An introductory guide to quality improvement in perioperative medicine

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What is QI?

In the Japanese healthcare system, QI often means “Quality Indicator,” which refers to measuring the quality of healthcare quantitatively with numbers or statistics, such as how many patients fall during hospitalization or how often surgical site infection occurs. However, in general, QI refers to “Quality Improvement” and encompasses a larger concept of improvement in healthcare. In this context, QI in healthcare can be defined as a systematic framework to improve patient care with long-term, continuous, and sustainable changes [1, 2]. From here on, we will refer to QI as Quality Improvement, and it is worth noting that its history in healthcare spans over at least the past 100 years [3]. The Donabedian model was the initial framework for healthcare quality, which includes elements of structure, process, and outcomes. This model laid the foundation for the Institute for Healthcare Improvement’s (IHI) Model for Improvement with three types of measures (outcome, process, and balancing) [4]. Currently, QI is considered a fundamental part of modern medicine in many countries, for physicians and is even taught to medical students [5]. In many healthcare systems, we recognize there can be a significant gap between what we learn from clinical research and what we do in our daily practices [6]. It is quite common to encounter

situations where we cannot adapt the results from randomized controlled trials and systematic reviews, or even apply guidelines as intended to achieve the best outcomes for the patients we see and treat. Evidence-based medicine (EBM) focuses on “doing the right things” and pursuing the best medicine, while QI focuses more on “doing things right” and determining how to implement changes [7]. These concepts do not conflict, rather complement each other. They are inseparable for developing better clinical outcomes, although QI has different scientific approaches than clinical trials (Table 1).

Running a QI project may sound difficult, but it simply requires understanding and following a general, structured flow. First, one must clarify the clinical goal, which is motivated by providing better patient care in the institute. QI’s target in healthcare is well known as the “Triple Aim” which refers to improving patient outcomes, enhancing the patient experience, and reducing per capita healthcare cost. One of these three aims is set as a primary outcome of the QI project. Second, one must specify the project aim in the form of an Aim Statement using SMART criteria (SMART is an acronym meaning Specific, Measurable, Achievable, Realistic, and Timely). Of note, one must be careful not to rush to a solution as it is important to take the time to characterize the causes of a target issue or understand the relevant processes in the local context. After developing the aim, a multidisciplinary dedicated team is organized to conduct a root cause analysis for detecting specific causes of the target issue from diverse perspectives. The team presumes the barriers or obstacles for the improvement and discusses which items can be improved in the institute by considering available human resources, financial circumstances, and stakeholders’ engagements. Generally speaking, a successful QI project is supported by multiple departments, involving chiefs in clinical service and hospital executives. The team decides which data to collect for the outcome, process, and

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Table 1 Comparison of approaches: randomized controlled trial and quality improvement for a hypothetical QI Project

	Randomized controlled trial	Quality improvement
Motivation	Clinical question E.g., what is the best treatment for preventing maternal hypotension after neuraxial anesthesia during cesarean delivery?	Clinical goal E.g., how to improve maternal experience during cesarean delivery under neuraxial anesthesia?
Participant	Limited (strict inclusion & exclusion criteria) E.g., elective cesarean delivery under fix-dosed spinal anesthesia at term, singleton, aged between 18 and 50 years, no hypertension, no diabetes, no cardiac co-morbidities, etc.	Opened (minimal exclusion) E.g., elective cesarean delivery under neuraxial anesthesia with a clinical decision made by in-charge anesthesiologists at the local hospital between January and December of the same year (i.e., one calendar year)
Intervention	Simple, commonly single intervention E.g., norepinephrine for maintaining maternal blood pressure with 1L fluid loading and 15-degree LUD until delivery for all participants, protocol violations would be excluded from the analysis	Complicated, often multilayered involving interdepartmental changes E.g., bundle of care: 1. Updating preoperative ordering allowing fluid intake ≤ 2 hrs with educating nurses; 2. Encouraging anesthesiologists to check blood pressure every minute and give vasopressors prophylactically; and, 3. Asking obstetricians to keep LUD until delivery
Comparison	Parallel E.g., phenylephrine infusion of 50 mcg/min^{-1} with norepinephrine 2.5 mcg/min^{-1}	Chronological E.g., standard practice in January (before implementing the change) and in December (after implementing the change) of the same year
Outcome	Specific E.g., difference in maternal blood pressure, the incidence of maternal hypotension & bradycardia, umbilical arterial pH, neonatal status, estimated blood loss, adverse events (hypertension, nausea & vomiting, etc.)	Comprehensive E.g., 1. Outcome measure; patient-reported experience during cesarean delivery, length of stay, etc., 2. Process measurement; implementation rate of preop fluid intake, prophylactic vasopressor use, the implementation rate of LUD; and 3. Balancing measure; the incidence of preop fluid intake within 2 h before surgery
Conclusion	Universal E.g., norepinephrine is better for preventing maternal hypotension after spinal anesthesia compared with phenylephrine	Local E.g., the bundle of care improved mothers' intraoperative experience during surgery and shortened length of stay in "our" hospital

RCT randomized controlled trial, QI quality improvement, LUD left uterine displacement

balancing measurements to provide the evidence that will show how clinical outcomes change due to the improvement. To achieve continuous QI, the project should be monitored using improvement tools, such as the Plan–Do–Study–Act (PDSA) cycle, and Six Sigma and Lean strategies [8]. The PDSA cycle is the most commonly applied tool for QI due to its simplicity and feasibility. This model provides a framework of improvement for establishing, examining, and implementing changes; Plan—think out what we should change; Do—test the change; Study—learn from the results of the change; and, Act—upgrade the regular protocol (Fig. 1). We have created a project example to demonstrate using the PDSA cycle for continuous QI.

