Evaluation of a tiered operating room strategy at an academic centre: comparing high-efficiency and conventional operating rooms

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Background: Wait times for many elective orthopedic surgical procedures in Ontario have become unacceptably long and substantially exceed the recommended guidelines. As a consequence, many patients experience chronic pain, disability and other poor health outcomes. The purpose of this study was to test a novel, resource-saving redesign of outpatient operating room (OR) services, based on tiered grouping of surgical cases, to maximize health benefits for patients while improving efficiency and decreasing wait times.

Methods: This prospective cohort study enrolled adult patients scheduled to undergo unilateral lower limb procedures that had a low requirement for surgical resources and did not require admission to the hospital (ambulatory surgical services) at an academic hospital. Patients were randomly assigned to a conventional OR group or a high-efficiency (tiered) OR group, in which the intensity of surgical, anesthesia and nursing resources was matched to the procedure and the patient's health status. The tiered OR made use of local anesthesia and a block room rather than general anesthesia. Primary outcomes were costs of surgical services provided and patient health outcomes; secondary outcomes were patient and staff satisfaction with each OR setup.

Results: The costs associated with the high-efficiency OR were 60% lower than those associated with the conventional OR (this was primarily due to the streamlining of OR care and elimination of the need to use a postanesthetic care unit), with the same or equivalent patient health outcomes. No differences in patient and staff satisfaction were found between the 2 setups.

Conclusion: The use of tiered, ambulatory services for elective orthopedic surgery does not compromise health outcomes and patient satisfaction, and it is associated with substantial cost savings.

Contexte : En Ontario, les temps d'attentes de plusieurs interventions en chirurgie orthopédique non urgentes s'allongent déraisonnablement et excèdent largement ceux des lignes directrices. Par conséquent, plusieurs patients doivent vivre avec de la douleur chronique, une invalidité ou d'autres problèmes de santé. Le but de cette étude était de mettre à l'essai une nouvelle configuration des services en salle d'opération pour les patients ambulatoires qui permettrait d'économiser les ressources et qui se fonderait sur un regroupement des cas chirurgicaux en échelons afin de maximiser les bienfaits pour la santé des patients tout en améliorant l'efficacité et en diminuant les temps d'attente.

Méthodes : Dans cette étude de cohorte prospective, les patients adultes participants ont subi dans un hôpital universitaire une intervention chirurgicale unilatérale à un membre inférieur demandant peu de ressources et ne nécessitant pas d'hospitalisation (services de chirurgie ambulatoire). Les patients étaient répartis aléatoirement en 2 groupes : 1 groupe était assigné à une salle d'opération classique, et l'autre à une salle à rendement élevé (interventions échelonnées), où l'intensité des ressources allouées à l'intervention, à l'anesthésie et au personnel infirmier correspondait au type d'intervention et à l'état de santé du patient. La salle d'opération par échelons avait la possibilité d'utiliser l'anesthésie locale dans une salle d'anesthésie locorégionale plutôt qu'une anesthésie générale. Les paramètres principaux de l'étude étaient le coût des services chirurgicaux fournis et les résultats cliniques des patients; le paramètre secondaire était la satisfaction des patients et du personnel de chaque configuration de la salle d'opération.

Résultats : Les coûts associés aux salles d'opération à rendement élevé étaient inférieurs de 60 % à ceux associés aux salles d'opération classiques (cette différence s'expliquerait par la simplification des soins en salle d'opération et l'élimination du

besoin d'une salle de réveil), pour des résultats cliniques similaires ou équivalents. Aucune différence dans la satisfaction des patients et du personnel n'a été observée entre les 2 configurations.

Conclusion : Le recours à l'échelonnage des services ambulatoires pour l'exécution des interventions en chirurgie orthopédique non urgentes ne compromet ni les résultats cliniques ni la satisfaction des patients et s'accompagne d'une réduction substantielle des coûts.

In Canada, more than 11% of the country's gross domestic product (GDP) and almost 50% of provincial budgets are spent on health care expenditures,[1] yet the high spending is not favourably reflected in Canada's ranking among the 36 countries in the Organisation for Economic Co-operation and Development (OECD) in terms of the ratio of GDP spending to life expectancy.[1] With an increasing volume of patients requiring surgery, the demand for surgical services has fast outpaced available resources. This frequently leads to prolonged surgical wait times: for example, in 2018, the average wait for elective orthopedic surgical procedures at London Health Sciences Centre (LHSC) (a tertiary care hospital within the Southwestern Ontario Local Health Integration Network [LHIN], with 1 of the longest wait times in Ontario) was reported as 96 days to first surgical consultation, and an average of 254 days to surgery.[2] Prolonged wait times have been correlated not only with a high rate of pain and depression, but also with other poor patient health outcomes.[3,4] Moreover, prolonged waiting increases the actual cost of providing health care, because many patients will seek access through emergency departments (EDs) or outside of their own LHIN.[2] Such long wait times, combined with provincial budget cuts and mandates of fiscal responsibility, demonstrate that an immediate implementation of innovative ideas is imperative.

