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Improving Access to Minimally Invasive Hysterectomy for Large Uteri in a Community-Focused Academic Center

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Abstract

Background: Despite the benefits of laparoscopic hysterectomy, uterine size remains a common indication for abdominal hysterectomy.

Objective: This study aims to assess whether a quality improvement (QI) intervention to increase alignment of pre-operative evaluation and the ultimate surgical route improves access to laparoscopic hysterectomy and reduces conversion from laparoscopy to laparotomy.

Methods: A before-and-after single-center, single-phase QI project was conducted. Women aged ≥18 years undergoing hysterectomy for benign indications from 2019–2024 were included. Patients with malignant pathology, concomitant urogynecologic procedures, and those with missing data were excluded. At our institution, a group approach was employed in which the route-deciding surgeon may differ from the operating surgeon, leading to discrepancies in surgical feasibility and high conversion rates. The QI intervention consisted of routing all patients with uteri ≥16 weeks to a group of surgeons with minimally invasive surgery (MIS) expertise for both pre-operative planning and operative management. Data collected included demographics, comorbidities, prior surgeries, surgical routes, complications, and length of hospital stay. Cases were stratified by uterine weight.

Results: Of 906 total hysterectomies, 724 (79.9%) occurred pre-intervention and 182 (20.1%) post-intervention. Following the QI, the overall rate of planned MIS significant-

ly increased from 78% to 92% ($p < 0.001$). Among patients with uteri weighing >500 g (approximately 16-week size), MIS rose from 37% to 82% ($p < 0.001$). Same-day discharge significantly increased from 57% to 76% ($p < 0.001$). No significant difference in complication rates was observed. The overall laparoscopy to laparotomy conversion rate declined from 5.9% to 0.5% ($p = 0.002$), and from 10.8% to 0% ($p = 0.01$) in patients with large uteri.

Conclusion: The involvement of MIS-trained surgeons in both planning and execution was associated with increased access to laparoscopic hysterectomy and a reduced conversion rate to laparotomy, particularly in patients with large uteri. This QI study provides Class III evidence.

***Keywords*:** Large uteri; Minimally invasive hysterectomy; Quality improvement

INTRODUCTION

In the United States of America (USA), approximately 14.6% of all adult women have undergone a hysterectomy, making it one of the most common gynecologic procedures.[1] Hysterectomies can be performed via different routes, with minimally invasive approaches preferred over laparotomy due to their shortened hospitalization and post-operative recovery times.[2,3] Laparoscopic hysterectomies have also been associated with lower reported pain scores, faster return to normal activity, fewer surgical site infections, and decreased risk of venous thromboembolism when compared with the abdominal approach.[4,5] Expert gynecologic surgeons have demonstrated the feasibility of minimally invasive routes for large uterine specimens, even exceeding 1,000 g.[1,6-8] Given the benefits of minimally invasive surgery (MIS), hospital systems strive to increase access to these techniques, with some centers achieving up to 96.7% of all hysterectomies performed minimally invasively.[9,10]

Despite data supporting the safety of MIS for large specimen hysterectomy, uterine size continues to be cited as a common indication for abdominal hysterectomy.[7] Additionally, limitations in visualization, exposure, and the need for tissue extraction may increase the rate of conversion to laparotomy. Large-specimen minimally invasive hysterectomies can be complex and present additional challenges for the general obstetrician-gynecologist, with prior studies suggesting that graduating residents may be underprepared to independently perform complex surgical gynecology.[11-13] Moreover, inadequate reimbursement for gynecologic surgery has contributed to a high prevalence of low-volume surgeons, which may be associated with higher complication rates, thereby further widening the gap in access to high-quality surgical care.[14]

At our institution, systems-based scheduling constraints have resulted in a team-based care model in which the surgeon determining the route of hysterectomy is not always the surgeon who ultimately performs the procedure. To address these limitations, we implemented a single-center, single-phase quality improvement (QI) initiative comprising the following: (i) pre-operative assessment and examination of patients with large uteri exclusively performed by a group of surgeons with MIS expertise; and (ii) surgery for these patients performed by the same group of surgeons.[15,16] Our objective was to assess whether this bundle is associated with increased access to minimally invasive hysterectomy and whether this intervention is associated with a reduction in the current conversion rate from laparoscopy to laparotomy.

