

GYNECOLOGY

Effect of postoperative partial bladder filling after minimally invasive hysterectomy on postanesthesia care unit discharge and cost: a single-blinded, randomized controlled trial



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BACKGROUND: Hysterectomy is one of the most common surgical procedures performed each year with substantial related health care costs. This trial studied the effect of postoperative bladder backfilling to submicturition level in the operating room and its effect on early postoperative patient care and related cost.

OBJECTIVE: The objective of the study was to compare the effect of bladder backfilling on early postoperative patient care and related cost.

STUDY DESIGN: This was a randomized, single-blinded, controlled trial conducted between April 2016 and February 2017 at a single urban university hospital providing tertiary care for minimally invasive gynecologic surgery. Ninety-one patients undergoing straight-stick laparoscopic and robot-assisted hysterectomy by minimally invasive gynecologic surgeons for benign indications were recruited. The bladder was partially backfilled with 150 mL of normal saline postoperatively in the intervention group and drained in the control group, as per standard of care. Main outcomes studied were time needed to void, time spent in the postanesthesia care unit, and postanesthesia care unit cost after minimally invasive hysterectomy. Our secondary outcomes were postoperative complications.

RESULTS: Forty-six patients (50.5%) were randomized to the intervention group, and 45 patients (49.5%) to the control group. Baseline

comparative analysis of demographics and preoperative patient-specific variables, surgical history, intraoperative characteristics, and administered medications found the 2 groups to be largely homogenous. After regression analyses for adjustment, we found a significant reduction in the time needed to void, time spent in the postanesthesia care unit, and postanesthesia care unit—associated cost in the intervention group. Patients voided 64.9 minutes earlier than the control group ($P = .015$) and spent 64 fewer minutes in the postanesthesia care unit ($P = .006$), resulting in \$401.5 (USD) saving per patient ($P = .006$). None of the patients encountered any postoperative complications.

CONCLUSION: Based on the findings of this randomized clinical trial, postoperative bladder backfilling to submicturition level shortens the time needed for patients to void in the postanesthesia care unit, resulting in shorter postanesthesia care unit stay and resultant cost savings. Conservatively projecting our findings on minimally invasive hysterectomy procedure is estimated to result in \$69 million to \$139 million (USD) per year in savings. Initiating similar investigations in other ambulatory surgical fields will likely result in a more substantial impact.

Key words: health care costs, hysterectomy, postanesthesia care unit, postoperative bladder backfilling

Recent advances in health care delivery focus on preventative medicine, the shift for conservative procedure-based management, and ambulatory surgical care (ASC) for a wide variety of clinical conditions across specialties. This change has been reflected in the field of gynecologic surgery because the number of inpatient hysterectomies has been steadily declining.¹ However, experts argue that this

perceived decline is a result of the outpatient migration of those procedures.

Nationwide inpatient census fails to capture an additional 100,000–200,000 hysterectomies performed in the ambulatory setting each year.² Hysterectomy remains one of the most common surgical procedures performed on an annual basis and accounts for more than \$5 billion (USD) in health care costs.³ The most recent inpatient census from 2010 estimates upwards of 430,000 patients receiving a hysterectomy, 40% of those performed laparoscopically and close to half discharged on the same day.^{4,5} Minimally invasive surgery for a hysterectomy has several advantages over its laparotomy counterpart.^{6–9}

We recently witnessed a considerable research effort aimed at promoting the safety of hysterectomy in the ambulatory

surgical care setting. In select tertiary care centers, same-day discharge rate is upwards of 99% after minimally invasive hysterectomy.¹⁰ As for procedures performed in outpatient surgery centers, the discharge rate is expected to be 100%.

