Optimizing opioid prescribing practices after minimally invasive lung resection through a quality-improvement intervention

Evan Barber, MD
Melissa Whidden RD, MHE
Francisco Aguirre, PEng, MBA
Andrew Graham, MD

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Correspondence to:
E. Barber
Division of Thoracic Surgery
Room B211, 1702 20th St W
Saskatoon SK S7M 0Z9
evan.barber@gmail.com

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Background: In their 2019 guideline on the prescribing and management of opioids after elective ambulatory thoracic surgery, the Canadian Association of Thoracic Surgeons (CATS) recommended 120 morphine milligram equivalents (MME) after minimally invasive (video-assisted thoracoscopic surgery [VATS]) lung resection. We conducted a quality-improvement project to optimize opioid prescribing after VATS lung resection.

Methods: We assessed baseline prescribing practices for opioid-naive patients. Using a mixed-methods approach, we selected 2 quality-improvement interventions: formal incorporation of the CATS guideline into our postoperative care pathway, and development of a patient information handout regarding opioids. The intervention was initiated on Oct. 1, 2020, and was formally implemented on Dec. 1, 2020. The outcome measure was average MME of discharge opioid prescriptions, the process measure was proportion of discharge prescriptions exceeding the recommended dosage, and the balancing measure was opioid prescription refills. We analyzed the data using control charts, and compared all measures between the pre-intervention (12 mo before) and postintervention (12 mo after) groups.

Results: A total of 348 patients who underwent VATS lung resection were identified, 173 before the intervention and 175 after the intervention. Significantly less MME was prescribed after the intervention (100 v. 158, $p < 0.001$), and a lower proportion of prescriptions were nonadherent to the guideline (18.9% v. 50.9%, $p < 0.001$). Control charts showed special cause variation corresponding with the intervention, and system stability existed after the intervention. There was no statistically significant difference in the proportion or dosage of opioid prescription refills after the intervention.

Conclusion: After implementation of the CATS opioid guideline, there was a significant reduction in opioids prescribed at discharge and no increase in opioid prescription refills. Control charts are a valuable resource for monitoring outcomes on an ongoing basis and for assessing the effects of an intervention.

Contexte : La ligne directrice de l'Association canadienne de chirurgie thoracique (ACCT) sur la prescription et la prise en charge des opioïdes après une chirurgie thoracique ambulatoire non urgente, publiée en 2019, recommande 120 mg d'équivalent morphine par jour (ÉMJ) à la suite d'une résection pulmonaire à effraction minimale (chirurgie thoracique vidéo-assistée, CTVA). Nous avons mené un projet d'amélioration de la qualité pour optimiser la prescription d'opioïdes après cette opération.

Méthodes : Nous avons évalué les pratiques de prescription initiales chez des patients n'ayant jamais pris d'opioïdes. Avec une approche de méthodes mixtes, nous avons sélectionné 2 interventions d'amélioration de la qualité : l'intégration officielle de la ligne directrice de l'ACCT à notre parcours de soins postopératoires et l'élaboration d'un document d'information sur les opioïdes à l'intention des patients. L'intervention a démarré le 1er octobre 2020 et a été officiellement mise en œuvre le 1er décembre 2020. L'indicateur de résultat était l'ÉMJ moyen des ordonnances d'opioïdes au moment du congé; l'indicateur de processus était la proportion d'ordonnances au moment du congé dépassant la posologie recommandée; et l'indicateur d'équilibre était le nombre de renouvellements d'ordonnances d'opioïdes. Nous avons analysé les données avec des cartes de contrôle et avons comparé tous les indicateurs entre les groupes préintervention (12 mois avant) et postintervention (12 mois après).

