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ORIGINAL ARTICLE

Encrypted smartphone text messaging between spine surgeons may reduce after-hours surgery

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Abstract

Purpose "After-hours" non-elective spine surgery is associated with increased morbidity. Decision-making may be enhanced by collaborative input from experienced local colleagues. At our center, we implemented routine use of a cross-platform messaging system (CPMS; WhatsApp Inc., Mountain View, California) to facilitate quality care discussions and collaborative surgical decision-making between spine surgeons prior to booking cases with the operating room. Our aim is to determine whether encrypted text messaging for shared decision-making between spine surgeons affects the number or type of after-hours spine procedures.

Methods We retrospectively compared the number, type and length of after-hours spine surgery over three time periods: (A) June 1, 2016–May 31, 2017 (baseline control); (B) June 1, 2017–May 31, 2018 (implementation of retrospective quality care spine rounds); and (C) June 1, 2018–May 31, 2019 (implementation of CPMS). A qualitative analysis of the CPMS transcripts was also performed to assess the rate of between-surgeon agreement for timing and type of procedure.

Results The mean number of after-hours spine surgeries/month over the three study periods (A, B, C) was 10.83, 9.75 and 7.58 ($p = 0.014$); length of surgery was 41.82, 33.14 and 25.37 h/month ($p = 0.001$). Group agreement with the attending spine surgeon plan was 74.3% overall and was highest for the most urgent and least urgent types of indications.

Conclusions Prospective (i.e., prior to booking surgery) quality care discussion for joint decision-making among spine surgeons using CPMS may reduce both the number and complexity of after-hours procedures.

Keywords Spine surgery · After-hours · Adverse event · WhatsApp · Outcome · Quality care

Introduction

After-hours spine surgery is typically performed for patients with neurological compromise or unstable pathology. Examples include spinal cord injury [1], cauda equina syndrome [2], unstable fracture [3], metastatic cord compression [4] and epidural abscess [5]. After-hours surgery is associated with increased risk of perioperative complications, longer length of stay and higher mortality [6, 7]. As a result, surgeons must balance the need for emergency surgery with the risks of operating at odd hours under suboptimal conditions.

Retrospective quality rounds do not impact decision-making in real time. In addition, current practice does not allow for experience sharing between spine surgeons at an institution. To attempt to reduce variation and improve quality, the spine surgeons at our center decided as a group to discuss each after-hours case prior to booking the procedure. Shared decision-making has been used in other medical teams via cross-platform messaging systems (CPMS) [8–10].

We chose a free encrypted commercial CPMS (WhatsApp Inc., Mountain View, California). This application provides instant sharing of a variety of file formats (text, photos, audio, video) between surgeons [11, 12]. Utilization of this software to facilitate discussions between cases prior to booking allows for collective experience sharing and collaborative decision-making.

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The purpose of this study was to determine the impact of routine quality care discussions and collaborative decision-making between spine surgeons using CPMS on number, case time and urgency of after-hours spine surgery.

Materials and methods

We conducted a single-center retrospective study of all after-hours spine surgery at our Canadian center from June 1, 2016 to May 31, 2018. “After-hours” was defined as 17:00–07:00 on weekdays or anytime on weekends (Saturday/Sunday) or statutory holidays. The cohort was divided into three equal time periods: (A) June 1, 2016–May 31, 2017 (baseline control); (B) June 1, 2017–May 31, 2018 (implementation of retrospective quality care spine rounds); and (C) June 1, 2018–May 31, 2019 (implementation of CPMS). In total, 368 patients were included: A (130 patients), B (117 patients) and C (91 patients).

For the baseline period A, spine cases were included in separate neurosurgery and orthopedic surgery morbidity and mortality rounds, but there were no formal quality rounds for the spine group. For period B, monthly spine quality rounds were attended by the surgeons responsible for on-call spine services, which included six surgeons of different ages, levels of experience and training background (orthopedic surgery and neurosurgery). The CPMS group (period C) was composed of the same spine surgeons as in A and B. The amount of call taken by individual group members and the amount taken by neurosurgeons versus orthopedic surgeons did not vary significantly between the three study periods.

The on-call spine surgeon provided an anonymized clinical synopsis and representative imaging on CPMS for cases they planned to book for emergency surgery. A variable amount of feedback was posted by group members. The final course of action for each case was determined by the on-call surgeon responsible for the patient. Participation of all CPMS group members was not mandatory, but encouraged. There was no set number of responses or time required before the on-call surgeon could book the case. Depending on urgency, there was not always time for multiple responses. In some cases, there was only feedback from one or two CPMS group members.