MATERIALS AND METHODS

This study was a before-and-after, single-phase QI project in the Department of Obstetrics, Gynecology and Reproductive Sciences, Division of Advanced Minimally Invasive Gynecologic Surgery at The University of Texas Health Science Center at Houston, Texas, USA. The study was reviewed by the McGovern Medical School at The University of Texas Health Science Center Institutional Review Board and deemed to be a QI project. Upon review, it did not meet the regulatory definition of human subjects' research and did not deviate from the standard of care. Because the project qualified as a QI project and was conducted within the standard of care, informed consent was not required, and submission to the UTHealth Houston Committee for Protection of Human Subjects (CPHS) was therefore not necessary. The protocol was also approved by the QI committees for UTHealth and Harris Health (Lyndon B. Johnson General Hospital; registration number: 2023-1893).

At our institution's safety-net county academic hospital, pilot data collected between 2019 and 2023 demonstrated that 70% of hysterectomies were performed through a minimally invasive approach. In this institution, surgical patients are referred and scheduled from multiple clinics. Due to system-based schedule limitations, a group approach has been established in which the surgeon who determines the route may not be the surgeon who performs the procedure, thereby creating opportunities for discrepancy between pre-operative planning and the actual surgical route.

Pilot data showed that uterine size was a major factor in the decision to proceed with laparotomy, and the group approach was a major contributor to the low rate of MIS hysterectomy and high rate of conversion to laparotomy. For the purpose of this study, women under-

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going robotic-assisted hysterectomies, conventional laparoscopic hysterectomies, and laparoscopic-assisted vaginal hysterectomies were included in the MIS cohort. Patients undergoing vaginal hysterectomies were excluded given the exceedingly low number of large specimen hysterectomies performed via vaginal route only. The intention of the quality initiative was to implement a sustainable change in practice using a Define, Measure, Analyze, Improve, and Control framework to optimize surgical outcomes and increase access to MIS for patients with large uteri.

Participants included women aged 18 years or older undergoing hysterectomy for benign indications. Due to the nature of this study, randomization was not performed. Patients with malignant pathology, concomitant urogynecologic procedures, and those with missing data (e.g., uterine weight) were excluded. The QI intervention involved a team of surgeons with MIS expertise conducting both pre-operative assessments and surgeries for patients with large uteri (≥16-week size). Surgeons with MIS expertise were determined based on pilot data retrospectively collected and selected for their historic and consistent ability to perform complex gynecologic surgery and MIS hysterectomy for large uteri. Specifically, four surgeons were included in this group, who had either completed formal fellowship training in minimally invasive gynecologic surgery or had successfully completed more than 12 large-specimen minimally invasive hysterectomies (>500 g) in the past 12 months.

Following the QI initiative, specimen extraction during minimally invasive hysterectomy for large uteri was performed using an in-bag containment system, either via the vaginal or abdominal route. Data regarding extraction techniques were not available for all cases performed prior to the initiative; however, contained tissue extraction has been common practice at our institution for many years. The primary outcome evaluated the percentage of hysterectomies that were successfully completed through MIS. Secondary outcomes included the conversion rate from MIS to laparotomy, the rate of same-day discharge, and the rate of surgical complications.

Prior to the intervention, data were collected by reviewing electronic medical records of patient demographics, hysterectomy route, and surgical outcomes between January 1, 2019, and May 31, 2023. Data were de-identified and documented securely in REDcap. Demographic information included age, race/ethnicity, parity, body mass index, and smoking status. Additional data included medical comorbidities such as diabetes, hypertension, chronic kidney disease, and prior abdominal surgery. Other variables, including estimated blood loss (EBL), pre- and post-operative hemoglobin, need for blood transfusion, length of hospital stay, 30-day post-operative complications, emergency room visits, readmission, reoperation, and mortality, were also evaluated and obtained directly from the electronic medical record. The complication rate was examined as a composite score, as complications were infrequent, which limited the feasibility of statistically meaningful analyses when stratified by individual complication type or by severity grading systems such as Clavien–Dindo.

An integrated care platform within the electronic medical record system that includes most other major hospital systems in the Houston area was used to evaluate readmissions and emergency room visits at other institutions. The intervention was implemented on June 1, 2023, and was conducted over a 12-month period, with data collection culminating on June 1, 2024. Outcomes of interest were evaluated in the intervention group and compared to the historical control group. Differences in demographics, comorbidities, surgical routes, and outcomes were compared across uterine weight categories using descriptive statistics. Multivariable logistic regression, adjusting for confounders, was performed. The decision was made a priori that a 15% increase in the rate of MIS was considered significant and would indicate that the intervention was effective. This was selected as a meaningful benchmark based on internal baseline performance, expectations, and national targets. The results are presented as an adjusted odds ratio with a 95% confidence interval (CI). Statistical significance was established if the associated p-value was < 0.05 or the 95% CI did not cross 1. All statistical analyses were conducted using Stata (15.1, Stata Corp LLC, USA).