Résultats : Nous avons répertorié un total de 348 patients ayant subi une résection pulmonaire par CTVA, 173 avant l'intervention et 175 après. L'ÉMJ prescrit était significativement inférieur après l'intervention (100 mg c. 158 mg, $p < 0{,}001$) et une proportion moindre des ordonnances ne respectaient pas la ligne directrice (18,9 % c. 50,9 %, $p < 0{,}001$). Les cartes de contrôle ont montré une variation due à des causes

spéciales correspondant à l'intervention et une stabilité du système après celle-ci. Nous n'avons observé aucune différence statistiquement significative pour la proportion ou la posologie des renouvellements d'ordonnances d'opioïdes après l'intervention.

Conclusion : La mise en œuvre de la ligne directrice de l'ACCT sur les opioïdes a été suivie d'une diminution importante des opioïdes prescrits au moment du congé et de renouvellements d'ordonnances d'opioïdes inchangés. Les cartes de contrôle sont une ressource utile pour la surveillance des résultats en continu et l'évaluation des effets d'une intervention.

Canada is currently experiencing a crisis of opioid misuse. In 2016, there were 2861 apparent opioid-related deaths in the country, and, on average, 16 patients were admitted to hospital daily with opioid-related poisoning.[1] Although illicit opioid production remains a major factor, prescription medication is also driving the problem. Canada is the second-largest consumer of prescription opioids in the world, with more than 20 million prescriptions dispensed in 2016.[1,2] In the province of Alberta, in 2017, 66% of apparent opioid-related accidental deaths occurred within 30 days of filling an opioid prescription.[1] As opioid prescribers, surgeons are faced with the responsibility of helping patients achieve adequate pain control while minimizing harm at the individual and societal levels. Systematic reviews have identified that about 40%–95% of opioid pills prescribed postoperatively are never consumed,[3,4] which suggests that practices can be optimized to reduce overall supply without sacrificing adequate analgesia.

Relative to other surgical cohorts, patients undergoing thoracic surgery are the most likely to be opioid-naive preoperatively and to have persistent opioid use postoperatively.[5,6] Although pain after thoracic surgery is notable for its potential intensity and duration,[7] surgical teams' prescribing practices likely contribute to new persistent opioid use postoperatively.[8] In a retrospective population-based study, the quantity of opioids used postoperatively was most strongly associated with the amount prescribed, with an additional 5 pills taken for every 10 prescribed.[9] Determining an appropriate quantity of opioids to prescribe postoperatively is largely nonstandardized and remains a challenge for surgeons, although several consensus statements and guidelines have addressed postoperative opioid use.[10–12] In 2019, the Canadian Association of Thoracic Surgeons (CATS) published a guideline on the prescribing and management of opioids after elective ambulatory thoracic surgery, in which they recommend standardized quantities of opioids to be prescribed after minimally invasive and open procedures.[13] This guideline presented a comparative standard to assess opioid prescribing practices after thoracic surgery at our centre, and to determine whether an opportunity for improvement existed.

There is increasing recognition that patients experience avoidable harm and unwarranted variations of care;[14] the set of approaches to address these concerns is known as quality improvement. Organizations such as the Institute for Healthcare Improvement provide resources for quality improvement, and a variety of methodologies, such as Six Sigma and Lean, have been adapted from other fields. A common feature of quality-improvement work is the use of implementation science supported by techniques of statistical process control such as run charts and control charts.[15,16] These techniques may be unfamiliar to many surgeons, as, traditionally, outcomes in surgery are measured over a fixed period of time and are reported with the use of descriptive or comparative statistics. In a quality-improvement approach, data must be measured and reported more frequently over time to assess the impact of changes and ensure the reliability of the system;[17,18] methods of statistical process control are most commonly used in this setting.

The evidence for the benefits of quality-improvement approaches to health care improvement remains mixed.[19] In a surgical setting, the use of structured improvement techniques has been infrequently reported and often has focused on access to care such as reduction in surgery cancellations.[20] Further study of the use of quality-improvement approaches within surgery is warranted. The goal of our work was to assess the baseline opioid prescribing practices of our group and improve them through a structured quality-improvement intervention.