The City of London is served by 2 hospitals (London Health Sciences Centre and St Joseph's Healthcare Centre), spread over multiple campuses, which also function as the regional referral centre for Southwestern Ontario; however, the hospitals do not offer the same orthopedic services. Under the current surgical workflow at our institution, all patients pass through the same operating room (OR) process (consisting of pre-admit, actual OR, post-anesthesia care unit [PACU] and post-recovery), regardless of their health status, the method of anesthesia or the surgical procedure performed (a patient requiring a minor hardware removal procedure goes through the same workflow as a patient undergoing a major joint replacement). This suggests a potential strategy to optimize surgical services by matching incoming patients with the required surgical resources and patient health status.

The purpose of this study was to test a novel, streamlined form of outpatient OR services ("high-efficiency OR") based on tiered grouping of surgical cases. The ultimate goal is to redesign the surgical services to maximize health benefits for patients and improve wait times as well as produce substantial savings in resources (thus freeing up the standard OR for more complex cases).

Methods

This prospective cohort study included adult patients (aged > 18 yr) with no substantial or life-threatening comorbidity (American Society of Anesthesiologists score ≤ 3) who were seeking an elective unilateral lower limb orthopedic procedure that did not require hospital admission and that had a low requirement for surgical resources at London Health Sciences Centre (a tertiary care academic hospital in London, Ontario). The following were included in the definition of a low requirement for surgical resources: optimizing and standardizing surgical trays, as well as plate and screw systems, which were customized to minimize the extent of equipment, setup and sterile processing. Patients were randomly assigned to 1 of 2 groups: conventional OR (n = 100) or (2) high-efficiency (i.e., tiered) OR (n = 100). OR tier was allocated by matching the intensity of surgical resources to the health status of each patient (Table 1). The procedures included forefoot and midfoot corrective surgery, foot and ankle fracture fixation, deformity correction, fusions, instability surgery, irrigation and débridement, tendon transfers, excision and hardware removal. Patients having bilateral operative procedures and those with concurrent injuries that were deemed to delay or alter rehabilitation were excluded from the study. The study was approved by the Health Sciences Research Ethics Board at the University of Western Ontario.

High-efficiency OR

The streamlined, high-efficiency OR differed from the conventional OR as follows: (a) patient intake did not involve a pre-admit clinic or it was from the ED with ambulatory intake only; (b) cases requiring the same type of surgery were grouped together; (c) the choice of anesthesia was limited to local, nerve block and conscious sedation (general anesthetic was used

Table 1. Definitions of operating room tiers

	Operating room tier			
Variable	1	2A	2B	3
Length of surgical procedure, h	< 1	< 1.5	< 1.5	< 5
Length of recovery from surgery, h	< 1	< 2	< 2	< 2
Operating room staffing (rotating charge nurse or other nurse covers lunch breaks)	1 RN (circulator)	2 nurses: 1 RPN (scrub) and 1 RN (circulator)	2 nurses: 1 RPN (scrub) and 1 RN (circulator)	2–2.5 nurses: 1 RPN (scrub), 1 RN (circulator) and 1 float
ASA	≤ 3	≤ 3	≤ 3	≤ 3
Anesthesia	No general anesthesia	General or regional anesthesia or both	General or regional anesthesia or both	General or regional anesthesia or both
Examples	Distal extremity procedures (hands, legs), foot procedures, ankle arthroscopy, carpal tunnel syndrome	Knee or hip arthroscopy, hernia, fusion, ACL repair	Intra-abdominal (e.g., gallbladder), arteriovenous fistula	Facelift, breast lift, abdominoplasty, liposuction

ACL = anterior cruciate ligament; ASA = American Society of Anesthesiologists score; RPN = registered practical nurse; RN = registered nurse.

only if absolutely necessary) and a block room was used; (d) a scrub nurse was not used, instrumentation was limited to 25 instruments on a surgical tray (standardizing or optimizing the number of instruments and the amount of equipment required to perform surgeries, as agreed upon by the 3 treating surgeons); and (e) patients were discharged directly to postoperative care; the PACU was used only if the patient was given a general anesthetic.

Primary outcomes

The primary outcomes were all costs associated with surgical and patient care, as well as levels of patient health. The collection of the micro-costing data was carried out by the hospital administration (decision support, finance departments) and a research technician. The OR expenses included the cost of equipment, supplies, medications and salaries for allied health care staff, including nurses; surgeons' salaries were not included. Patient health was assessed using the Patient-Reported Outcomes Measurement Information System (PROMIS),[5] EuroQol EQ-5D-5L (visual analogue scale [VAS] of overall health, index value, quality-adjusted life years [QALY])[6,7] and the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP)[8] patient-reported surgical satisfaction questionnaires. EQ-5D-5L questionnaires were administered at 2-week, 6-week, 3-month and 6-month follow-ups; ACS NSQIP questionnaires were administered at 6-week follow-up.

Secondary outcomes

The secondary outcomes were patient and staff satisfaction with each OR setup, using the patient surgical experience satisfaction survey (PSESS),[9] the Consumer Assessment of Healthcare Providers and Systems (CAHPS)[10] and the Institute for Healthcare Improvement (IHI)[11] staff questionnaires. IHI surveys were designed to assess the satisfaction of an employee with their work environment, as well as to provide role-specific feedback. The PSESS and CAHPS surveys were administered at 2-week follow-up.