RESULTS

A total of 906 patients underwent hysterectomy during the study period (2019–2024). Of these, 724 (79.9%) had surgery pre-intervention, and 182 (20.1%) post-intervention.

Table 1 shows the baseline patient characteristics comparing pre- and post-intervention groups. The mean age was 43.8 years in the pre-intervention group and 44.7 years in the post-intervention group. The majority of patients were Hispanic in both groups. The pre-intervention group had more Black and fewer White patients (21% vs. 7%) compared to the post-intervention group (10% vs. 12%). The mean uterine weight in the pre-intervention group was higher at 512 g ($n = 572$) versus 419 g ($n = 470$) in the post-intervention group ($p = 0.021$). No significant differences were observed in other demographics or comorbidities.

Based on **Table 2**, the overall rate of planned MIS significantly increased from 78% to 92% after the QI intervention ($p < 0.001$). When stratified by uterine weight, the pre-operative plan for a minimally invasive surgical route for large uteri (>500 g; approximately 16-week size) increased from 47% to 78% ($p < 0.001$).

Regarding the actual surgical route (**Table 2**), following the QI intervention, a significantly higher proportion of patients underwent MIS (72% vs. 92%, $p < 0.001$). The overall conversion rate from MIS to laparotomy decreased from 5.9% to 0.5% ($p = 0.002$). In the cohort of patients with uteri > 500 g (approximately 16-week size), the rate of MIS increased from 37% to 82% ($p < 0.001$). None of the large-specimen uterus cases were converted from laparoscopy to laparotomy after the QI intervention. In this subgroup, specifically, the conversion rate decreased from 10.8% to 0% ($p = 0.011$).

Figure 1 demonstrates the trend of increasing rates of MIS for both large specimen hysterectomies and the total number of hysterectomies post-intervention, as well as a significant decrease in the conversion rate to laparotomy.

After adjusting for confounders, including race, ethnicity, and uterine

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Table 1. Baseline patient characteristics			
Characteristics	**Pre-intervention (*n* = 724)**	**Post-intervention (*n* = 182)**	***p***
Average age (years [SD])	43.8 (5.9)	44.7 (6.2)	0.960
Race (*n* [%])			
Black	152 (21)	18 (10)	<0.001***
Hispanic	464 (64)	107 (59)	
White	53 (7)	23 (12)	
Other	56 (8)	34 (19)	
Ethnicity (*n* [%])			
Hispanic	513 (70.9)	151 (82.9)	0.001**
Non-Hispanic	211(29.1)	31 (17.04)	
Mean body mass index (mean [SD])	32.88 (6.7)	32.64 (7.3)	0.667
Mean uterine weight (g; mean [SD])	512(572)	419 (470)	0.021*
Parity (*n* [%])			
Nulliparous	59 (8.2)	11 (6.1)	0.342
Parous	665 (91.8)	171 (93.9)	
Tobacco use (*n* [%])			
No	613 (87.8)	165 (90.7)	0.287
Yes	85 (12.2)	17 (9.3)	
Diabetes (*n* [%])	105 (14.5)	27 (14.5)	0.910
Hypertension (*n* [%])	195 (26.9)	41 (22.5)	0.226
Prior abdominal surgery (*n* [%])	584 (80.7)	145 (79.7)	0.763

Note: *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$ indicate statistical significance.
Abbreviation: SD: Standard deviation.

Table 2. Pre-operative planned route versus actual surgical route			
Group	**Pre-intervention**	**Post-intervention**	***p***
Pre-operative planned route			
Large uteri (>500 g or ≥16-week size; *n*)	287	55	<0.001***
Laparotomy	152 (53%)	12 (22%)	
MIS	135 (47%)	43 (78%)	
All hysterectomies (*n*)	724	182	<0.001***
Laparotomy (*n* [%])	159 (22%)	15 (8%)	
MIS (*n* [%])	565 (78%)	167 (92%)	
Actual surgical route			
Large uteri (> 500 g or ≥16-week size; *n*)	287	55	<0.001***
Laparotomy (*n* [%])	181 (63%)	10 (18%)	
MIS (*n* [%])	106 (37%)	45 (82%)	
All hysterectomies (*n*)	724	182	<0.001***
Laparotomy (*n* [%])	200 (28%)	14 (88%)	
MIS (*n* [%])	524 (72%)	168 (92%)	
Conversion rate from MIS to laparotomy			
Large uteri (> 500 g or ≥16-week size; *n* [%])	31 (10.8%)	0 (0.0%)	-
Total (*n* [%])	43 (5.9%)	1 (0.5%)	-

Note: ***$p < 0.001$ indicates statistical significance.
Abbreviation: MIS: Minimally invasive surgery.

