REVIEW

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Measuring and monitoring perioperative patient safety: a basic approach for clinicians

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Purpose of review
Recent research points to considerable rates of preventable perioperative patient harm and anaesthesiologists' concerns about eroding patient safety. Anaesthesia has always been at the forefront of patient safety improvement initiatives. However, factual local safety improvement requires local measurement, which may be afflicted by barriers to data collection and improvement activities. Because many of these barriers are related to mandatory reporting, the focus of this review is on measurement methods that can be used by practicing anaesthesiologists as self-improvement tools, even independently from mandatory reporting, and using basic techniques widely available in most institutions.

Recent findings
Four mutually complementary measurement approaches may be suited for local patient safety learning: incident and rate-based measurements, staff surveys and patient surveys. Reportedly, individual methods have helped to tailor problem solutions and to reduce patient harm, morbidity, and mortality.

Summary
Considering the potential for perioperative patient safety measurements to improve patient outcomes, the absence of a generally accepted measurement standard and manifold barriers to reporting, a pragmatic approach to locally measuring patient safety appears advisable.

Keywords
anaesthesia, patient safety, preventable patient harm, quality improvement, quality indicators

INTRODUCTION

Patient safety has always been a core principle for anaesthesia and perioperative care. Unsurprisingly, anaesthesiologists and their organizations have initiated seminal patient safety initiatives [1▪▪,2,3]. However, recent reports reveal anaesthesiologists' concerns about threats to patient safety: increasing workload and production pressure, financial austerity and older, sicker patients, among others, which may foster frustration and stress, create temptations to 'cut corners', and lead to the perceived erosion of patient safety [4▪].

Such views are in line with current data about patient safety outcomes. According to the WHO, 10% of patients are harmed during hospital care [5]. A recent systematic review found that 20% of surgical and 34% of ICU patients were harmed during their hospital stay [6▪▪]. Importantly, 50% of these harms were judged to be preventable [6▪▪]. Why should these numbers concern anaesthesiologists? Despite its low specific risk [7], anaesthesia contributes to overall perioperative risk, including respiratory, infectious [8], neurologic, cardiovascular, thromboembolic and other complications [9▪], and thereby also to surgical mortality [10] that may not have generally improved over the last decades [11▪]. Patient safety, defined as 'the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare' [12,13], is a shared responsibility of all professional groups involved in the perioperative process. Moreover, clinicians directly involved in adverse events can become second victims [14], which may represent an additional intrinsic motivation and interest in improving patient safety.

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Curr Opin Anesthesiol 2020, 33:815–822

DOI:10.1097/ACO.0000000000000930

KEY POINTS

- Current concerns of anaesthesiologists about eroding patient safety are in line with reports about considerable rates of preventable perioperative patient harm.
- Perioperative patient safety measurement has the potential to improve patient outcomes but may be compromised by multiple barriers.
- In the absence of a generally accepted 'gold standard' of perioperative patient safety measurements, pragmatic local approaches may be achieved by combining incident-based and rate-based measurements with staff and patient surveys.

In line with the quotation 'if you cannot measure it, you cannot improve it' (arguably attributed to British physicist Lord Kelvin [15]), factually *improving* patient safety requires *measuring* it: local safety priorities may vary significantly between hospitals and over time [16,17]. Reportedly, local quality-improvement efforts are particularly important for improving operative outcomes [9▪]. Given the importance of measurement, it is striking that, in a recent survey of European anaesthesiologists, only 55.7% of respondents indicated that their hospital produced an annual report on patient morbidity and mortality, and only 37.3% indicated an annual report on improving patient safety [18▪]. This finding may be partially related to barriers to mandatory or public reporting, including concerns over competitive disadvantages or legal consequences [19].

Acknowledging such concerns as well as the intrinsic motivation of clinicians to improve safety of care, the focus of this review of current literature is on the benefits of routinely measuring and monitoring perioperative patient safety as a self-improvement tool for frontline anaesthesiologists, and based on essential techniques that are readily available in most institutions.

PRACTICAL APPROACHES TO MEASURING AND MONITORING PERIOPERATIVE PATIENT SAFETY

Patient safety is a particular attribute of quality of care and a 'nonquantifiable construct' [20] that cannot be measured directly. No generally accepted or evidence-based set of perioperative patient safety indicators is available to date to describe the entirety of this construct [21]. Practitioners are often left to their own compilation of what information to collect, following national or regional regulatory requirements, customs and local needs. Nevertheless, the framework for measuring quality aspects in healthcare proposed by Avedis Donabedian is widely accepted [22,23] and distinguishes 'structures' (e.g. personnel, equipment and so on), 'processes' (e.g. activities) and 'outcomes' (results) [22]. Four measurement methods are presented in the following section that gauge mutually complementary aspects of patient safety issues (see Table 1) [1▪▪,24,25▪,26▪,27–37,38▪,39,40–56].