Data analysis

Statistical analysis was carried out using SPSS v. 24 (SPSS Inc.). All parametric data were expressed as means with standard deviations (SDs). Student *t* tests and one-way analysis of variance (ANOVA) were used for continuous parametric data, while the Mann–Whitney *U* test and Kruskal–Wallis ANOVA were used for nonparametric data. The χ^2 test was used for categorical data; 95% confidence intervals (CIs) were calculated for all proportions. A p value of less than 0.05 was considered statistically significant. A patient sample size calculation was performed using EQ-5D-5L data, with power set at 80%.

Results

There were no major differences in patient age or overall health status between the conventional and high-efficiency OR groups. Patients in the high-efficiency OR group had a symptomatic orthopedic condition for a longer duration than those in the conventional OR group (88 [SD 13] v. 45 [SD 8] mo, $p < 0.01$), but they reported having a higher level of function (Likert scale score of 75.4 [SD 2.5] v. 65.4 [SD 3.1], $p < 0.01$) and were more active (Likert scale score of 67.8 [SD 3.2] v. 49.1 [SD 3.5], $p < 0.01$) (Table 2).

OR and associated costs

The expenses associated with patient surgical care (cost of both the labour and materials used) were 60% lower

in the high-efficiency OR than in the conventional OR (Table 3). The turnover time per case fell from an average of 23.5 minutes in the conventional OR group to just 8.75 minutes in the high-efficiency OR group (Figure 1). The most substantial savings were associated with bypassing the PACU and decreasing OR-associated labour and materials costs. It is important to note that, in this design, surgical procedures were taken from the tier 3 staffing model (i.e., conventional OR) to the tier 1 model, which is a lower resourced environment than the conventional OR. Moreover, time to patient discharge was also significantly lower in the high-efficiency OR group ($p < 0.01$), and there were fewer reported adverse effects from anesthesia (Table 4).

Table 2: Characteristics of study patients in the conventional and high-efficiency operating room groups

Variable	No. of patients;* OR type		*p* value
	Conventional OR *n* = 100	High-efficiency OR *n* = 99	
Age, yr, mean ± SD (95% CI)	48.8 ± 1.6 (45.7–51.8)	54.3 ± 1.5 (51.3–57.3)	0.012
Sex, no.			
Male	42	31	
Female	57	68	
Other	1	0	
Smoking status, no.			
Smoker	21	23	
Nonsmoker	51	52	
Ex-smoker	26	17	
Physical attributes			
BMI, mean ± SD (95% CI)	29.8 ± 0.6 (28.6–31.2)	27.3 ± 0.6 (26.1–28.5)	0.004
Work status, no.			
Employed full time	47	44	0.78
Employed part time	9	6	
Student	5	2	
Homemaker	4	3	
Retired	17	21	
Retired because of disability	11	10	
Other	5	8	
Chronic pain, no.			
Yes	66	67	
No	31	27	
Time with condition, mo, mean ± SD	45 ± 8	88 ± 13	0.005
Reason for surgery, no. (%)			
Pain	56 (58)	69 (75)	0.001
Discomfort	1 (1)	6 (6)	
Appearance	0	0	
Function	21 (22)	12 (13)	
Other	19 (20)	5 (5)	
Presurgery levels, mean ± SD			
Pain (/10)	6.3 ± 0.3	6.0 ± 0.3	0.37
Function (/100)	65.4 ± 3.1	75.4 ± 2.5	0.013
Activity (/100)	49.1 ± 3.5	67.8 ± 3.2	< 0.001

BMI = body mass index; CI = confidence interval; OR = operating room; SD = standard deviation.
*Unless indicated otherwise.

Patient health outcomes

No differences were found in the calculated PROMIS Pain Interference (63.1 [SD 0.7] v. 64.7 [SD 0.8]) (Figure 2A), Global Physical Health (42.2 [SD 0.8] v. 42.8 [SD 0.8]) or Global Mental Health (49.1 [SD 1.0] v. 49.5 [SD 1.1]) (Figure 2B) T-scores of patients in the conventional and high-efficiency OR groups ($p = 0.13$, $p = 0.79$ and $p = 0.57$, respectively) (Figure 2).

There were no differences in self-reported patient EQ-5D-5L baseline VAS scores of overall patient health between the conventional and high-efficiency OR groups ($p = 0.99$). VAS scores increased from 75 (SD 2) to 77 (SD 2), 78 (SD 2), 81 (SD 2) and 83 (SD 8) in the conventional OR group, and from 74 (SD 2) to 72 (SD 2), 77 (SD 2), 78 (SD 3) and 74 (SD 12) in the high-efficiency OR group at 2-week, 6-week, 3-month and 6-month follow-ups ($p = 0.66$) (Figure 3A). Computed EQ-5D-5L index values for patients in the conventional and high-efficiency OR groups slightly decreased from their baselines of 0.63 (SD 0.02) and 0.66 (SD 0.02), respectively, at 2-week follow-up, to 0.56 (SD 0.02) for the conventional OR group and 0.61 (SD 0.02) for the high-efficiency OR group; the index values then progressively increased at 6-week, 3-month and 6-month follow-ups to 0.68 (SD 0.02), 0.72 (SD 0.02) and 0.79 (SD 0.03) for the conventional OR group and to 0.72 (SD 0.02), 0.75 (SD 0.02) and 0.72 (SD 0.04) for the high-efficiency OR group ($p = 0.23$) (Figure 3B).