The decision to discharge patients from the postanesthesia care unit (PACU) is dependent on clear objective criteria set to ensure patient safety. Those mostly include assessing the patient's vitals, consciousness, pain level, and functional status. Given the historically elevated rates of postoperative urinary retention after pelvic surgery, all patients are required to void before discharge.¹¹

Factors associated with urinary retention in that population are poorly understood; they include postoperative catheter management, type of anesthesia, postoperative analgesia, surgical stress, and trauma to pelvic sacral

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AJOG at a Glance

Why was this study conducted?

Minimally invasive hysterectomy is one of the most commonly performed surgical procedures in the United States. Cost optimization during such procedures is likely to have major repercussions on our health care systems.

Key findings

Partial bladder filling after hysterectomy is independently associated with cost reduction.

What does this add to what is known?

Filling the bladder to submicturition levels after hysterectomy minimizes the length of the stay in the recovery unit and associated costs.

nerves.^{12,13} The incidence of urinary retention is lower in laparoscopic hysterectomy when compared with abdominal and vaginal approaches.¹⁴

Based on our experience, the time spent in the PACU before voiding is the most common culprit in delaying patient discharge home. In our center, per the implemented enhanced recovery after surgery protocols, the Foley catheter is removed in the operating room at the conclusion of the surgical case. The delay in the urge to micturate in the absence of postoperative urinary retention is most often due to a combination of dehydration from preoperative fasting, insensible losses, and the time spent to fill an empty bladder.

Given that the initial urge to micturate is the range of approximately 300 mL, we conducted a single-blinded, randomized control trial to evaluate the effect of partially backfilling the bladder with normal saline to a submicturition-sensation level of 150 mL at the conclusion of surgery.¹⁵ We studied the impact of our intervention on the time needed to void, the time needed for discharge from PACU, and their inherent effect on cost savings.

Material and Methods

This randomized clinical trial was conducted in between April 2016 and February 2017 at a single urban university hospital providing tertiary care for minimally invasive gynecologic surgery. Given the considerable variation in surgical techniques used for hysterectomy and the significant interinstitutional differences in PACU regulations and staff

comfort with same-day discharge, we designed this study as a single site, single division to minimize bias.

Fellowship-trained, high-volume surgeons performed all the procedures. All patients were counseled on same-day discharge during a preoperative visit. The Institutional Review Board of George Washington University approved the study protocol. The trial was registered with Clinical Trials (Clinicaltrials.gov) as NCT027411531. All participants gave written informed consent at a preoperative visit or on the day of surgery. Patients were free to withdraw at any given time.

Participants

All patients between 18 and 65 years of age scheduled to undergo an elective minimally invasive hysterectomy for benign indications with the division of minimally invasive gynecologic surgery were enrolled at the outpatient clinic or on the day of surgery. All the enrolled patients were candidates for same-day discharge. Patient undergoing a minimally invasive hysterectomy through conventional straight-stick laparoscopy or the robot-assisted platform were included in our recruitment process. Patients who had baseline urinary disease or were incapable of informed consent were excluded. Similarly, patients who underwent hysterectomy for prolapse of incontinence symptoms were not included in this cohort.

Randomization

A computer-generated randomization program with random allocation was

used. Given that no standard definition exists for postoperative urinary retention, patient-specific variables were not included in the 1:1 randomization scheme. Shortly before the conclusion of the surgical case, the participating research coordinator opened a sealed envelope containing the patient's assignment. The research coordinator then notified the surgeon via a secure phone call or a secure messaging service pertaining to the patient allocation unless there were issues of patient safety or operative complications. The physician involved in backfilling the bladder at the conclusion of the case was not involved in the decision to discharge from the PACU. In addition, the patients were blinded to the intervention. The time needed to void, the time needed for discharge from the PACU, and the PACU-related costs were collected from the electronic medical record following discharge.

Interventions

At the conclusion of the hysterectomy procedure, a postoperative cystoscopy, using a 5 mm laparoscopic camera was performed for each case to ensure bladder integrity and bilateral jets as part of our standard surgical protocol. For the control group, the bladder was drained at the conclusion of the cystoscopy. For the intervention group, we partially backfilled the bladder with 150 mL of normal saline through the Foley catheter using the laparoscopic suction/irrigation device.