Incident-based learning

The measurement focus of incident-based learning is on *qualitative* understanding (Table 1). Using this case-based approach, frequently occurring and 'typical' problems, as well as rare but potentially serious events, can be described in meticulous detail [57▪]. Using an incident reporting system [1▪▪,19,26▪], these qualitative data are usually collected anonymously, and reports can be disseminated within the local institution or within the wider professional community [24]. Incident reporting is an invaluable way of learning about the essence, nature and specific mechanisms ('pathophysiology') of safety issues. Despite different concepts, morbidity and mortality conferences (MMCs) are another way of 'incident-based' learning within medical teams [1▪▪,36].

Analysis of reports using structured protocols and root cause analysis (e.g., the 'London Protocol' [12,58]) may reveal local system weaknesses, and allow tailoring of local solutions [26▪]. As root cause analysis is time-consuming and labour-intensive, more rapid but less in-depth alternative techniques have been described, which should be combined according to the context [25▪]. If specific incident patterns are frequently observed, or reveal important risks, locally adapted safety indicators can be developed and used for rate-based measurements. Interestingly, incident reporting systems appear to be most effective when owned by clinical teams and when data analysis and action implementation occur locally [26▪].

Limitations of incident reporting follow from its methodical features. Because the reference population (denominator) for a particular type of event is mostly not known, it does not make sense to calculate incident rates or use their numbers or trends as a measure of safety [1▪▪,26▪]. Other common limitations of incident reporting include many barriers [4▪,27], related underreporting, as well as hindsight bias [1▪▪]. Because incident reporting focuses on individual cases, the generalizability of insights and locally elaborated solutions is usually limited.

Many hospitals currently have incident reporting systems. In a recent review, 78.7% of responding anaesthesiologists stated that their hospital used a

Table 1. Measuring and monitoring perioperative patient safety – four complementary clinical routine approaches

Description	Measurement focus	Methodology: data type, data collection, analysis	Implications, impact	Limitations	Examples
Incident-based learning	Experience-based [24], qualitative understanding of the 'nature of safety issues'; generating hypotheses about safety mechanisms.	Qualitative data [1▪▪]; usually anonymous data collection [24]. Case-based analysis (root cause analysis; related methods [25▪]).	Insights into local system weaknesses; locally tailored solutions [26▪].	No quantitative measure of patient safety [1▪▪,26▪]. Limited generalizability. Risk of barriers and underreporting [4▪,19,27] and of hindsight bias [1▪▪].	Local hospital IR systems [24]; regional and national systems for IR dissemination [24,26▪,28–35]. MMC [36].
Rate based learning	Measurement-based quantitative understanding of the 'extent of safety issues [20]'. Quantitative trends monitoring.	Quantitative data, usually prospectively collected according to quality indicators. Quantitative data analysis (e.g., rates).	Quantitative measurement [1▪▪]. Surgical outcomes reporting may beneficially impact morbidity [37] and mortality [37,38▪]. Validated indicators available for research purposes [1▪▪].	No 'gold standard' set of indicators available for routine use. Variability/ inconsistency in denominator definition [1▪▪]. Barriers to reporting [39].	Hospital morbidity and mortality reports [2]. Quality reporting.
Staff views	Staff views on patient safety [46].	Quantitative (qualitative) survey data. Survey analysis methods.	Better safety culture associated with lower surgical morbidity [40–42] and mortality [43]. Targeted interventions may improve safety culture and patient outcomes [44,45].	Limitations of survey tool validation [46].	Safety Attitudes Questionnaire SAQ [46,47]; other survey tools [42,43,48].
Patients' views	Patients' views on patient safety. Outcomes that matter to patients (value-based care) [49].	Quantitative (qualitative) survey data. Survey analysis methods.	Patients' safety reports (PSR) associated with rates of patient harm [50,51]. PSR may contribute to reduce harm [52] and provide learning opportunities [53,54].	Limitations of survey tool validation and generalizability [54]. Impact of integrating PSR into clinical care not fully clear [52].	Patient measure of safety (PMOS) [51,52,55]; OpenNotes reporting tool [54]; patient experience questionnaire [50,56]; commercially available tools [51].