The calculated postoperative QALY values for the patients in the conventional OR group were found to progressively increase to 0.023 (SD 0.001), 0.072 (SD 0.002), 0.159 (SD 0.004) and 0.347 (SD 0.012) at 2-week, 6-week, 3-month and 6-month follow-ups, respectively ($p < 0.001$) (Figure 3C); those for patients in the high-efficiency OR group also progressively increased, to 0.024 (SD 0.001), 0.076 (SD 0.002), 0.169 (SD 0.004) and 0.303 (SD 0.018) at 2-week, 6-week, 3-month and 6-month follow-ups, respectively ($p < 0.001$). There was no statistical difference in QALY between patients in the conventional OR group and those in the high-efficiency OR group ($p = 0.25$).

Patient and staff satisfaction

Patient satisfaction with their preoperative (Table 5) or postoperative experience (Table 4, Table 6) was found to be equivalent for patients in the conventional and high-efficiency OR groups. The 2 groups of patients reported having similar levels of education and previous surgical experience ($p = 0.460$ and $p = 0.310$, respectively) (Figure 4).

Twenty-two staff in the conventional OR setup and 40 in the high-efficiency OR setup participated in the IHI survey. The mean scores of interdisciplinary job satisfaction with the work environment across the surveyed categories (team rating, intrateam courtesy, communication and cooperation, team morale, personnel morale and setup preference for family and friends) were found to be equivalent among the staff groups, except for team morale, which was lowest among nurses (Table 7). No differences were found in staff job satisfaction between the conventional and high-efficiency OR groups (Table 8).

Discussion

Unacceptably long wait times within the Canadian health care system, which are particularly evident in Southwestern Ontario, have long been one of the key subjects requiring prompt governmental intervention. Although in recent years a decision was implemented to allocate more funds to perceived high-priority areas such as hip and knee replacement procedures, it has resulted in the neglect of other surgical procedures, such as those for foot and ankle.[12] Given that the status quo is unsustainable, we undertook a trial of a novel surgical model of OR setup, making use of a tiered OR for ambulatory surgery that would allow for expedited access for day surgery cases.

In our pilot trial, we tiered OR cases by matching the required surgical resources to the health status of each patient. Patient enrolment was primarily based on postoperative recovery parameters; patients with comorbidities that would require the patient to be admitted to a ward (e.g., uncontrolled diabetes, heart failure or uncontrolled hypertension) were excluded. Age and body mass index were not exclusion criteria: planned surgical procedures did not require general anesthesia, thus eliminating concerns of postoperative hypoxia due to apnea or airway difficulty due to paralysis of the respiratory tract.[13,14]

Substantial cost reduction in the high-efficiency OR was achieved by (a) using patient selection criteria

Table 3: Surgical and other care costs per patient in the conventional and high-efficiency operating room groups

	Conventional OR, $			High-efficiency OR, $				
Category	Labour	Materials	Total	Labour	Materials	Total	Comparison of high-efficiency OR with conventional OR, %	% of total savings
OR	249	220	469	75	97	172	↓63	59
PACU	129	7	136	0	0	0	↓100	17
Day surgery	139	16	155	116	13	129	↓17	20
Clinical laboratory	4	1	5	0	0	0	↓100	1
Medical imaging	15	1	16	8	0	8	↓50	3
Physiotherapy	7	0	7	10	0	10	↑43	2
Pastoral care	1	0	1	0	0	0	↓100	0
Net total	544	245	789	209	110	319	↓60	

OR = operating room; PACU = postanesthesia care unit. All prices are in Canadian dollars, and are rounded to the nearest dollar.