Quantitative data including the number, type and length of after-hours procedures, as well as the booking priority were derived from a database maintained by the health region (Digital Health Analytics). Surgical booking priority (i.e., urgency) at our center is defined as follows: E1 (surgery to be performed within 1 h), E2 (surgery to be performed within 8 h) and E3 (surgery to be performed within 24 h). We assessed the number of decompression and instrumentation/fusion procedures as well as the number of cases involving neurophysiologic monitoring (electromyography, somatosensory evoked potentials, motor evoked potentials or combinations thereof). We also performed a subgroup analysis of these metrics on weekday and weekend periods.

The Digital Health Analytics database provided the total number of cases and operating time during the day for spine surgery, including flexible time that the operating room (OR) makes available for inpatient urgent cases during the regular workday to determine whether operating time available during the day changed between study time periods.

Monthly rates for these data were computed over each study period. Differences between rates were used to compute variance. Monthly data were analyzed and compared using one-way ANOVA. Statistical analysis was conducted using SPSS 21.0 (IBM, Chicago, IL).

A secondary outcome was the rate of agreement collected from discussions between spine surgeons as recorded on CPMS transcripts. Rate of group agreement, type of change suggested, agreement on final surgical plan and agreement on level of urgency was derived from conversation transcripts. This was compared by proportion of agreement.

We also conducted a survey on perceptions of the system for CPMS group members. Responses were graded on a Likert scale from 1 to 5, labeled as follows: 1—Strongly Disagree, 2—Disagree, 3—Neutral, 4—Agree and 5—Strongly Agree. We asked questions related to usability, usefulness and impact of the CPMS discussions. We analyzed these data for median $\pm$ interquartile range (IQR).

This study obtained operational approval and was exempt from the requirement of Research Ethics Board review and approval based on article 2.5 of the tri-council policy statement (tcps2) [13]. Patient consent was not required.

Results

The results are summarized in Table 1 and graphically shown in Figs. 1A–C. There was a significant reduction in the number (A: 10.83 ± 3.18, B: 9.75 ± 2.52, C: 7.58 ± 2.47, $p = 0.01$) and length (A: 3.59 ± 0.50 h, B: 3.28 ± 0.50 h, C: 2.88 ± 0.35 h, $p = 0.003$) of after-hours spine surgeries performed during the three time periods. The number of E3 procedures decreased (A: 6.75 ± 2.45, B: 4.92 ± 1.73, C: 3.83 ± 1.59, $p = 0.005$) as did the number of cases requiring IONM (A: 6.25 ± 1.71, B: 4.75 ± 2.09, C: 3.67 ± 2.27, $p = 0.026$). The number of E1 and E2 cases and type of surgery (decompression vs fusion) were similar between gro ups.

A separate subgroup of weekend and weekday after-hours periods was conducted (Supplemental Tables 1, 2 and 3). The average operating time for after-hours procedures and the number of E3 cases remained significantly lower through the three time periods (Supplementary Tables 1 and 2).

Table 1 Statistical analysis summary of after-hours spine surgery from period A–C database. Data are represented as mean ± standard deviation. All representative p-values are as calculated using one-way ANOVA. IONM, intraoperative neuromonitoring. E1, OR to occur within 1 h, E2, OR to occur within 8 h, E3, OR to occur within 24 h. A: baseline prior to quality improvement rounds, B: retrospective quality improvement rounds and C: usage of CPMS for case discussion

	A	B	C	*p* value
Total emergency cases (n)	130	117	91	
Cases/month	10.83 ± 3.18	9.75 ± 2.52	7.58 ± 2.47	0.01
Operating time/month (hours)	41.82 ± 14.44	33.14 ± 7.77	25.37 ± 8.06	0.001
Average case time (hours)	3.59 ± 0.50	3.28 ± 0.50	2.88 ± 0.35	0.003
E1 (< 1 h) cases/month	0.58 ± 1.16	0.33 ± 0.65	0.50 ± 0.80	0.77
E2 (< 8 h) cases/month	3.83 ± 2.08	4.83 ± 2.29	4.08 ± 2.15	0.53
E3 (< 24 h) cases/month	6.75 ± 2.45	4.92 ± 1.73	3.83 ± 1.59	0.005
Decompression cases/month	1.41 ± 0.79	1.00 ± 0.95	1.25 ± 1.48	0.67
Fusion cases/month	3.67 ± 1.92	3.41 ± 1.67	2.75 ± 1.66	0.31
Surgeries with IONM/month	6.25 ± 1.71	4.75 ± 2.09	3.67 ± 2.27	0.026

The amount of operating time available for spine surgery during the day was not significantly different through the three study periods. There was, however, a significant reduction in the average length of daytime spine surgery (Supplementary Table 3).