By using available equipment and resources, virtually no cost was added to the case. Time to void was calculated from the removal of the Foley catheter in the operating room to the time the patient voided in the PACU. Time spent in the PACU was from the time the patient was admitted to the PACU to the time of discharge from the PACU, excluding transport time.

Outcomes

Patient variables were grouped into 3 main categories. Preoperatively we collected patients' age, race, body mass index, preoperative hematocrit, parity, history of cesarean delivery, and medical

TABLE 1
Patient demographics and clinical characteristics

Variables	Control (n = 45)	Partial fill (n = 46)	Pvalue
Age, y, mean (SD)	45.0 (6.3)	43.9 (5.4)	.404
BMI, kg/m ² , mean (SD)	34.1 (9.6)	33.4 (7.7)	.777
Hematocrit, %, mean (SD)	35.6 (5.9)	36.4 (4.5)	.432
Race/ethnicity			.297
African American	34 75.5%	28 60.8%	
White	5 11.1%	11 23.9%	
Asian	0 —	1 2.1%	
Hispanic	6 13.3%	5 10.8%	
Other	0 —	1 2.1%	
Parity			.749
0	14 31.1%	14 30.4%	
1	11 24.4%	7 15.2%	
2	8 17.7%	12 26.0%	
3 or more	12 26.0%	13 28.2%	
Current smoker (yes/no)	1 2.2%	2 4.4%	1.000
Heart disease (yes/no)	16 35.5%	9 20.0%	.100
Diabetes (yes/no)	3 6.6%	4 8.8%	.694
Asthma (yes/no)	6 13.3%	5 11.1%	.748
Thyroid disease (yes/no)	0 0.0%	7 15.5%	.012 ^a
Neuropathy (yes/no)	5 11.1%	7 15.5%	.535
Deep vein thrombosis (yes/no)	2 4.4%	1 2.2%	1.000

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and surgical history. For intraoperative variables we collected the operative time (time from first skin incision to the time of completed skin closure), time from anesthesia induction to extubation, uterine weight, estimated blood loss, intravenous fluid, urine output, qualitative assessment of adhesive disease severity, and organ injury.

We also collected all the medications given by the anesthesia team, intraoperatively, and in the PACU. Lastly, to assess the safety profile of the partially backfilling of the bladder, we gathered postoperative variables including reoperation, readmission, intensive care unit admission, deep vein thrombosis, pulmonary embolism, cuff cellulitis, cuff dehiscence, surgical site infection, and ileus.

Our outcomes of interest were time needed to void, total time spent in the PACU, and PACU-related cost. Comparisons between the 2 groups were made using Student or Satterthwaite *t* tests for normally distributed continuous variables and a Wilcoxon rank sum test for skewed variables. A Pearson's χ^2 or Fisher exact test was used for categorical variables, as appropriate. For all analyses, $P < .05$ was considered to be significant. Analyses were done using SAS version 9.4 (SAS Inc, Cary, NC).

Results

Ninety-one patients were included in our final analysis. Forty-six patients (50.4%) were randomized to the intervention group, and 45 (49.4%) patients to the control group. One patient originally assigned to the control group sustained a bladder injury intraoperatively and was excluded from the analysis.

The 2 groups were compared for differences in demographics and patient characteristics (Table 1), intraoperative characteristics (Table 2), and administered medications (Table 3). The 2 groups were found to be largely homogenous. We found a difference in thyroid disease ($P = .01$) and Rocuronium ($P = .03$) dose administered. Given that the 2 cohorts were homogenous for all other tested variables, we assumed successful randomization.