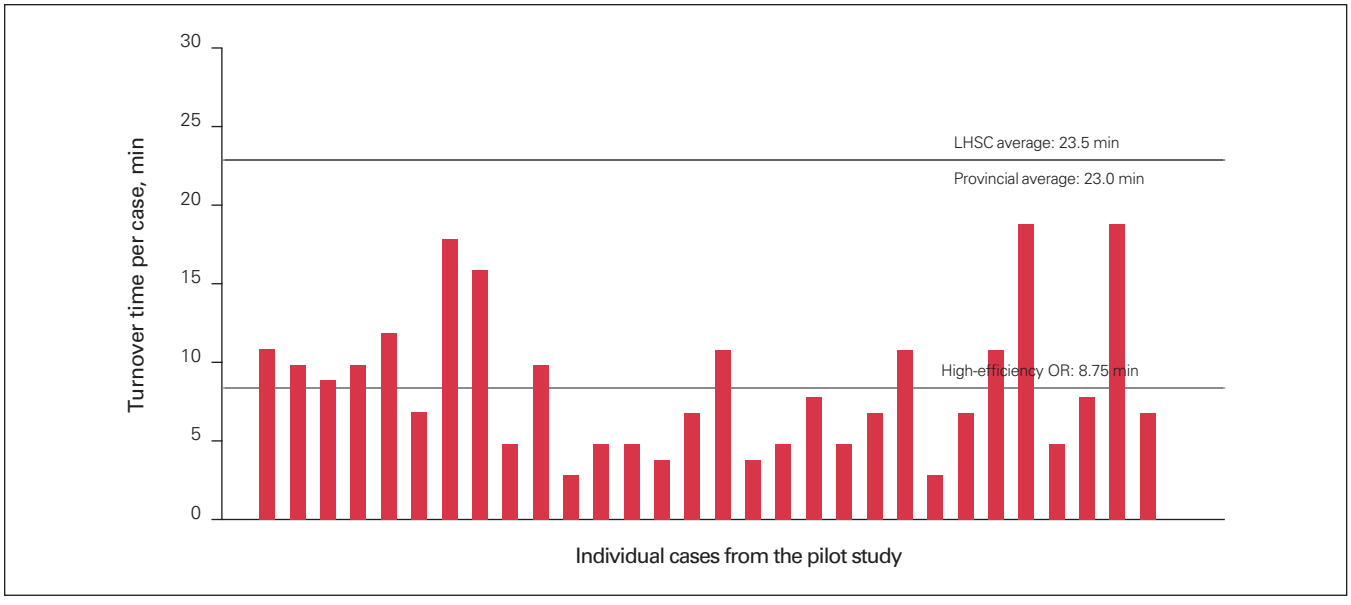

Fig. 1. Case turnover times in the high-efficiency and conventional operating room (OR). LHSC = London Health Sciences Centre.

Table 4: Comparison of discharge times and results of patient surgical experience satisfaction surveys in the conventional and high-efficiency operating room groups

Variable	No. (%) of patients;* OR type		*p* value
	Conventional OR	High-efficiency OR	
Informed about anesthetic preoperatively	64 (66.7)	82 (84.4)	0.01
Time to discharge, h			
< 1	2 (2.1)	19 (19.4)	< 0.01
1–2	33 (34.4)	44 (44.9)	
3–6	29 (30.2)	10 (10.2)	
> 6	6 (6.3)	4 (4.0)	
Other	2 (2.0)	0 (0)	
Did not recall	4 (4.0)	4 (4.0)	
Preference to stay in hospital			
Yes	6 (6.2)	7 (7.1)	0.39
Yes, overnight	10 (10.3)	5 (5.1)	
No	81 (83.5)	86 (87.7)	
Side effects from anesthesia			
No	61 (62.0)	79 (81.0)	< 0.01
Yes	37 (38.0)	19 (19.0)	
Likelihood of recommending anesthetic, mean ± SD	8.67 ± 0.188	9.2 ± 0.181	0.04
Type of take-home instructions			
Verbal	11 (11.0)	3 (3.0)	0.03
Written	9 (9.0)	6 (6.0)	
Verbal and written	71 (75.0)	71 (90.0)	
Did not recall	4 (4.0)	1 (1.0)	

OR = operating room; SD = standard deviation. The standard patient surgical experience satisfaction survey questionnaire was used.
*Unless indicated otherwise.

recommended for ambulatory surgery (i.e., American Society of Anesthesiologists [ASA] score ≤ 3),[13,15–18] permitting the use of local anesthesia and nerve blocks (proven to provide better pain control[19]), eliminating the need for PACU; (b) eliminating the scrub nurse, as well as designating roles to the circulating nurse or OR aide, thus saving 1 full-time salaried position;[20–22] (c) minimizing the number of instruments and amount of equipment required to perform surgeries (the high-efficiency OR carried out less complex cases and thus required fewer tools); and (d) grouping similar cases together, allowing for better operative efficiency.[23] A minimal, negligible increase in physiotherapy cost was offset by improved outcomes for the patients and led to a relative decrease in the surgeon workload.[24–27] Moreover, better operative efficiency allowed more cases to be completed in an OR day.

No differences in patient health outcomes were found in terms of physical and mental health or pain interference scores. Patients in the conventional and high-efficiency OR groups had equivalent levels of overall health (VAS score, index values and QALYs) over their follow-up period (up to 6 mo postoperatively). These data indicate that the quality of health care received by the 2 groups provided the same health benefits, at substantially reduced cost of care for the high-efficiency OR group.

