellness, to discover personal and organizational approaches to prevent physician distress, and to create a workplace that is a source not only of energy expenditure but also energy renewal.⁷⁷ Although this approach might be seen as a luxury of a wealthy USA medical centre, failure to address the needs of a profession and specialty such as anaesthesia, whose clinicians work daily in stressful situations, will lead to personal distress and the potential for increased patient harm. A coordinated effort is needed to address this serious problem for the medical workforce.⁷⁸ Developing a workplace where staff feel joyful, productive, engaged, and physically and psychologically

safe will ensure that staff are able to provide safe, high-quality care to patients.⁷⁹

Looking to the future

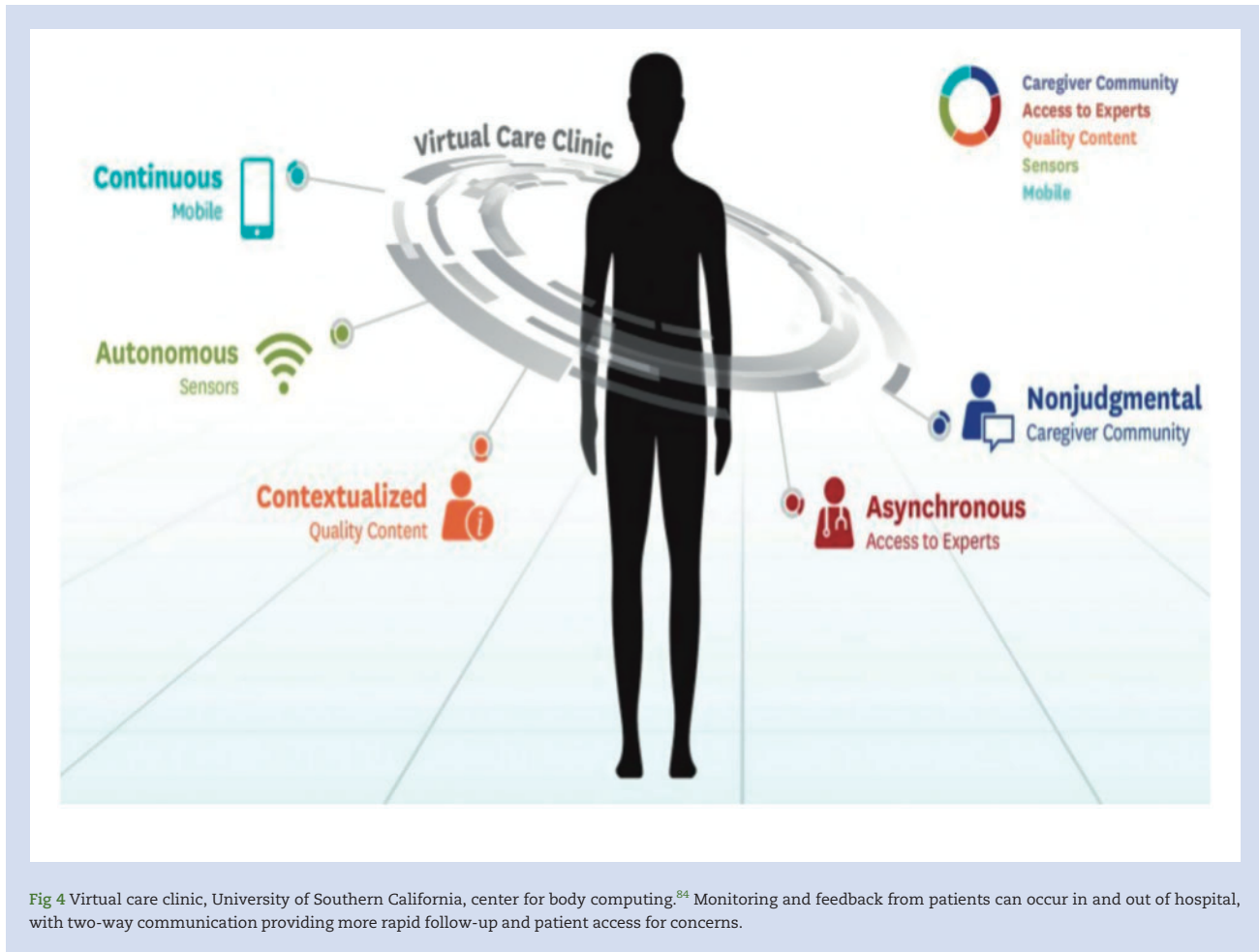
What else is shaping quality, safety, and outcomes in anaesthesia and perioperative medicine? The concept of shared decision-making and co-production and co-design of pathways with patients may become more widespread⁸⁰ as patients become more informed consumers. Technology is likely to foster greater engagement of patients with the widespread use of apps where patients can monitor and feedback their recovery,⁸¹ providing much greater data on patient outcomes after surgery.⁸² If even 10% of patients fed back their data for a year after a common procedure, such as a knee replacement, our understanding of the subtle challenges involved in recovering from an operation would be enhanced. Patient-focused checklists already support patients on crucial steps in their recovery.⁸³