For the outcomes of interest, we used the *t* test for comparison. A generalized

TABLE 1
Patient demographics and clinical characteristics (continued)

Variables	Control (n = 45)	Partial fill (n = 46)	Pvalue
History of cesarean delivery (yes/no)	10 22.2%	12 26.0%	.667
History of laparoscopic myomectomy (yes/no)	0 —	1 2.1%	1.000
History of abdominal myomectomy (yes/no)	1 2.2%	4 8.7%	.361
History of otherwise unspecified laparoscopy (yes/no)	9 20.0%	8 17.3%	.750
History of otherwise unspecified laparotomy (yes/no)	2 4.4%	2 4.3%	1.000

BMI, body mass index.

^a Statistically significant.

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linear model was used as a confirmatory analysis to adjust for age, body mass index, race, Neostigmine, intravenous

fluids, thyroid disease, and Rocuronium. We found a statistically significant decrease in time needed to void

($P = .01$), total time spent in the PACU ($P = .007$), and PACU-related cost ($P = .005$) (Table 4).

After adjustment, we found a significant reduction in the time needed to void, PACU time, and PACU cost in the intervention group. Patients voided 64.9 minutes earlier than the control group ($P = .01$) and spent 64.5 fewer minutes in the PACU ($P = .006$) (Table 4). The decrease in time spent in the PACU translated into a significant reduction in PACU-related cost: an average of \$401.5 (USD) ($P = .006$) per patient (Table 4 and Figure). None of the patients encountered any postoperative complications, suggesting the safety of bladder backfilling but limiting our statistical analysis for those variables.

Comment

Our findings suggest that partial bladder filling after hysterectomy is associated with a significant decrease in time spent in the PACU, which led to a substantial reduction in PACU-related cost spending. Given the scant evidence in the literature about bladder dysfunction and time needed to void after hysterectomy, we studied all variables thought to affect bladder function in that setting. A comprehensive review of patient demographics and comorbidities, intraoperative characteristics, and anesthetic and analgesic medication used were collected for analysis. We limited our trial to 1 institution and strived to apply strict surgeon-related inclusion criteria to ensure high-quality data and minimize surgeon and institution-related bias.

After the initial comparative analysis between the 2 randomized cohorts, they were found to be largely homogeneous for all the factors studied. On average patients who were randomized to partial bladder backfilling voided 64 minutes earlier and spent 64 fewer minutes in the PACU, resulting in \$401 (USD) in cost savings per case.

Based on the most conservative approximations, 272,000 minimally invasive hysterectomies are performed yearly in the United States.^{1–5} With PACU minute costs in the range of \$4–8 (USD) per minute,¹⁶ our virtually free-of-charge

TABLE 2
Intraoperative characteristics

Variables	Control (n = 45)	Partial fill (n = 45)	Pvalue
Minimally invasive route			.952
Robotic	34 75.5%	33 75.0%	
Laparoscopic	11 24.4%	11 25.0%	
Operative time, min, mean (SD)	101.2 (38.6)	91.7 (36.1)	.235
Time from intubation to extubation, min, mean (SD)	131.8 (44.5)	119.2 (37.2)	.148
Urine output, mL, mean (SD)	230.2 (124.8)	190.4 (89.1)	.103
Intravenous fluid, mL, mean (SD)	1526.1 (596.9)	1281.6 (430.2)	.057
Estimated blood loss, mL, mean (SD)	117.5 (138.1)	108.4 (150.0)	.475
Uterine specimen weight, g, mean (SD)	490.6 (418.5)	469.7 (384.5)	.807
Organ injury (yes/no) ^a	1 2.22%	2 4.44%	1.000

^a Not affecting urinary system or same-day discharge.