Methods

Before this project, discharge opioid prescribing by our group was at the discretion of individual prescribers, without standardization. Assessment of our baseline opioid prescribing practices after minimally invasive thoracic surgery showed that the practices were not optimal, as compared to the CATS guideline.[13] We thus implemented an intervention that used both implementation science and the use of process control charts as analytical tools to optimize opioid prescribing practices of the thoracic surgery team, consisting of 6 surgeons, 2 nurse practitioners and, typically, 1–3 rotating resident physicians.

Cohort

The patients included in this study were a cohort of patients undergoing minimally invasive (video-assisted thoracoscopic surgery [VATS]) lung resection, as identified in the Operating Room Information System, an

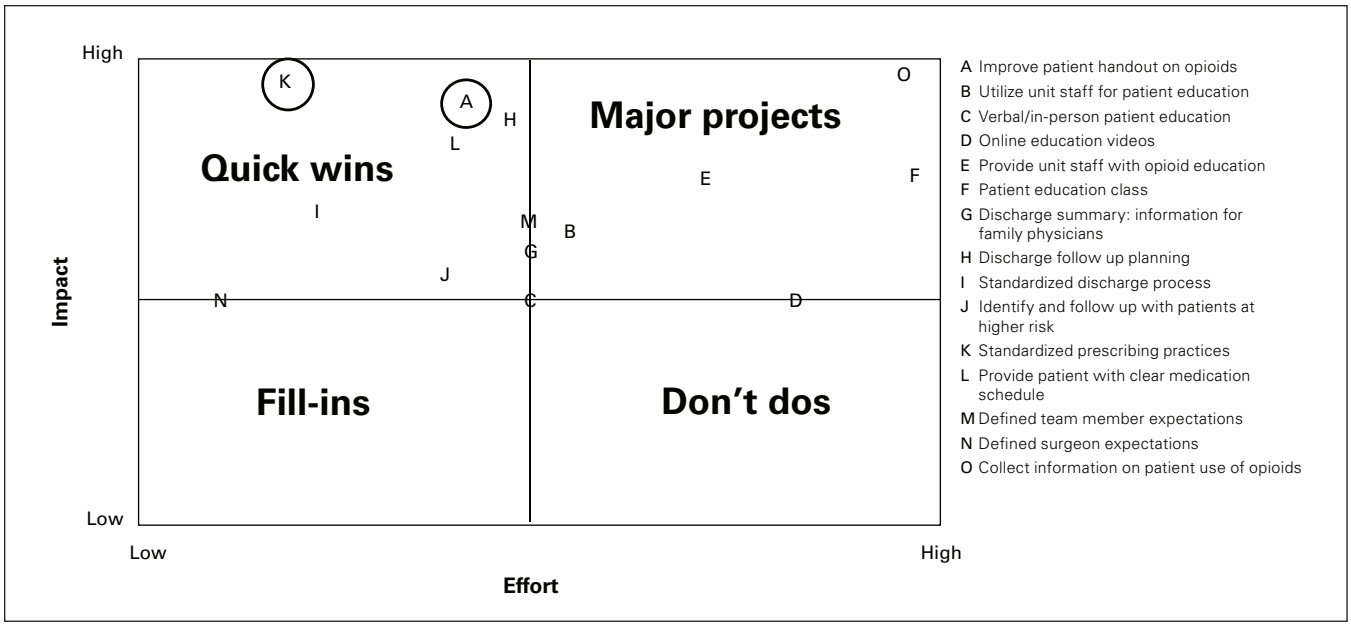

Fig. 1. Action priority matrix resulting from the quality-improvement process. Team meetings identified possible interventions, which were ranked according to expected impact and effort; 2 were chosen for implementation: "A" and "K."

institutional database at the Foothills Medical Centre, Calgary, Alberta. Opioid-naive patients who underwent VATS lobectomy, segmentectomy or wedge resection performed in the 12 months before or the 12 months after the quality-improvement intervention were included. Patients were classified as opioid naive if they had not filled any opioid prescriptions between 12 months and 31 days before their procedure, as described previously.[21]