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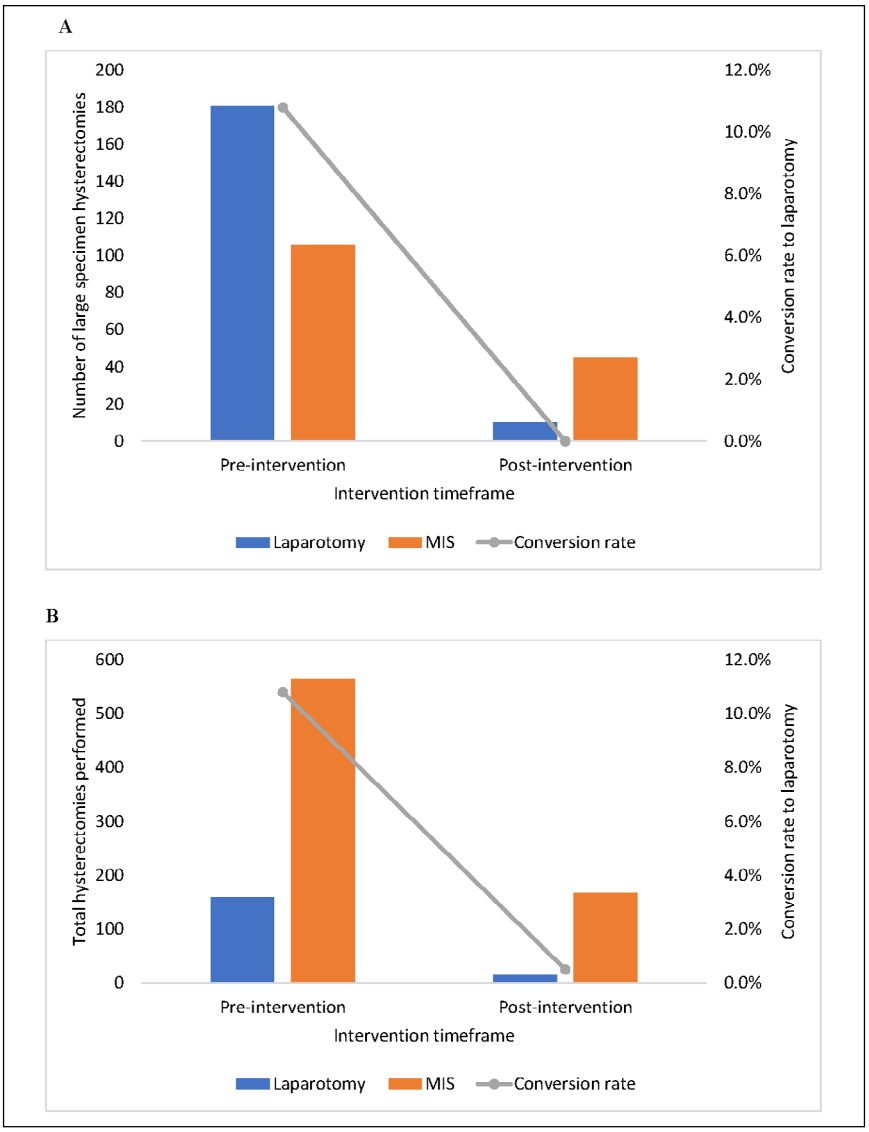

Figure 1. Pre- and post-intervention surgical routes: (A) Large specimen hysterectomies and (B) all hysterectomies
Abbreviation: MIS: Minimally invasive surgery.

size, the intervention was independently associated with a significant reduction in the odds of hysterectomy via laparotomy (odds ratio = 0.18; 95% CI = 0.09–0.355; $p < 0.001$). This association remained consistent when uterine weight was categorized as <500 g, 500–1,000 g, and >1,000 g (Table A1).