In our hypothetical QI example, an obstetric anesthesia team receives negative feedback from patients about uncomfortableness related to an elective cesarean delivery. The

team finds that preoperative thirst is the leading cause of the patients' complaints, so they attempt to shorten the period of NPO order for clear fluid before surgery. As obstetricians routinely order the NPO, the anesthesia team thinks that if anesthesiologists make the order, patients will drink clear fluid as much as possible before surgery (Plan). The team picks a week for testing the new preoperative NPO elective order (Do), followed by analyzing the number of NPO violations. The analysis reveals that only 5% of the patients take clear fluid within 2 h before surgery (Study), and the team decides to implement the new NPO order to upgrade their daily practice (Act). The PDSA cycle is then repeated on the change to their practice to measure if an improvement is observed. Most QI projects require several PDSA cycles, and the team adjusts the protocol until they observe the improvement. The improvement can be visualized using a Shewhart control chart (Fig. 2).

Fig. 1 The model for improvement

Perioperative quality improvement: what anesthesiologists can contribute?

Like other specialties, anesthesia has been developing QI in perioperative medicine, and Chahal et al. recently published their elegant QI project in *Anaesthesia* [9]. They conducted a five-year QI project with four-staged implementations in Melbourne, Australia, and achieved a significant reduction in perioperative venous thromboembolism (VTE) (from 3.1 per 1,000 to 0.6 per 1,000). The hospital realized that the generally applied 'one-size-fits-all' approach did not address patient-specific risk and considered clinical balance between VTE prophylaxis and bleeding. After a baseline audit, they developed the surgical-thrombo-embolism-prevention (STEP) QI program with a multidisciplinary team involving hematology, anesthesia, surgery, pharmacy, nursing, and hospital stakeholders/executives. The STEP assessed both surgical risks (low/intermediate/high/major abdominopelvic) and medical risks (age, BMI, heart failure, platelet count, hyperfibrinogenemia, estrogen therapy, active cancer, preoperative immobility, history of VTE, pregnancy) for developing VTE, and they created a comprehensive algorithm which encompassed specific recommendations and helped frontline providers decide VTE prophylaxis. Implementing the algorithm significantly increased their VTE prophylaxis rate from 69 to 91%. Furthermore, they found a statistically significant reduction of postoperative bleeding complications from 10.0 to 6.3 in 1,000 (relative risk reduction 37%, $p=0.02$). They implemented multiple interventions, including staff education, mandatory risk assessment, a smartphone application, medication chart modification, nurse involvement, and an e-learning module. While results from a QI project are occasionally difficult to generalize because each institute has different practices, and although

Fig. 2 An example of successful Shewhart control chart. *UCL* upper control limit, *CL* center line, *LCL* lower control limit, *PDSA* Plan-Do-Study-Act. The primary purpose of a control chart is to monitor the data stability by visualizing the sequential improvement. *UCL* and *LCL* are calculated by the mean ± 3 standard deviations, *CL* rep-

resents the mean value, and data outside the control limits are considered abnormal. As long as data are normally distributed, there is 0.3% chance of the outliers occurring. The figure shows significant improvements after running two cycles of *PDSA* with considerable changes in control limits

the external validity of this QI project needs to be assessed, the magnitude of this specific QI project's achievement is a valuable lesson for clinical quality improvers (CQI) who conduct and drive QI projects in other institutes.

Clinical quality improver: a novel academic career

The traditional academic pathway is built on scientific publications detailing research done by clinician–scientists, but in the last 2 decades this pathway is becoming more open to clinician–educators as well. Expanding promotion criteria beyond traditional scholarship enables CQIs to also have a career in academia [10]. Currently, academic medical centers in the UK and North America have been striving to improve care quality with strong leadership by CQIs [11]. The realm of QI projects and associated publications in academic journals is growing this field scientifically. The Standard for Quality Improvement Reporting Excellence (SQUIRE) guidelines provide a standard for reporting on QI projects [12], analogous to the CONSORT guidelines for randomized controlled trials [13]. The SQUIRE guidelines provide a framework to report QI projects in healthcare, thus bringing an academic and scholarly lens to these projects. Authors must report a problem description, available knowledge, the rationale behind the interventions, and specific aims following the guidelines, allowing other CQIs to understand clearly why the QI project was implemented. A search of the PubMed database for publications with the

term “quality improvement” in their title or abstract returns 407 publications in 2000 compared to 5,687 publications by the end of 2020 (PubMed accessed on December 29, 2020).

How and where to learn QI

Although QI is gaining popularity in healthcare, in regions where in-person training courses are not available, there appears to be less QI being learned and undertaken. Several key textbooks help one to systematically learn QI, such as *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance* [14] and *The Health Care Data Guide: Learning from Data for Improvement* [15]. Moreover, high-quality online materials are provided by credible organizations. For example, the Institute for Healthcare Improvement, located in Boston, has been a leading organization in QI and provides educational materials through its Open School, a series of comprehensive courses to learn the fundamentals of QI and implement a QI project in a local setting with mentorship support [16]. BMJ Quality & Safety provides various review articles for QI, specifically aiming at how to educate QI in junior faculty members [17], how to learn QI from publications [7], and how to become a champion leader in QI [18]. To deepen QI knowledge, online Master's level courses are also available from several universities, such as Johns Hopkins [19], which have a range of tuition costs. Like in other clinical practice areas, one needs formal education, including didactic lectures, and practical training with mentors, and opportunities to address

clinical issues. Our hope is to see QI continue to be used by physicians to contribute to improving healthcare systems and resulting in improved patient outcomes.

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