Opioid prescribing ascertainment

To ascertain the patients' opioid prescription history, a unique linkage of an institutional database and a provincial database was developed. Once the cohort of surgical patients was identified in the institutional Operating Room Information System, a patient identifier was linked to the provincial Alberta Netcare Electronic Health Record Pharmaceutical Information Network, which records all prescriptions dispensed from pharmacies in Alberta. All prescriptions for opioids were extracted from the network. To allow for the variety of opioids prescribed, we converted the prescriptions to morphine milligram equivalents (MME) using a standardized table provided by Alberta Health Services. The data were updated monthly to a Web-based dashboard. We confirmed the accuracy of the data by examining the health records of a convenience sample of patients who had undergone minimally invasive lung resection.

Intervention

The quality-improvement project was defined in 3 phases: pre-intervention phase, intervention phase and postintervention phase. The pre-intervention phase consisted of the 12 months before initiation of the intervention. In this phase, we collected opioid prescribing data for patients discharged between Oct. 1, 2019, and Sept. 30, 2020.

The quality-improvement intervention was initiated on Oct. 1, 2020, and was formally implemented on Dec. 1, 2020. We used a mixed-methods approach, with the guidance of a quality-improvement consultant. First, the thoracic surgeons received individualized prescribing reports comparing their practices to the CATS guideline, and these data were discussed as a team. Second, the quality-improvement consultant conducted one-on-one semistructured interviews with 12 team members to identify factors contributing to prescribing variation and to brainstorm possible solutions. The consultant identified themes, which were presented to the thoracic surgery team. We used an action priority matrix activity[22] in which the interventions were ranked according to expected impact and effort to select 2 interventions for implementation in a plan–do–study–act cycle: improve the patient handout containing information on opioids, and standardize opioid prescribing practices for patients undergoing lung resection (Figure 1).

The surgeons agreed to use the dosage of 120 MME recommended in the CATS guideline[13] as the standard quantity for patients having undergone VATS lung resection; it was acknowledged that practitioner judgment could result in lower or higher quantities prescribed. The new prescribing guideline was incorporated into documentation for our clinical pathway for patients undergoing lung resection and distributed to the team. Also added to the postoperative pathway were scheduled acetaminophen for 7 days and nonsteroidal anti-inflammatory drugs for 3 days,

assuming no contraindications. Intraoperative medications remained at the discretion of the anesthesiologist.

In collaboration with nurse practitioners, thoracic surgeons, patients and educators, a new handout to facilitate patient teaching at discharge was created and implemented throughout the unit.

The postintervention phase consisted of the 12 months after the intervention was implemented, during which we assessed whether a reduction in opioids prescribed at discharge had occurred and, if so, whether it was maintained. The postintervention cohort was defined by a discharge date from Dec. 1, 2020, to Nov. 30, 2021.

Measures

Outcome measure: discharge prescriptions

We attributed opioid prescriptions dispensed within 3 days of discharge to the thoracic surgical team at the time of hospital discharge and referred to them as "discharge prescriptions." We selected the 3-day window because, in Alberta, opioid prescriptions must be filled within 48 hours of the prescription. In addition, the 3-day window has been adopted in previous studies examining opioid prescribing.[23] We defined the outcome measure as mean MME of discharge prescriptions.

Process measure: nonadherence to opioid dosage guideline at discharge

We converted the CATS guideline for opioid discharge prescriptions[13] to 120 MME to allow comparison with various opioids. We defined the process measure as the proportion of discharge prescriptions nonadherent to this guideline.

Balancing measure: postoperative refills of opioid prescriptions

Postoperative refills were considered to be any prescription filled for opioids 4–90 days after discharge, consistent with previous publications.[21] These may have been prescribed by any provider in Alberta. We defined the balancing measure as the mean MME of refill prescriptions (those without a prescription were included in calculations as 0 MME) and the proportion of patients who received them.