Patient levels of satisfaction with the 2 OR setups were also found to be equivalent. It has been reported that level of education and previous experience with surgical procedures may influence patient satisfaction,[28] but we did not find any differences for these 2 parameters. Although the evidence is not clear, wait times can also determine patient

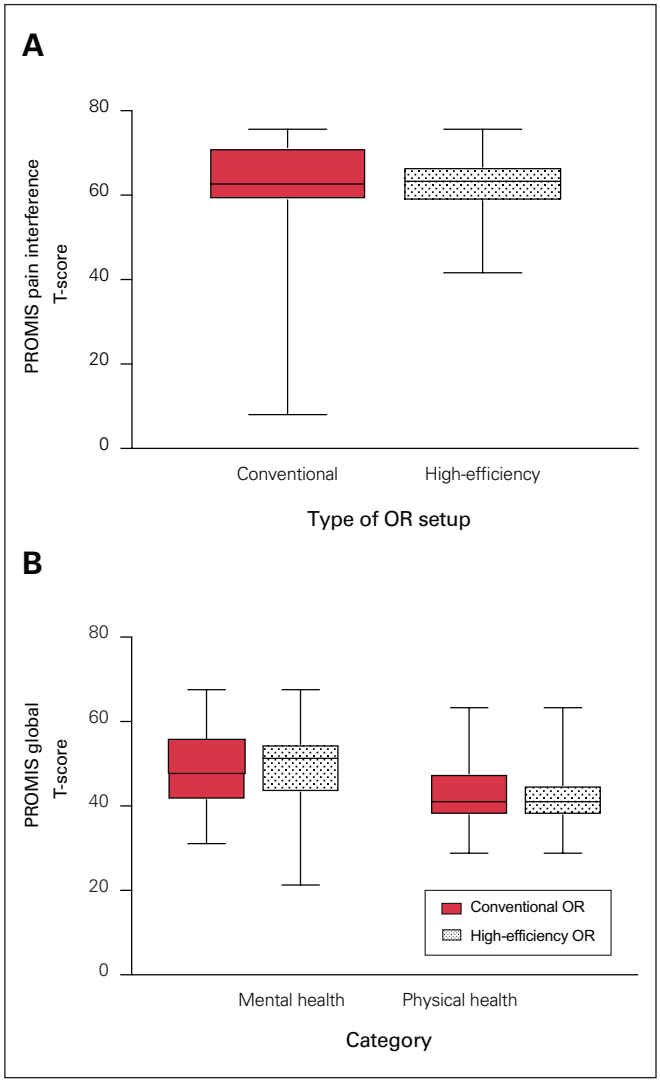

Fig. 2. Patient health outcomes as measured by the Patient-reported Outcomes Measurement Information System (PROMIS): (A) pain interference; and (B) global (mental and physical health) scores. T-scores were compared with those of the general North American population. In the box-and-whisker plots, the box represents the median and interquartile range; the whiskers represent the most extreme values within 1.5 times of the interquartile range beyond the 25th and 75th percentile. OR = operating room.