Analysis of the CPMS transcripts showed that 110 cases were discussed. The indication for after-hours spine surgery was: trauma (39%), oncology (20%), infection (20%), degenerative (18%) and other (3%) including CSF leak, postpartum epidural hematoma and postoperative epidural hematoma.

CPMS transcripts showed general agreement among the surgeons in 84 (76.3%) cases: the group agreed on the initial plan in 48 (43.6%) cases, recommended a more complex plan in 12 (10.9%) cases, a less complex plan in 19 (17.3%) cases and non-operative care in 5 (4.5%) cases. Complexity refers to number of levels, addition of instrumentation or addition of further stages of surgery. There was some disagreement with the on-call surgeons' final decision with respect to the type of procedure in 26 (23.6%) cases.

Recommendations for the urgency of surgery could be derived from the CPMS transcripts in 101 (92%) cases. There was group agreement in 75/101 (74.3%) cases. Agreement with respect to timing was highest for more urgent cases (E1 5/5 (100%); E2 28/35 (80%)) and lower for less urgent cases (E3 24/41 (58.5%)). Agreement was high for flex time during the day 7/7 (100%) and non-operative care in 11/12 (92%).

A survey was distributed to surgeons to evaluate perceptions of the CPMS case review strategy (Table 2). All 6 participating surgeons responded. Surgeons felt they could reach colleagues (4.5 ± 1), CPMS impacted their decision-making (5.0 ± 1), the CMPS process was useful (4.5 ± 1) and recommended CMPS to other centers (4.0 ± 1). On average, surgeons felt they could reach 3.3 of their colleagues through CPMS, representing half of the spine service.

Discussion

Quality improvement initiatives are essential for optimizing patient outcomes. Charest-Morin et al.[6] demonstrated that after-hours spine surgery was an independent predictor of perioperative morbidity and mortality. These authors have advocated strategies to minimize the risk of after-hours spine surgery, with a particular emphasis on the value of regular quality care rounds. They did not address assessment and selection of appropriate emergency cases, which is the purpose of our study.

An issue with quality assurance rounds is that they are retrospective. A recurring discussion at our rounds was the original indication for surgery and the technical aspects of the procedure (e.g., whether or not to fuse, how many levels, anterior versus posterior). In the absence of high-quality clinical studies (and there is very little published with respect to after-hours spine surgery), best practice is facilitated by integrating expert consensus [14]. The best experts regarding local OR resource considerations after-hours are the surgeons who work in that environment. At our center, the spine surgery group agreed to review each other's after-hours cases in a prospective fashion (i.e., prior to booking) to integrate collective experience. The end result is a collective decision-making paradigm accessing the cumulative experience of the surgeons.

Advanced communication technology is widely utilized in current surgical practice, but its impact is likely vastly underreported. CPMS platforms have been utilized in oral surgery [15, 16], orthopedic surgery [17] and acute surgical teams [18] demonstrating enhanced communication efficacy and high doctor satisfaction. WhatsApp™ has been studied as a platform for diagnostic and consultation review for pediatric fractures [19], burn care [20], combat injury [21] and spinal fracture evaluation [22]. It has also been used to facilitate communication between teams in the prehospital