Analytic framework

To compare the pre- and postintervention data, we assessed each measure using 2 analytic strategies: traditional hypothesis testing and statistical process control methods with control charts. For control charts, we used rules for identifying special cause variation, as described by Montgomery and colleagues.[24] We created subgroups for control charts using the first and second half of every month to achieve 24 subgroups for the pre-intervention phase and 24 subgroups for the postintervention phase (20–30 subgroups are generally recommended for analysis[15,25]). We constructed control charts for each measure as previously described[25] to both identify special cause variation associated with the intervention and establish whether changes were maintained over time in a stable fashion. We performed all analysis using the QI Macros extension (KnowWare International) for Excel (Microsoft Corporation). Data collected during the 2-month intervention period are included graphically in the figures but were excluded from calculations. We considered p values less than 0.05 to be significant.

For the outcome measure of discharge prescriptions (average MME), we performed 2-sample t tests with unequal variance. We constructed X-bar and S control charts to assess the mean MME prescribed, standard deviation (SD) and variation in practice over time.

For the process measure of nonadherence to the opioid dosage guideline at discharge, we performed 2-proportion tests. We constructed p-charts to assess the proportion of prescriber nonadherence to opioid guidelines.

Finally, for the balancing measure of postoperative opioid prescription refills (mean MME and proportion of patients receiving refill), data on this measure were immature from September 2021 to November 2021, and this period was excluded from calculations. We used 2-sample t tests with unequal variance to assess mean MME, and 2-proportion tests to compare the proportion of patients who received refills. We used X-bar and S control charts to assess the mean MME prescribed and SD, and variation over time, and p-charts to assess the proportion of patients who received refill prescriptions.

Results

A total of 173 opioid-naive patients underwent VATS lung resection in the 12 months before the intervention, and 175 in the 12 months after the intervention. The data for all 348 were included for analysis.

Discharge prescriptions

Before the intervention, a mean of 158 MME (SD 155 MME) was prescribed at discharge, compared to 100 MME (SD 72 MME) after the intervention. On average, after the intervention, patients filled discharge prescriptions for 58 fewer MME, a significant difference (95% confidence interval [CI] 27.9 to 91.7). The X-bar chart showed special cause variation, with lower quantities prescribed after the intervention, indicating a significant desired change (Figure 2A). The variability of the average discharge prescription dosage also showed a significant decrease on the S-chart (Figure 2B). The average MME of discharge prescriptions after the intervention showed only common cause variation, indicating maintenance of the change over time (Figure 2C).