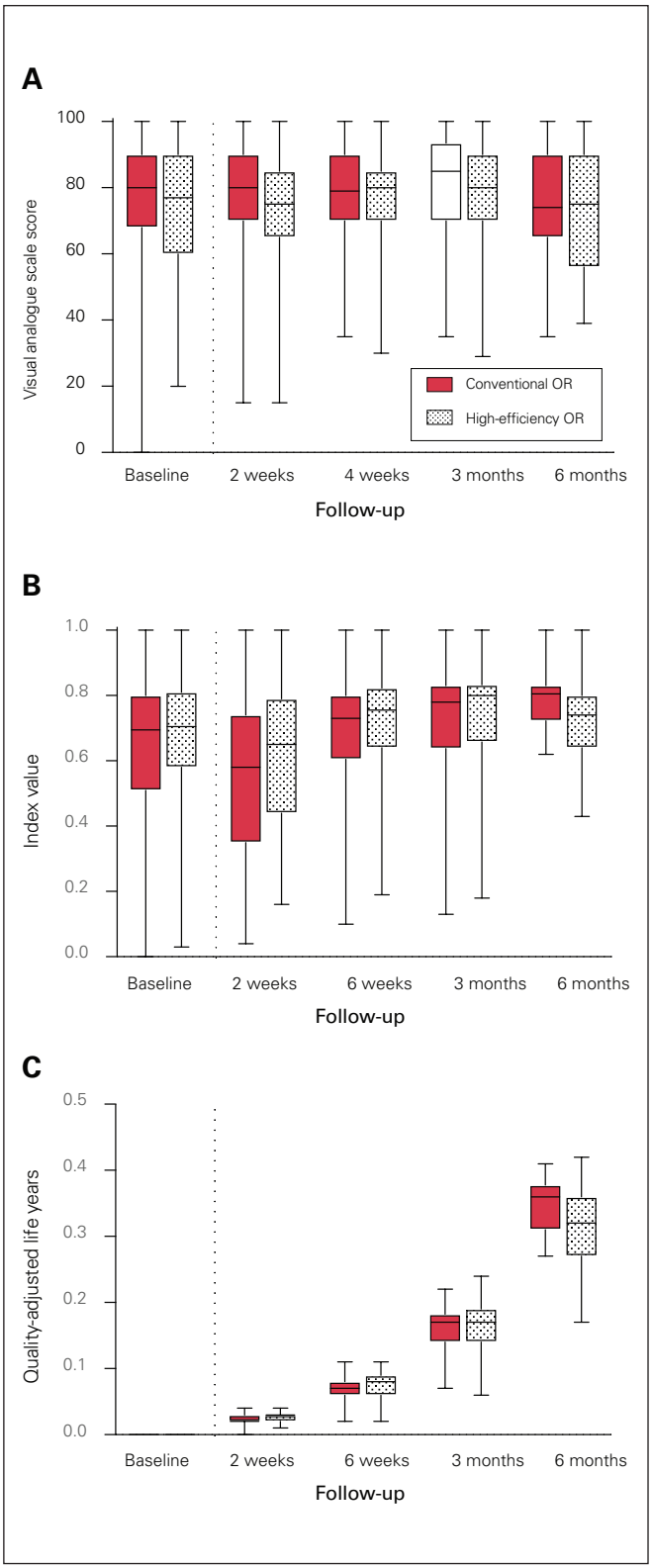

Fig. 3. Patient health outcomes as measured by EQ-5D-5L: (A) visual analogue scale (VAS) score of overall health, (B) index value and (C) quality-adjusted life years. In the box-and-whisker plots, the box represents the median and interquartile range; the whiskers represent the most extreme values within 1.5 times of the interquartile range beyond the 25th and 75th percentile.

Table 5: Patient satisfaction with the preoperative surgical experience

Topic; OR type	% of patients; degree of agreement: Yes, definitely	Yes, somewhat	No	*p* value
There was sufficient information in the presurgery package				
Conventional	75	22	3	0.16
High efficiency	84	16	0	
Patient was given easy-to-understand presurgery instructions				
Conventional	84	13	3	0.14
High efficiency	92	8	0	
Surgeon listened carefully to patient				
Conventional	88	11	1	0.66
High efficiency	92	7	1	
Surgeon spent adequate time with patient				
Conventional	77	20	3	0.54
High efficiency	82	17	1	
Patient was encouraged to ask questions				
Conventional	74	21	5	0.27
High efficiency	81	12	7	
Surgeon showed respect for patient's perspective				
Conventional	89	10	1	0.40
High efficiency	94	6	0	
Image helped patient to understand procedure				
Conventional	85	11	4	0.92
High efficiency	86	11	3	
Stress relief*				
Conventional	75	22	3	0.95
High efficiency	77	20	3	

OR = operating room. The standard Consumer Assessment of Healthcare Providers and Systems (CAHPS) questionnaire was used.

*The patient was made to feel calm and relaxed on the day of their procedure.

outcomes.[3,4,28–30] In our study, the lack of difference in patient satisfaction levels might be explained by patients requiring surgery because of the presence of substantial preoperative pain and placement on the wait list for a longer duration in the high-efficiency OR group, even though these patients appeared to have a higher functional and activity status than those in the conventional OR group.

Staff acceptance and satisfaction were also important to our study: they play a key role in the success of any surgical setup.[31] As found previously, staff prefer the ambulatory care surgical format because it reduces the need for overtime or call schedules.[32] We found similar levels of satisfaction between the conventional and high-efficiency ORs: the high-efficiency OR

Table 6: Patient satisfaction with the postoperative surgical experience

Topic; OR type	% of patients; degree of agreement: Yes, definitely	Yes, somewhat	No	*p* value
Outcome of surgery was explained to patient				
Conventional	48	34	18	0.30
High efficiency	55	35	10	
Patient was informed what to expect during recovery period				
Conventional	54	31	15	0.23
High efficiency	61	32	7	
Patient was given information on emergency symptoms				
Conventional	72	15	13	0.25
High efficiency	71	22	7	
Patient was given instructions on recovery period				
Conventional	69	22	9	0.52
High efficiency	75	20	5	
Sufficient pain relief was provided before discharge				
Conventional	77	11	12	0.12
High efficiency	83	13	4	
Surgeon gave enough attention to patient postoperatively				
Conventional	77	20	3	0.24
High efficiency	88	9	3	
Surgeon spent enough time with patient postoperatively				
Conventional	65	25	10	0.56
High efficiency	74	20	6	

OR = operating room. The standard Consumer Assessment of Healthcare Providers and Systems (CAHPS) questionnaire was used.