Technology can be used to prepare better for surgery. At the University of Southern California, the Center for Body Computing is working on intelligent avatars that can respond to patient questions and is using virtual technology to show patients the operating room. Imagine how much better a patient might feel coming in for surgery if they have had a 'virtual' look around a ward and the operating theatre and have 'virtually' met some of the team. The whole concept comes together as a 'virtual care clinic', where care can be supervised without the physical presence of the patient (Fig. 4).⁸⁴

Conclusions

The last 25 yr have brought many successes and innovations to the field of anaesthesia, which in turn have delivered significant improvements to patients. Yet while the future undoubtedly holds more challenges, there is palpable energy and momentum paired with continuous aspiration to deliver the highest quality care in anaesthesia, intensive care, and perioperative medicine. Quality improvement projects in anaesthesia act as a conduit of some of this energy and can promote accelerated learning through a collaborative approach. An example of this type of approach is the UK Perioperative Quality Improvement Programme (PQIP),⁸⁵ which not only increases the awareness of the need to improve perioperative safety and outcomes, but also provides the tools to support local quality improvement initiatives and promote understanding of better outcome measurement. Large-scale studies, where change happens locally but where results are pooled regionally, nationally, or internationally, such as EPOCH, the ICU Liberation collaborative, and the Emergency Laparotomy Collaborative,⁸⁶ recognize that for change to occur it must be context sensitive,⁸⁷ that the specifics of the change (testing the efficacy of the intervention) can be dictated by the project, but the way that change occurs (the importance of implementation) must be driven by the front line providers. Although the results of many of these studies are awaited, it seems likely that this type of research will provide greater learning about how to make change happen at a local level and, coupled with large numbers of patients studied, will provide the statistical power that small, local quality improvement studies have lacked to date.⁸⁸

There are some emerging challenges and opportunities for the specialty of anaesthesia, such as the growing population of elderly patients with complex needs. Ensuring that we follow up all our patients for longer periods, focus on the outcomes most important to them, and work with patients to design care that



delivers what they really want will lead to a greater understanding of how to improve care for all our patients. New models of payment, which use long-term outcomes as payment incentives, can promote opportunities to increase value in health care through a greater focus on outcomes and the delivery of high-quality evidence-based care at decreased cost. With so much change occurring in the world of health care, it is essential to remember to care for ourselves and colleagues, provide wellbeing programmes to mitigate burnout, and promote 'joy in work',⁷⁹ which should include reflection on and celebration of the success of our specialty to date.

Authors' contributions

Wrote and delivered the original lecture: C.J.P.
 Design, development, drafting, and revision of the article: G.A., M.C.
 Final approval for publication and accountable for all aspects of the work: C.J.P., G.A., M.C.

Declaration of interests

C.J.P. holds shares in Fidelity Health and is a Fellow of, and Faculty member of, the Institute for Healthcare Improvement, USA.

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