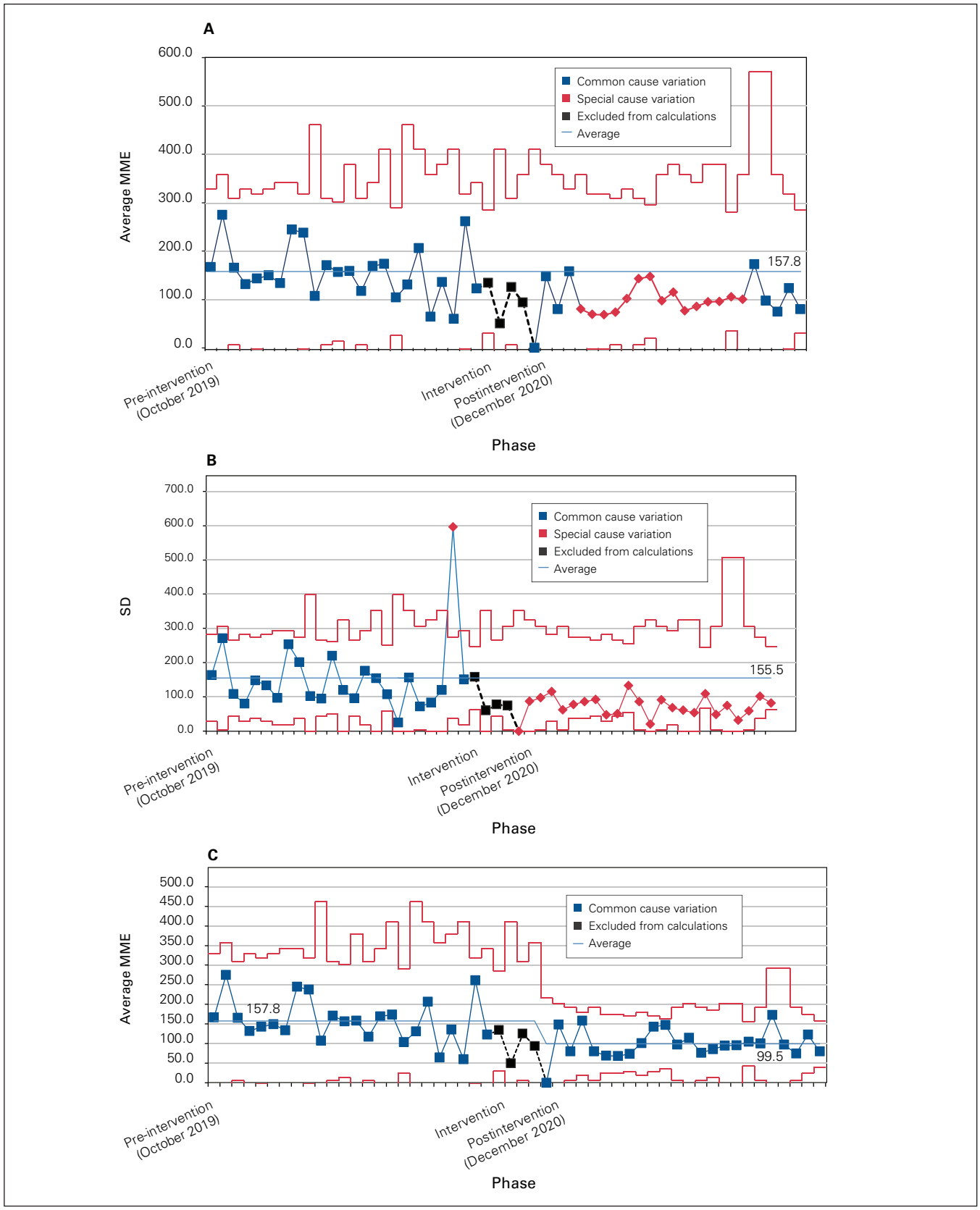

Fig. 2. A) Average morphine milligram equivalents (MME) of discharge prescriptions. Outcome measure is an X-bar chart of opioid discharge prescriptions. B) Standard deviation (SD) of discharge prescription MME. Outcome measure is an S-chart of opioid discharge prescriptions. C) Average MME of discharge prescriptions. Outcome measure is an X-bar chart to assess stability of discharge prescriptions after the quality-improvement intervention. In all panels, the red line represents the control limit, 3 SDs from mean. Subgroups are semimonthly.