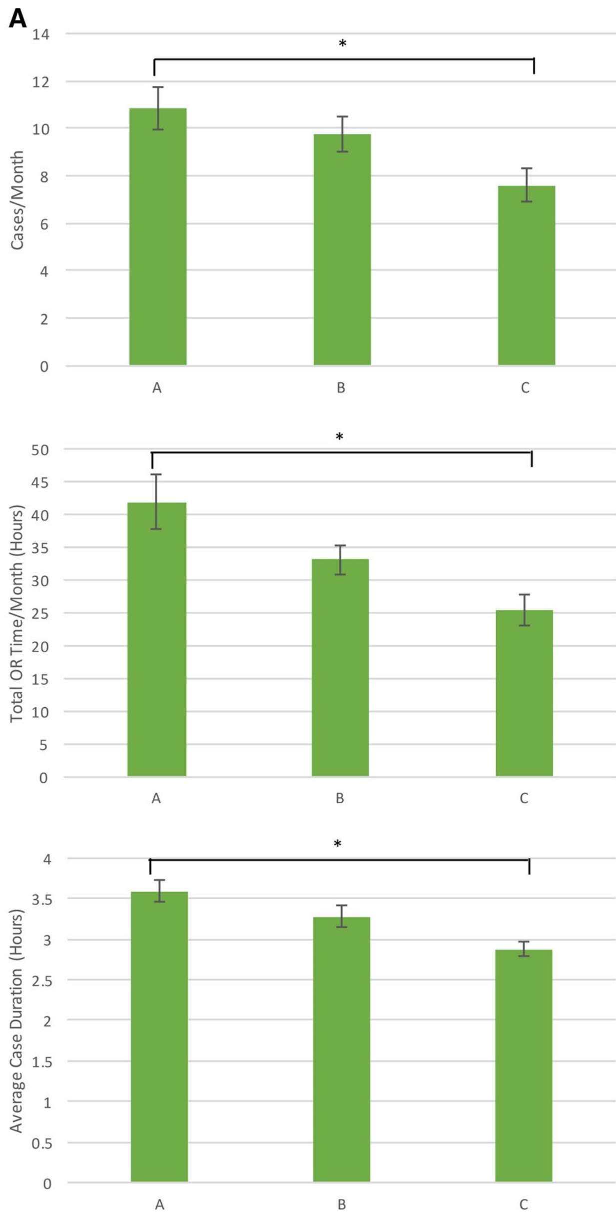

Fig. 1 Trend from period A to C on after-hours spine cases. **A** After-hours cases, total operative time, average case time. **B** Number of cases according to the emergency status (E1, E2 and E3). **C** Number of cases according to the type of procedure (decompressions and fusions), after-hours spine cases with IONM (intraoperative neuromonitoing). Comparisons performed with one-way ANOVA; asterisk (*) indicates $p < 0.05$

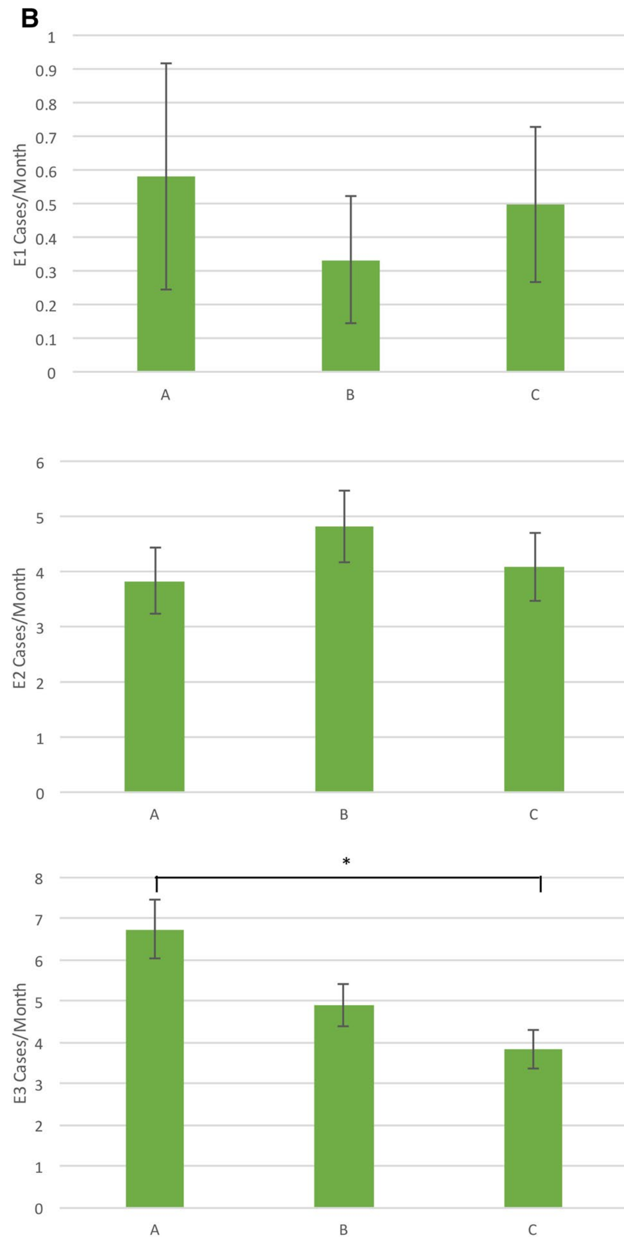

Fig. 1 (continued)

mobilization of cardiac catheterization resources [23] and to facilitate communication with patients [24]. It has mostly been used within healthcare teams [25, 26]. Published reports have mainly focused on user satisfaction, with few demonstrating impact on practice.