IR, incident reporting; PMOS, patient measure of safety; PSR, Patients' Safety Reports; SAQ, Safety Attitudes Questionnaire.

critical incident reporting system [18▪]. Numerous professional societies and other organizations also offer incident reporting systems, sometimes in combination with other quality data collection systems. Examples include CIRS-AINS in Germany [26▪,28], CIRRNET in Switzerland [26▪,29], SENSAR in Spain [26▪,30], SALG in the UK [26▪,31], CAIRS in Canada [32,33], webAIRS in Australia and New Zealand [34] and AIRS in the USA [35]. Some of these organizations regularly share educational examples and information about incidents [35,59].

Rate-based learning

Rate-based learning uses quantitative approaches to measure and monitor patient safety (Table 1). For mandatory or public reporting, the term 'quality reporting' is sometimes used [60]. Data are usually collected prospectively and routinely according to quality indicators and for every patient of a defined population. Data are suited for quantitative analysis, calculation of rates and trend analysis.

Outcomes are usually the most meaningful aspect from the patient's view and represent the basis for value-based healthcare, but they are still underused as indicators in routine quality improvement [49]. Importantly, anaesthesia management may impact overall postoperative complications [9▪]. Importantly, such adverse outcomes are increasingly occurring in the postoperative period [61] and may escape short-term data collection. Notably, routine quality reporting of surgical outcomes *per se* may

beneficially impact morbidity and mortality [37,38▪]. Nonetheless, only 55.7% of responding anaesthesiologists in a recent survey indicated that their hospitals produced an annual morbidity and mortality report [18▪].

There is no 'gold standard' set of indicators for rate-based learning. Adverse outcomes, such as in-hospital mortality, have limited validity as safety indicators when used in isolation [57▪]. Meanwhile, more specific, valid and evidence-based indicators are available. A recent systematic review identified eight perioperative safety and quality improvement indicators for research purposes [1▪▪,62▪▪]: surgical site infection at 30 days, stroke within 30 days of surgery, death within 30 days of coronary artery bypass grafting, death within 30 days of surgery, admission to the intensive care unit within 14 days of surgery, readmission to the hospital within 30 days of surgery and length of hospital stay (with or without in-hospital mortality) [62▪▪]. It is not clear how well these indicators can be used for routine quality improvement, but they provide a promising indicator set if the required data can be collected. In addition, mortality after major complications, also called 'failure to rescue' [1▪▪,17,63,64], is increasingly seen as an indicator for the safety of hospital care [65,66▪]. More standardized outcome indicators 'that matter to patients' are needed to realize 'value-based' healthcare [49].

Limitations of rate-based learning methods include inconsistent or variable definitions [1▪▪], cumbersome and slow reporting processes, as well as barriers and underreporting [39]. Practical examples include hospital morbidity and mortality reports [1▪▪,2], quality reporting systems run by professional societies and other organizations (e.g. the anaesthesia quality data system AQUA in Switzerland [67] and the National Anesthesia Clinical Outcomes Registry NACOR in the US [60,68]) or mandatory public reporting (e.g. mandatory in-hospital mortality reporting in Switzerland [69]).

Staff views on patient safety

Subjective views of healthcare professionals provide important additional information about local patient safety (Table 1). One widely used method is the Safety Attitudes Questionnaire (SAQ) [40,46,47,70]. The SAQ measures staff attitudes across six patient safety-related areas, and provides a snapshot assessment of safety climate [46]. Interestingly, better safety culture (measured using SAQ) has been found to be associated with lower surgical morbidity [40,41]. Using different survey tools, other studies also found associations of staff's safety perceptions with postoperative morbidity [42,48] and mortality [43]. Notably, frontline clinicians' (but not senior managers') perceptions can predict morbidity and mortality [71]. Reportedly, units with less than 60% of respondents reporting positive safety attitudes may gain the most from quality improvement efforts [44]. According to moderate level evidence, targeted interventions may improve safety culture and patient outcomes [45]. Limitations of safety attitude assessments include limitations of survey instrument validation, among others [46].