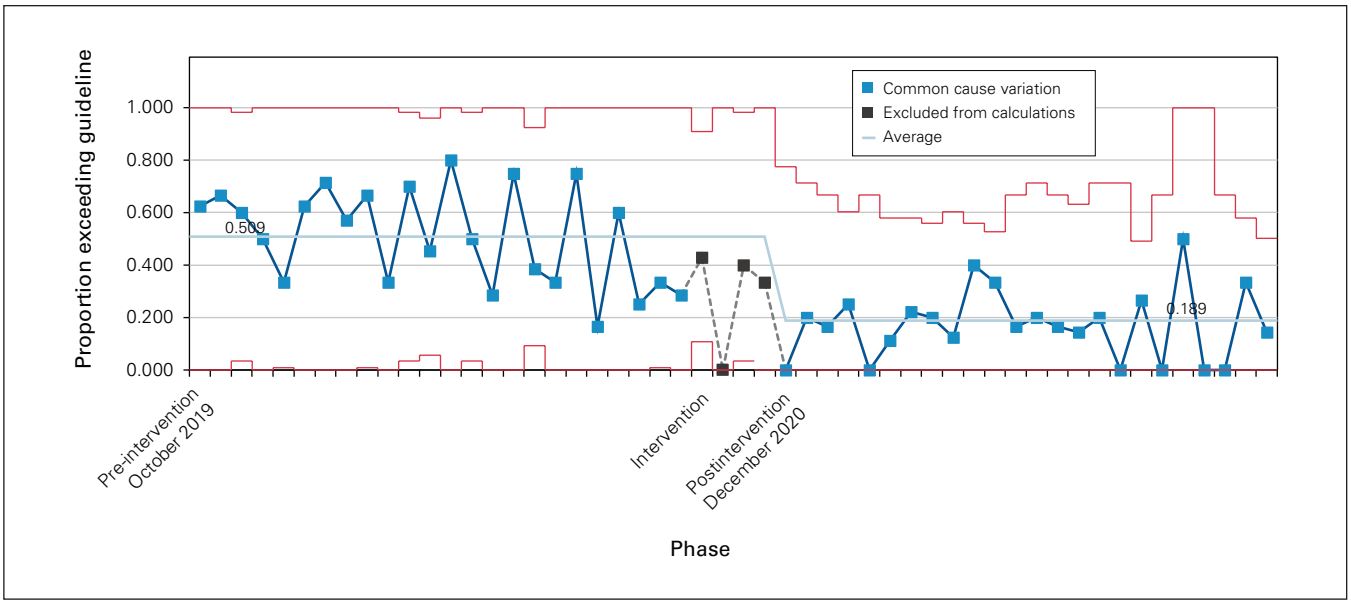

Fig. 3. Proportion of opioid prescriptions nonadherent to the Canadian Association of Thoracic Surgeons discharge prescribing guideline.[13] The process measure is a p-chart assessing the stability of practitioner nonadherence to the guideline after the quality-improvement intervention. The red line represents the control limit, 3 standard deviations from mean. Subgroups are semimonthly.

Nonadherence to opioid prescribing guideline at discharge

Before the intervention, 50.9% (88/173) of patients were discharged with higher quantities of opioids than recommended in the CATS guideline. After the intervention, on average, 18.9% (33/175) of prescriptions exceeded the standard, indicating a significant absolute reduction of nonadherence of 32.0% (95% CI 22% to 41%). In the p-chart, special cause variation indicated improved adherence after the intervention; only common cause variation was seen after the intervention, confirming stability of the change (Figure 3).

Postoperative refills of opioid prescriptions

The proportion of patients who received a prescription refill increased from 18.5% (n = 32/173) before the intervention to 22.0% (n = 30/136) after the intervention, a nonsignificant difference (p = 0.2 for 1-tail test assuming more patients would receive a prescription, 95% CI –5.5% to 12.6%). Regarding the MME of refill prescriptions, 2 patients were significant outliers, receiving quantities greater than 10 SDs above the mean for their respective phase cohorts; 1 was in the pre-intervention group (29 700 MME), and the other was in the postintervention group (70 000 MME). Without excluding these outliers, after the intervention, there was an average increase of 360 MME in refill prescriptions, which did not reach statistical significance (p = 0.3 for 1-tail test assuming an increase in mean MME, 95% CI –715 MME to 1435 MME). Excluding these 2 outliers, the average increase of MME prescribed after discharge was 17 MME, which also did not reach statistical significance (p = 0.4 for 1-tail test assuming an increase in mean MME, 95% CI –93 MME to 126 MME).

The X-bar chart for mean MME of refill prescriptions showed 3 subgroups with special cause variation both before and after the intervention that appeared unrelated to the intervention. The proportion of patients who received refill prescriptions showed only common cause variation on the p-chart, indicating no significant change in the balancing measure after the intervention.