The complication rate was examined as a composite score, including variables such as venous thromboembolism, surgical site infection, acute kidney injury, ileus, and cuff complications (e.g., dehiscence, hematoma, cellulitis, separation). Based on Table 3, no significant difference in the composite post-operative complication rate for all hysterectomies was observed between groups (7.6% vs. 7.1%, $p = 0.835$). Additionally, the same-day discharge rate significantly increased from 57% to 76% ($p < 0.001$), and the mean EBL was significantly lower after the QI intervention (267 mL vs. 201 mL, $p = 0.004$).

DISCUSSION

Through coordinated efforts to increase the alignment of faculty with MIS expertise and scheduled hysterectomies, our institution observed an increase in the overall rate of MIS from 72% to 92% (Table 2). This improvement was particularly remarkable for large uteri >500 g or approximately 16-week size, where MIS rates were 37% pre-intervention and 82% post-intervention (Table 2). Across all uterine sizes, expanded access to MIS hysterectomy was associated with a lower laparoscopy-to-laparotomy conversion rate. No significant increase in surgical complications was observed post-intervention, and the same-day discharge rates were higher (76%) compared to pre-intervention, accompanied by a reduction in EBL (Table 3).

When comparing surgical routes for large specimen hysterectomy, MIS offers many advantages over laparotomy.[7,16] Mamik *et al.*[17] conducted a systematic review to evaluate the optimal hysterectomy approach for large uteri (>12-week size or >250 g) for benign indications. Their findings indicated that abdominal hysterectomies were associated with a six-fold greater risk of transfusion com-

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Table 3. Surgical outcomes

Outcome of interest	Pre-intervention	Post-intervention	*p*
Post-operative complications of all hysterectomies (*n* [%])			
None	669 (92.4%)	169 (92.9%)	0.835
Composite[a]	55 (7.6%)	13 (7.1%)	
Ureteral injury	4 (0.6%)	0 (0%)	0.315
Bladder injury	12 (1.7%)	1 (0.6%)	0.261
Bowel injury	4 (0.6%)	1 (0.6%)	0.996
VTE	4 (0.6%)	2 (1.1%)	0.417
Pyelonephritis	35 (4.8%)	5 (2.8%)	0.221
SSI	8 (1.1%)	2 (1.1%)	0.994
Acute kidney injury	3 (0.4%)	0 (0%)	0.384
Cuff complication	4 (0.6%)	1 (0.6%)	0.996
Ileus	1 (0.1%)	2 (1.1%)	0.105
Post-operative complications of uteri (> 500 g or ≥16-week size; *n* [%])			
None	258 (90%)	52 (95%)	0.278
Composite[a]	29 (10%)	3 (5%)	
ER visit (*n* [%])			
No	629 (87%)	153 (84%)	0.192
Yes	95 (13%)	29 (16%)	
EBL (mL [SD])	267 (282)	201 (275)	0.004**
Length of hospital stay (*n* [%])			
<1 day	410 (57%)	138 (76%)	<0.001***
≥1 day	314 (43%)	44 (24%)	

Notes: [a]Composite of complications includes ureteral injury, bladder injury, bowel injury, venous thromboembolism, pyelonephritis, surgical site infection, acute kidney injury, cuff complications, and ileus. **$p < 0.01$ and ***$p < 0.001$ indicate statistical significance.
Abbreviations: EBL: Estimated blood loss; ER: Emergency room; SD: Standard deviation; SSI: Surgical site infection; VTE: Venous thromboembolism.

pared to robotic-assisted total laparoscopic hysterectomies. Our results are consistent with these findings, suggesting lower EBL after the QI intervention. Furthermore, while uterine weight is an established independent risk factor for post-hysterectomy complications, laparoscopic approaches have consistently demonstrated lower odds of surgical complications compared to laparotomy, regardless of uterine size. This remains true even for extremely enlarged uteri.[7] In the present study, no significant difference in composite complication rates was observed following the QI intervention, which may reflect the overall low incidence of complications included in the composite outcome. However, the length of hospital stay was shorter, and EBL was lower in the post-intervention group, which may be attributed to known advantages of MIS approaches. Given the proven benefits of minimally invasive hysterectomy, efforts should be directed toward expanding access to these procedures whenever appropriate.