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TABLE 3
Intraoperative and postoperative medication characteristics

Variables	Control (n = 44)	Partial fill (n = 46)	Pvalue
Anesthesia medications			
Propofol, mg, mean (SD)	177.1 (34.2)	183.8 (50.8)	.921
Midazolam, mg, mean (SD)	1.9 (0.4)	1.9 (0.5)	.636
Lidocaine, mg, mean (SD)	80.2 (44.0)	101.8 (79.5)	.644
Neostigmine, mg, mean (SD)	3.9 (1.5)	3.6 (1.1)	.060
Rocuronium, mg, mean (SD)	63.0 (41.1)	49.9 (16.5)	.038 ^a
Ketamine, mg, mean (SD)	2.9 (9.8)	9.1 (21.1)	.165
Succinylcholine, mg, mean (SD)	19.1 (41.8)	20.4 (41.0)	.867
Ketorolac, mg, mean (SD)	8.7 (13.7)	10.9 (14.6)	.458
Intraoperative medications			
Fentanyl (yes/no), n (%)	42 (93.3)	42 (93.3)	1.000
Dilaudid (yes/no), n (%)	13 (28.9)	8 (17.7)	.213
Glycopyrrolate (yes/no), n (%)	42 (93.3)	41 (91.1)	.694
Phenylephrine (yes/no), n (%)	8 (17.7)	8 (17.7)	1.000
Morphine (yes/no), n (%)	2 (4.4)	1 (2.2)	1.000
Esmolol (yes/no), n (%)	6 (13.3)	6 (13.3)	1.000
Scopolamine (yes/no), n (%)	3 (6.7)	4 (8.9)	1.000
PACU medications			
Fentanyl (yes/no), n (%)	35 (77.7)	39 (86.6)	.270
Dilaudid (yes/no), n (%)	29 (64.4)	26 (57.7)	.517
Morphine (yes/no), n (%)	5 (11.1)	2 (4.4)	.434
Zofran (yes/no), n (%)	13 (28.8)	9 (20.0)	.327
Toradol (yes/no), n (%)	9 (20.0)	10 (22.2)	.796
Benadryl (yes/no), n (%)	3 (6.6)	2 (4.4)	1.000
Metoclopramide (yes/no), n (%)	5 (11.1)	5 (11.1)	1.000
Dexamethasone (yes/no), n (%)	2 (4.4)	1 (2.2)	1.000
Oxycodone (yes/no), n (%)	38 (84.4)	32 (71.1)	.128
Naloxone (yes/no), n (%)	3 (6.6)	1 (2.2)	.616

PACU, postanesthesia care unit.

^a Statistically significant.

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minor intervention is expected to save \$71 million to \$150 million (USD) per year on the health care system with likely no negative impact on the patient well-being. If this number is generalized to all surgical interventions requiring patients to void before discharge to mitigate postoperative urinary retention related morbidity, the associated cost savings are estimated to be much higher.

Also, with evidence showing that surgical cases ending later in the day are

more likely to be admitted overnight for that sole reason, shorter PACU stays will likely have a positive impact on same-day discharge.¹⁷

The strength of our study is based on the design; even though our trial was single blinded, it performed like a double-blinded, randomized control study. Patients were blinded to which group they were allocated, and staff involved with backfilling the bladder were not involved in the discharge

decision, which was made solely by the PACU staff when all the criteria for safe discharge were met.

Inherent to our study design is the strict surgeon inclusion criteria that eliminated surgeon case-volume bias. With robust evidence suggesting that surgeon caseload significantly affect postoperative outcomes, we ensured that all the cases recruited for analysis were performed by high-volume, fellowship-trained surgeons with more than 500 cases performed individually before the initiation of the study.¹⁸ Given the academic setting in which those procedures were performed, each case had a fellow in training or resident involved.

Also, our single-site design eliminated bias imposed by PACU and hospital ancillary staff shown to affect the decision to discharge patients from the PACU.¹⁹ Given the limited knowledge about postoperative bladder dysfunction after hysterectomy, another strength of our study is the holistic approach we used while collecting variables for analysis.

This study also has some limitations. The highly specialized setting in which our study was performed make our results less generalizable to other specialties or the general gynecological practice before additional larger multi-center studies are conducted. Another weakness is the null number of postoperative complications. Implementing the same project on a larger scale will improve detection of rare occurrences but jeopardizes the setting in which this study was conducted.