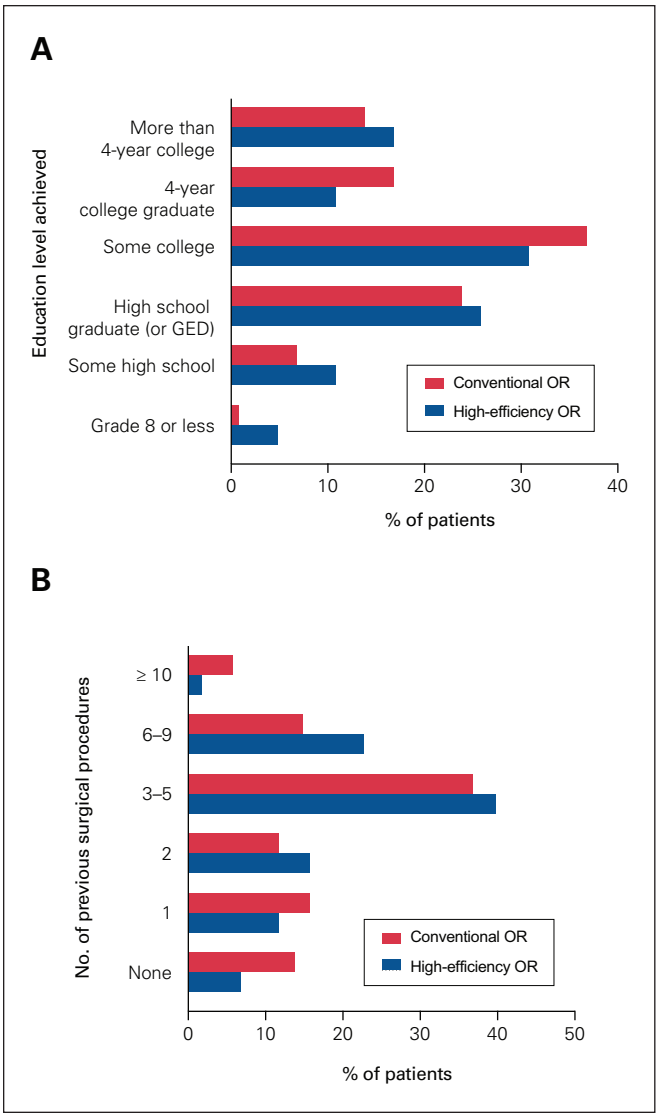

Fig. 4. Education level (A) and experience with previous surgical procedures (B) of patients in the conventional and high-efficiency operating room (OR) groups. GED = General Educational Development certificate; HS = high school.

setup was readily accepted by participants from all 3 assessed professions (anesthesiologists, surgeons, nurses), whose roles in this setup were similar to those in cross-functional teams at other institutions.[33] Surgeons appeared to be the most satisfied with the high-efficiency OR, even though they had fewer instruments to work with and no scrub nurse was present.[34]

The results of our study were the foundation for creating a stand-alone surgical centre, which has been operational for a year. The LHSC Surgicentre services multiple surgical disciplines and is currently under its first expansion, from 2 to 3 ORs, with plans to eventually move to 6 ORs.

Limitations

There were some limitations to our study. First, given the requirement and nature of the procedures, only relatively healthy patients were able to participate. Second, calculated T-scores for PROMIS can only be compared with those of a general North American population rather than a specific Canadian demographic (no Canadian data were available at the time of the study). Finally, there was some patient loss to follow-up, particularly at 6 months.

Conclusion

The use of a tiered OR for ambulatory surgery appears to offer a safe alternative to patients requiring low-resource surgery, to speed up patient access to low-priority surgical procedures. It can minimize the impact of unacceptable wait times, assuming that anesthesia prescreening rules are met. As such, otherwise-healthy

Table 7: Staff satisfaction with work environment, by staff group

Satisfaction category	Score, mean ± SD; staff group: Nursing *n* = 35	Surgery *n* = 8	Anesthesia *n* = 25	*p* value
Team rating	8.5 ± 1.1	9.3 ± 1.0	8.5 ± 1.4	0.28
Intra-team courtesy	8.5 ± 1.4	9.3 ± 1.0	8.9 ± 1.2	0.30
Communication and cooperation	8.3 ± 1.2	9.3 ± 1.0	8.4 ± 1.3	0.13
Team morale	6.8 ± 2.1	9.3 ± 1.0	8.3 ± 1.2	< 0.001
Personnel morale	8.3 ± 1.7	8.9 ± 1.7	8.6 ± 1.3	0.57
Setup preference for family*	9.2 ± 0.9	9.2 ± 1.0	8.8 ± 1.1	0.29
Average score	8.3	9.2	8.6	

SD = standard deviation. Standard Institute for Healthcare Improvement questionnaire was used.

*The preference indicated by the family members or friends who accompanied the patient to the hospital for their procedure with respect to whether the procedure would be done using the conventional or high-efficiency setup.

Table 8: Satisfaction among staff working in conventional and high-efficiency operating rooms

Staff group and satistfaction category	Score, mean ± SD; OR type: Conventional	High-efficiency	*p* value
Anesthesia staff			
Level of stress during preparation	4.3 ± 1.3	4.5 ± 1.2	0.82
Adequacy of preparatory time	6.3 ± 1.3	5.7 ± 1.3	0.34
Quality of communication	8.2 ± 1.2	7.6 ± 1.3	0.27
Surgical staff			
Level of stress during preparation	9.3 ± 1.3	9.5 ± 1.3	0.67
Adequacy of preparatory time	7.5 ± 1.3	9.8 ± 1.3	0.11
Quality of communication	9.0 ± 1.2	9.8 ± 1.2	0.17
Nursing staff			
Level of stress during preparation	5.0 ± 2.1	4.7 ± 1.8	0.79
Adequacy of preparatory time	4.9 ± 1.7	6.2 ± 1.4	0.30
Quality of communication	7.6 ± 1.1	6.9 ± 0.9	0.45
Anesthesia information	3.0 ± 1.7	2.3 ± 1.7	0.59
Discharge planning	1.8 ± 1.1	2.0 ± 1.1	0.89

OR = operating room; SD = standard deviation. Standard Institute for Healthcare Improvement questionnaires were used.

patients can be offered the option of having the required surgical procedure on an ambulatory basis, freeing up space in the conventional OR for patients who have complex health conditions or who require more complex procedures.

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