Hospitals are increasingly implementing QI projects to optimize surgical outcomes and reduce morbidity. In hysterectomies, there is concern that large uteri present technical challenges that may negate the benefits of MIS, such as increased operative time, the need for contained tissue extraction, or increased risk of complications (e.g., iatrogenic ureteral injury). It is known that gynecological procedures account for most of the iatrogenic ureteral injuries, and complex intra-abdominal pathology may further increase this risk.[18] Despite this, trained minimally invasive gynecologic surgeons have repeatedly demonstrated that, with adequate training and experience, this risk can be mitigated, benefiting the patient and reducing hospital costs.[19,20] We join a growing number of researchers in asserting that, with proper support and training, surgeons can safely pursue a MIS approach for large uteri exceeding 500 g and in patients with complex abdominal surgical history. As recommended by the American College of Obstetricians and Gynecologists, patients should be engaged in collaborative decision-making to determine the optimal surgical route.[2] In complex cases, patients should be referred to MIS-trained surgeons when available.

The success of MIS depends on sound pre-operative surgical assessment and planning. Lamersdorf *et al.*[21] reported that uterine weight, fibroid dimensions, adnexal disease, and adhesions are independent risk factors for conversion from laparoscopy to laparotomy, which may increase post-operative complications.

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Our study, which emphasized concordance between faculty performing pre-operative assessments and surgeries, suggests that MIS-trained surgeons can reliably evaluate these risk factors pre-operatively, thereby reducing the likelihood of conversion. Despite the growing evidence demonstrating the financial and medical benefits of MIS, increasing access to MIS hysterectomy requires intentional effort. QI projects can facilitate the integration of MIS approaches into complex, large-group practice settings, such as those at our hospital.

Our study data were collected over a five-year period, with the majority of outcome data collected prior to intervention implementation. This represents a potential limitation in evaluating causal relationships, as changes over time in practice patterns, Enhanced Recovery After Surgery protocols, and faculty composition may have influenced surgical approaches and outcomes but were not fully accounted for. For example, the number of fellowship-trained minimally invasive surgeons may have varied, equipment and technology may have been upgraded, and cumulative surgeon experience may have evolved during the study period, all of which could have impacted outcomes. Enhanced Recovery After Surgery protocols were employed at our institution prior to the start of data collection; however, these protocols may have evolved over time and could have influenced surgical outcomes. Additionally, the group-based care model implemented at our institution, while effective, may not be directly reproducible in all settings. However, the underlying principle of structured referral pathways to surgeons with MIS expertise is recommended and may be broadly generalizable.

The strengths of this study stem from a large sample size and well-defined, objective endpoints for minimally invasive surgical access. There was minimal loss to follow-up for post-operative check-ups, and the use of an integrated care platform within the electronic medical record system ensured that patients did not present with post-operative concerns at most other major hospital systems in the Houston area. This added an extra layer of validity to our findings. Our initial evaluation of alignment of MIS faculty with pre-operative planning and execution of large specimen hysterectomy is low-cost in nature and may be reproducible. Academic centers and group-practice environments with similar organizational structures may be able to adapt this approach to improve access to minimally invasive hysterectomy, patient outcomes, and the overall quality of surgical care.

CONCLUSION

In conclusion, patients undergoing minimally invasive hysterectomy experience fewer complications and faster recovery compared to those undergoing laparotomy. Despite this, rates of laparotomy remain unacceptably high in many institutions, with uterine size frequently cited as a limiting factor. Our QI intervention was associated with increased access to MIS and improved surgical outcomes when trained surgeons managed these complex cases. We encourage other centers to consider adopting similar referral pathways to expand access to surgeons with MIS expertise for patients with markedly enlarged uteri.

AUTHORS' DISCLOSURE

No funding was required for the completion of this project. This study was reviewed by the McGovern Medical School at The University of Texas Health Science Center Institutional Review Board on 04/21/2023 and classified as "Quality Improvement". This project was registered at both the University of Texas and Harris Health under the QI Project number 2023-1893. We acknowledge all authors have contributed to this paper and have sufficed the authorship requirements. Data is available from the authors upon reasonable request.

CONFLICT OF INTEREST

The authors report no conflicts of interest.

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APPENDIX

Table A1. Adjusted odds ratios for laparotomy after controlling for confounders

Variable	Odds ratio	*p*	95% confidence interval
Larger uterine size	34.18	<0.001***	20.68–56.50
Race			
African American	0.72	0.441	0.313–1.659
Hispanic	0.83	0.712	0.316–2.199
White	1.18	0.744	0.429–3.273
Ethnicity			
Hispanic	2.72	0.009**	1.283–5.762
Any ethnicity	0.04	<0.001***	0.017–0.114
Intervention	0.18	<0.001***	0.09–0.355

Note: $^{**}p < 0.01$ and $^{***}p < 0.001$ indicate statistical significance.

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