We report a statistically significant decrease in the number of after-hours spine surgeries after implementing routine use of CPMS between spine surgeons. The most significant reductions were for less urgent cases (E3). The intervention did not impact more acute emergencies (i.e., E1 and E2 procedures). The most critical emergencies are less controversial in terms of surgical indications and timing.

The complexity of after-hours surgeries may also have been reduced after implementing CPMS, as reflected by the reduction in average case time and the number of cases employing intraoperative neuromonitoring. This being said, average case duration decreased from period A to C in all subgroups, including daytime cases. The latter suggests that part of the effect may have been due to gains in surgeon experience through the study period.

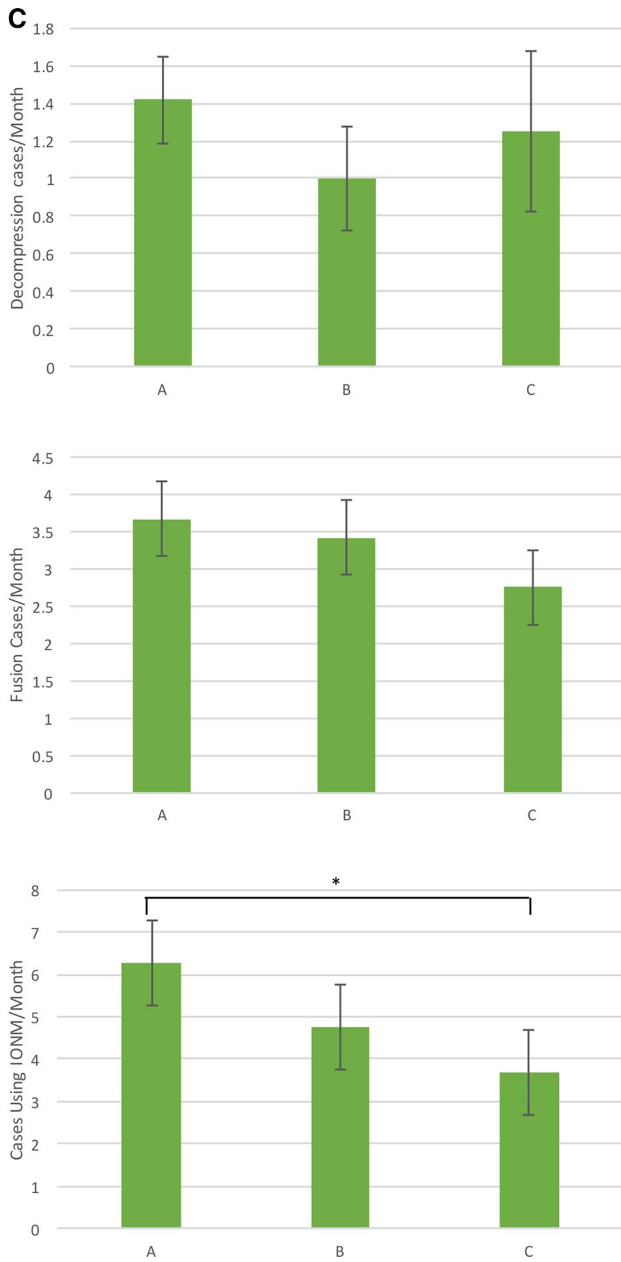

Fig. 1 (continued)

While CPMS technology seems to benefit team communication, digital security remains a significant concern. End-to-end encryption ensures that only the user and the people they are communicating with can read what is sent. This means that the transferred data alone cannot be read by WhatsApp™ or Internet servers. Data security on individual smart phones is the main vulnerability and is limited by user measures to gatekeep access to their phone and its applications (e.g., password protection). When an image transfer is loaded, it is important to make sure that the default "Settings" are such so that images are not stored on the user's cloud, which can then be accessed between devices and people sharing the same accounts. Clinical data should be limited to team members that require the information. Users must only enter the most relevant clinical information and the data must be anonymized. Lastly, data must be deleted when it is no longer needed. Settings on the application that allow "chats" to be backed up on the user hard drive or cloud should be turned off.