Patients' views on patient safety

The concept of value in healthcare calls for measures that include what matters from individual patient's views [49], but sufficient time is needed to talk with patients in order to understand these views. Reportedly, patients and families are willing to contribute their views on adverse outcomes and potentially contributing factors [53]. Moreover, patients' safety reports and experiences correlate with rates of actual patient harm [50,51] (Table 1). Although the impact of integrating patient's safety reporting (PSR) into active care is not fully clear [52], it may contribute to reducing patient harm when staff compliance is high [52] and may provide important learning opportunities [53,54]. More continuous patient–clinician relationships may help to better integrate patients' views [72,73], to let patients better understand clinicians and their roles [72,73], to enable shared decisions and to improve patient satisfaction [74]. Continuous patient–clinician relationships along the surgical path could be a way to optimize this interaction in anaesthesia, but they are limited by varying care organizations [75] and restricted time resources [76]. Barriers for involving patients' views may be imposed by illness severity as well as organizational, cognitive and communication-related factors, including language barriers [1▪▪]. Some of the tools used in the cited studies are freely available, for example the Patient Measure of Safety (PMOS) questionnaire [51,52,55], OpenNotes feedback reporting tool [54] and a patient experience questionnaire (Norwegian) [50,56], in addition to commercially available tools [51].

OPPORTUNITIES OF A LEARNING CYCLE FOR IMPROVING PERIOPERATIVE PATIENT SAFETY

Figure 1 visualizes how the presented methods can be used to improve patient safety, following the general concept of cyclic progress of the 'Plan, Do, Study, Act' cycles model [57▪]: either locally for developing clinical protocols and SOPs or at the general level for generating aggregated evidence.

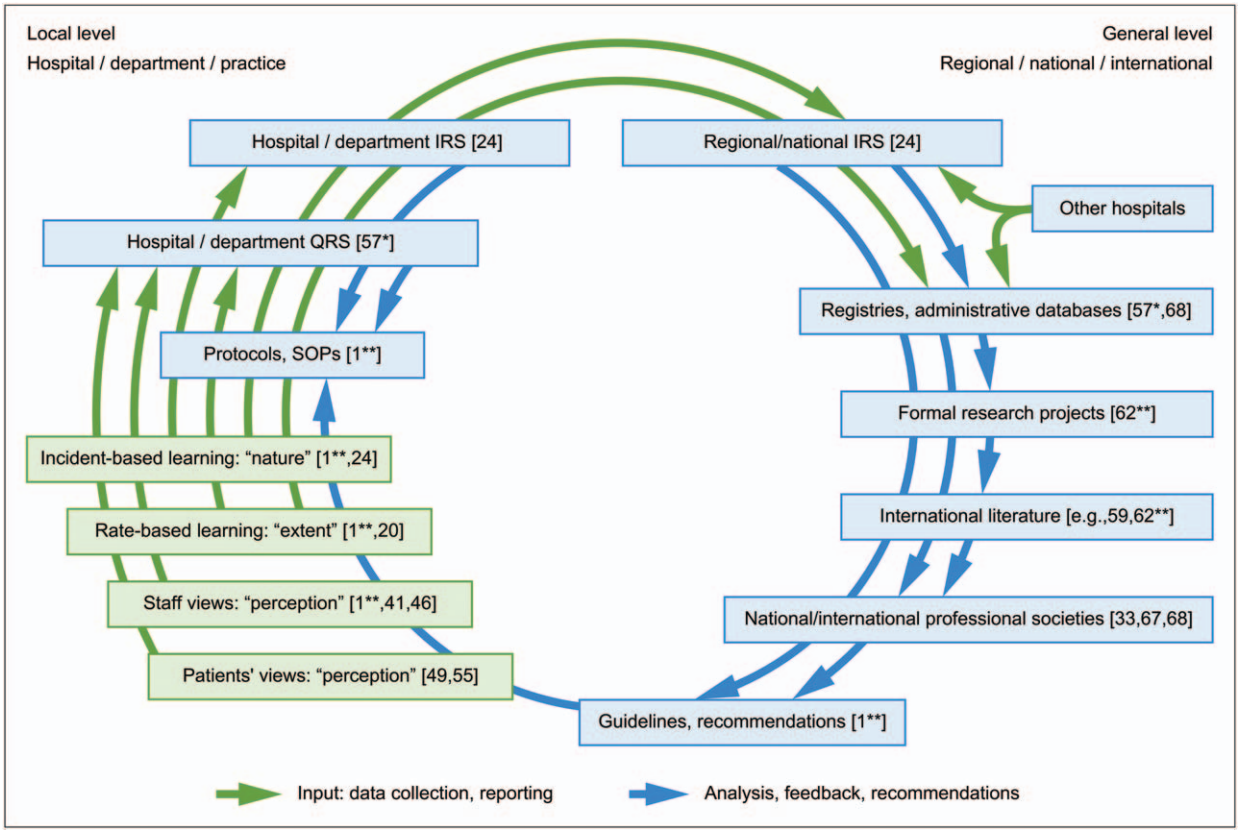

FIGURE 1. A learning cycle for improving perioperative patient safety. The learning cycle illustrates how the presented methods can be used to improve patient safety, either locally for developing clinical protocols and SOPs or at the general level for generating aggregated evidence (for details, see text). IRS, incident reporting system; QRS, quality reporting system; SOP, standard operating procedure. [Bracketed numbers] refer to numbers in the reference list. The figure was created using Microsoft PowerPoint for Mac, Version 16.16.25 (2018).