Discussion

As part of a quality-improvement initiative, the CATS guideline on the prescribing and management of opioids after elective ambulatory thoracic surgery[13] was formally incorporated into our group's postoperative pathway. After this intervention, the quantity of opioids prescribed at discharge decreased by 58 MME on average (about 15 mg of orally administered hydromorphone). The rate of nonadherence to the CATS guideline decreased from 51% to 19%, with no significant increase in refill prescriptions. The improvement seen in prescribing practices was maintained at 1 year.

We believe that 2 components of our quality-improvement intervention were especially fundamental to its success. The first was direct involvement of the clinical team in all aspects of the process, including a structured approach to reviewing outcome data, brainstorming and prioritizing solutions with the help of a quality-improvement consultant. Surgical teams may be tempted to move directly to solutions, such as implementing prescribing guidelines, while bypassing the additional steps of a quality-improvement intervention. Although we did not

formally study the team's attitudes after the intervention, we suspect that the team's investment in a formal process created clarity of goals, awareness of the problem, desire for improvement and less resistance to change. Our results are consistent with those of a recent study, which showed similar improvement in opioid prescribing outcomes with the use of a formal quality-improvement strategy.[26]

The second important component of the intervention was the use of control charts. Although control charts will be unfamiliar to many surgical teams, we advocate that the investment in learning to create and interpret these analytic tools is valuable. Outside of improvement initiatives, control charts allow frequent assessments of an outcome over time and help to differentiate expected variability from significant unexpected variability that requires further investigation. In the setting of improvement initiatives, control charts identify whether a change has occurred in the intended direction and whether the change can truly be attributed to the intervention; allow timely feedback to the team regarding ongoing performance; and allow for greater insight into what events are driving changes in outcome measures. We also report aggregate pre- versus postintervention measures because of their familiarity to clinicians and their ability to concisely describe the outcome measure.

Limitations

An asset to this project was the ability to obtain accurate data regarding prescribed MME by linking an institutional database to the provincial pharmacy information system. We found that an automated linked system was more complete and efficient than manual chart audits and allowed for monthly updates and reports regarding outcomes of interest.

A limitation of our approach is potential misallocation of prescribing measures, such as attribution of all prescriptions within 3 days to the surgical team when they actually may have been written by care providers not involved with the surgical team. However, we believe that this occurred infrequently; furthermore, including all prescriptions regardless of provider more fully represents the patient postoperative pain experience. A further limitation of our approach is that we did not have information on the number of tablets taken as opposed to filled. This additional information would be valuable at further refining opioid prescribing guidelines but would require different methods of data collection. Balancing measures other than opioid prescription refills, such as visits to the emergency department, could also be considered; however, these would likely be subject to more variables and be more difficult to attribute to the intervention.

The generalizability of our results may be limited for clinical teams that do not have consistent care providers doing the majority of the discharge prescribing. However, a component of our prescribing team is rotating providers, including weekend-only coverage, so we believe the use of the CATS guideline[13] would be helpful to surgical teams with more prescribers. In particular, attention to the orientation of rotating care providers and formalized care pathways may help overcome this barrier. Preprinted or computer-based prescriptions may also facilitate standardized prescribing, although this was not possible in our case, as paper-based triplicate pads were required for opioids. Going forward, we plan to sustain improvement by monitoring our opioid prescribing practices using control charts with the outcome, process and balancing measures described.

Conclusion

To improve opioid prescribing practices after thoracic surgery, our thoracic surgery team formally implemented the CATS opioid guideline,[13] with resultant significant reduction in opioids prescribed at discharge and no increase in prescription refills. Control charts are a valuable resource for monitoring outcomes on an ongoing basis, as well as assessing the effects of an intervention. As Canada continues to struggle with opioid misuse, interventions such as the one we describe may reduce opioid-related harm at the individual and societal levels.

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Affiliations: From the Section of Thoracic Surgery, Department of Surgery, University of Calgary, Calgary, Alta. (Barber, Graham); and Alberta Health Services, Edmonton, Alta. (Whidden, Aguirre).

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