Conclusion

Based on the findings of this randomized clinical trial, postoperative bladder backfilling to submicturition level shortens the time needed for patients to void in the PACU, resulting in a shorter PACU stay and resultant significant cost savings. Standardizing postoperative bladder backfilling into a protocol after a minimally invasive hysterectomy procedures is likely to have significant beneficial effects on the patient quality of care and cost savings. The easy generalizability of such practice to other procedures and surgical fields will likely result in a stronger impact. ■

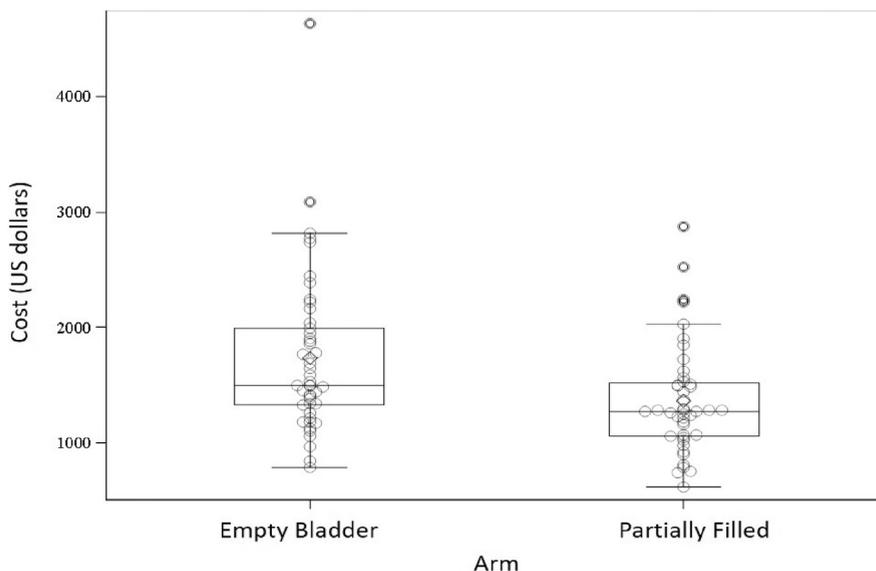
TABLE 4
Main outcomes

Variables	Control	Partial fill	Difference	95% CI	P value
Time to void, min, n	44	44			
mean (SE)	231.2 (17.3)	173.9 (15.9)	57.3	10.7–104.1	.017
Time spent in PACU, min, n	45	46			
mean (SE)	278.5 (16.7)	221.9 (12.0)	56.6	15.8–97.4	.007
PACU-related cost (USD), n	45	44			
mean (SE)	1736.4 (104.3)	1367.9 (71.3)	368.5	116.4–620.7	.005
Generalized linear model ^a	Control	Partial fill	Adjusted difference	95% CI	P value
Time to void, min, n	42	43			
mean (SE)	228.9 (29.0)	164.0 (23.2)	64.9	12.9–116.9	.015
Time spent in PACU, min, n	43	43			
mean (SE)	273.0 (25.5)	208.4 (20.4)	64.5	19.0–110.0	.006
PACU-related cost (USD), n	43	42			
mean (SE)	1737.1 (166.6)	1335.5 (136.0)	401.6	116.1–687.1	.006

Note, n's for generalized linear model are smaller because of missing values for either the outcome or the adjustment covariates. CI, confidence interval; PACU, postanesthesia care unit.

^a Adjusted for age, body mass index, rocuronium, neostigmine, intravenous fluids, and thyroid disease.

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FIGURE
Effect of partial bladder filling on PACU-related cost

The median is indicated by the line dividing the box into 2 parts. The inner quartile range is indicated by the box and represents the middle 50% of the data. Whiskers represent the largest or smallest values within 1.5 times the inner quartile range.

PACU, postanesthesia care unit.

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