WhatsApp has been widely used in some parts of the world and is supported by the National Health Service in the UK [12], but it is important to point out that WhatsApp™ is currently not considered a HIPPA-compliant smartphone-based group messaging application (HCGM) in the USA. Surgeons need to be aware of their local regulations for clinical use of smartphone technology.

Our study has several limitations. It was retrospective and limited to a single center. We used a historical comparison, so some change over the study period may be attributable to improvement of the team over time. Surgeons were aware that their treatment considerations would be observed by others, and this "Hawthorne effect" has been cited as a key type of bias across medical research [27]. Hawthorne effect occurs when the subjects being studied (in this case, the spine surgeons) change their behavior because they are aware that they are being observed. The generalizability of our results to other practices is questionable because the amount of after-hours spine surgery likely varies significantly between institutions, depending on the volume of emergencies and access to operating time during the day. Similar to other Canadian centers [6] OR time at our institution is limited; some of the surgeries performed after-hours probably could have been done during the day if resources were optimal. In addition, we are limited by the small size of our center and low after-hours case volumes. Each year included in the study only added around 100 cases, limiting the statistical power of this study.

Another limitation of our study is the aggregate-level data analysis used. We report changes in case volumes and duration of surgery, but did not analyze individual cases. As such, we do not report on the adverse event changes between cohorts. Factors such as demographics, comorbidities, complication rate and individual surgical plans for patients could not be compared between groups. However, we have no reason to suspect that these parameters would change significantly between study time periods.

There are several variables to account for over the three years study period that could have biased the results; however, the access to "in-hours" surgery time, the amount of time surgeons were required to be "on call," the proportion of neurosurgeons or orthopedic surgeons taking spine call, and the actual surgeons taking call did not change significantly.

Table 2 Surgeon responses to survey questions regarding CPMS review of cases prior to booking. Responses are on a Likert scale from 1 to 5, labeled as follows: 1—Strongly Disagree, 2—Disagree, 3—Neutral, 4—Agree and 5—Strongly Agree. IQR—Interquartile range

	Surgeon 1	Surgeon 2	Surgeon 3	Surgeon 4	Surgeon 5	Surgeon 6	Median ± IQR
I find the WhatsApp quality review process helps me to make my final surgical decision	4	4	4	5	4	4	4.0 ± 0
I find that I can generally reach colleagues for discussion using the WhatsApp quality review process	5	4	5	4	4	5	4.5 ± 1
I find the discussion generated on WhatsApp to be useful	5	4	4	4	4	4	4.0 ± 0
There have been cases where the WhatsApp quality review process has impacted my decision-making	5	5	4	5	4	5	5.0 ± 1
I find the WhatsApp quality review process to be efficient	4	4	4	4	4	5	4.0 ± 0
Overall, I think that the WhatsApp quality review process is useful	4	5	5	4	4	5	4.5 ± 1
I recommend this process to other centers	5	4	4	4	4	5	4.0 ± 1
Generally, I can reach X many of my colleagues	3	4	3	3	3	4	3.0 ± 1

In most cases, we found that smartphone messaging between spine surgeons did not so much change the decision to operate (especially for the most urgent and least urgent indications), but rather seemed to facilitate rescheduling some elective procedures between team members. Through improved communication, spine surgeons were able to achieve a more coordinated allocation of OR resources to optimize urgent care. Overall, usage of CPMS facilitated collaborative decision-making, which in turn impacted emergency case booking patterns.

Further study should be pursued, preferably in a prospective manner, in order to review this process in detail. In addition, analysis of more granular data may reveal more subtle trends in what type of surgery is impacted.

Conclusion

We have demonstrated that communication between spine surgeons using CPMS in order to facilitate collaborative surgical decision-making may impact both the number and length of after-hours spine surgeries. Further study is needed to determine the effects on patient outcomes and complication rate.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00586-022-07423-4.

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Declarations

Conflict of interest No conflict of interest or funding to disclose.

Ethical approval The ethical approval for this study was obtained from the Research Ethics Board Bio ID 949 and Saskatchewan Health Authority Approval ID OA-UofS-949.

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