Reportedly, individual methods have helped to tailor problem solutions [26▪] and to reduce patient harm [52], morbidity [37,40–42] and mortality [37,38▪,43]. Evidence generated at the general level may be integrated into local protocols. However, research settings do not always adequately represent routine practice [77]. Hence, local quality data may help to understand if interventions tested in 'artificial' research settings do actually work in routine practice [77], thereby creating 'real world evidence'.

IMPLICATIONS FOR PRACTICING ANAESTHESIOLOGISTS

Most barriers [4▪,19,27,39] that deter clinicians from utilizing these opportunities are related to mandatory or public reporting: clinicians may fear legal consequences [27] or worry about financial losses. In view of shortcomings of the reporting process [39] and of increasing production pressure [4▪], they may also lack the time and resources needed for data collection [39]. Addressing these challenges for mandatory or public reporting may require substantial efforts in research and development of the professional and legal framework; however, their discussion is beyond the scope of this review.

Difficulties of mandatory or public reporting should not keep clinicians from the advantages offered by local patient safety learning: first, potentially improving patient outcomes; second, creating 'real world evidence' regarding safety interventions; third, meeting legal requirements for quality improvement in some countries; and fourth, staying actively involved as clinicians in the generation, analysis and dissemination of patient safety data instead of completely outsourcing safety learning to quality management departments. Clinician involvement is essential for correct data interpretation in the clinical context and for ensuring effective learning by feeding data directly back to peer clinicians [78]. For example, perioperative hypothermia contributes to perioperative morbidity and mortality, with a reported incidence between 20 and 70% of patients [79]. Incident reports followed by rate-based measurements may help to determine the local rate, and to develop tailored solutions.

Finally, implementation of the four presented learning approaches can be started at a very elementary level using basic and widely available equipment and infrastructures, but data collection and analysis without the help of advanced technologies may be more laborious. However, examples of operating professional data management systems exist for incident-based learning [28–35] and rate-based learning [67–69]. In addition, survey tools can be downloaded for free for surveying staff [47,48] and patients [41,54,55].

CONCLUSION

Current concerns of anaesthesiologists about threats to patient safety [18▪] are in line with recent reports about significant rates of preventable harm in surgical patients [6▪▪]. Anaesthesia contributes to overall perioperative risk [8,9▪], and anaesthesiologists have longstanding commitments to patient safety improvement. However, patient safety profiles vary significantly between hospitals [16,17]. Hence, *local* safety measurement would be required to achieve *local* improvement, but many barriers may impair such measurement or reporting [4▪,18▪,19,27,39]. In the absence of a generally accepted gold standard for perioperative patient safety measurement, and given the opportunities that such measurements can offer for improving patient outcomes [26▪,37,38▪,40–43,52], four mutually complementary measurement approaches using widely available infrastructures in hospitals may help practicing anaesthesiologists as self-improvement tools: incident-based and rate-based measurements, staff surveys and patient surveys (Table 1). Future research and practice development should clarify, among others, how perioperative safety measurement requirements can be better aligned with clinical duties and workflow [39], which indicators actually 'matter for patients [49]', which can be best utilized beyond research purposes for quality improvement [62▪▪], and how to address common barriers [39]. Meanwhile, the potential for improving patient outcomes supports a pragmatic local approach to perioperative patient safety measurement.

Acknowledgements

None.

Financial support and sponsorship

The work for this review was funded exclusively by the author. Assistance with manuscript editing and formatting was obtained from American Journal Experts (AJE, Durham, North Carolina, USA; http://www.aje.com/en).

Conflicts of interest

The author is Past Chair of the Patient Safety and Quality Committee, European Society of Anaesthesiology (ESA), Brussels, Belgium; Member of the Data and Quality Committee, Swiss Society for Anaesthesiology and Resuscitation (SGAR), Bern, Switzerland; Associate Lecturer, University of Zurich, Switzerland; and Lecturer, Z-INA Nursing School, Zurich, Switzerland.

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