# Open vs. Minimally Invasive Hysterectomy: Commercially Insured Costs and Readmissions

**Kathryn Fitch, RN, MEd[1]; Warner Huh, MD[2]; Andrew Bochner, ASA, MAAA[1]**

[1]Milliman Inc.; [2]University of Alabama at Birmingham

## ABSTRACT

**Purpose:** To analyze commercial payer differences in the average costs and readmission rates between inpatient open hysterectomies and three types of outpatient hysterectomies: laparoscopic, laparoscopic assisted, and vaginal.

**Design/Methodology:** A retrospective claims data analysis was conducted using the 2012 and 2013 Truven Health Analytics MarketScan Commercial Claims and Encounter Database.

The study was limited to women 18–64 years old who had pharmacy coverage, 12 months of commercial insurance coverage in 2012, and at least 1 month in 2013.

Readmission costs were capped at $100,000 and outpatient hysterectomy costs were adjusted to be on the same basis as open costs based on the portion of cancer cases, geographic region, and risk profile.

**Results:** There were 21,926 hysterectomy cases meeting our criteria. Total average allowed costs for the day of surgery and 30 days following surgery were statistically significantly higher for inpatient open hysterectomies than outpatient hysterectomies (cost differences of $1,270 for laparoscopic, $2,764 for assisted laparoscopic, and $4,582 for vaginal; $P$<.001 for all comparisons). Readmission rates within 30 days following surgery were statistically significantly higher for inpatient open hysterectomies (3.05 per 100 cases) than those for outpatient laparoscopic (2.10 per 100 cases; $P$<.001) and assisted laparoscopic (2.17 per 100 cases; $P$=.01) hysterectomies, but not for vaginal hysterectomies (2.46 per 100 cases; $P$=.16).

**Conclusion:** Inpatient open hysterectomies have statistically significantly higher average allowed costs than outpatient laparoscopic, laparoscopic assisted, and vaginal hysterectomies and statistically significantly higher readmission rates than outpatient laparoscopic and laparoscopic-assisted hysterectomies.

## INTRODUCTION

Hysterectomy is one of the most commonly performed major surgical procedures in women of reproductive age (Whiteman 2008). In the United States, approximately 600,000 hysterectomies are performed each year, with more than a third of women having undergone the procedure by the age of 60 years (Whiteman 2008). Similarly, the number of hysterectomies performed annually in other countries is high relative to the size of their respective female populations: approximately 150,000 in Germany (Stang 2011), 100,000 in the United Kingdom, 60,000 in France, and 30,000 in Australia (Garry 2005). Common indications for hysterectomy include uterine leiomyoma, endometriosis, uterine prolapse, cancer, endometrial hyperplasia, cervical dysplasia, and menstrual disturbances (Whiteman 2008).

Several surgical approaches are used to perform hysterectomy (Roumm 2005). Open abdominal hysterectomy, the most common and invasive approach, involves removing the uterus (with the ovaries and surrounding tissue, if necessary) through an abdominal incision (Roumm 2005, Warren 2009).

All other approaches, including both vaginal and laparoscopic hysterectomies, are classified as minimally invasive procedures (Warren 2009). Vaginal hysterectomy is performed as a total vaginal procedure (uses vaginal hysterectomy techniques only). Laparoscopic hysterectomy can be performed in one of three ways: (1) as a total laparoscopic hysterectomy (uses laparoscopic hysterectomy techniques only, with or without robotics); (2) as a laparoscopic-assisted vaginal hysterectomy (uses both laparoscopic and vaginal hysterectomy techniques); or (3) as a laparoscopic supracervical hysterectomy (uses laparoscopic techniques but with retention of the cervix) (Warren 2009). The choice of surgical approach is generally based on surgical indication, reimbursement considerations, training and expertise of the surgeon, and patient preference (Roumm 2005).

In recent years, the use of laparoscopic techniques has become increasingly common in the U.S. (Warren 2009) In fact, a large retrospective study (N=530,154) investigating national trends in the distribution of hysterectomy approaches found that the percentage of hysterectomies performed laparoscopically increased from 11% to 29% between 2003 and 2010 (Lee 2014). Furthermore, guidelines set forth by professional societies and organizations in the United States and Europe now recommend the use of minimally invasive hysterectomy procedures for both benign indications and endometrial cancer (ACOG 2009, AAGL 2011, Practice 2015, Colombo 2013).

Numerous studies have reported the economic outcomes associated with open compared with minimally invasive hysterectomy (Warren 2009, Lenihan 2004, Barnett 2010). The published literature suggests that laparoscopic hysterectomy is generally associated with greater clinical benefits than open hysterectomy, but data are lacking on the rate and cost of readmission. The purpose of the current study was to analyze differences in the average costs and 30-day readmission rates between inpatient open hysterectomies and three types of outpatient hysterectomies (laparoscopic, laparoscopic-assisted, and vaginal).

## METHODS

We performed a retrospective claims data analysis using the 2012 and 2013 Truven Health Analytics MarketScan Commercial Claims and Encounter Database (MarketScan), an information resource that includes the annual enrollment and paid health care claims of approximately 50 million commercially insured individuals covered by the benefit plans of large employers, health plans, and governmental and public organizations nationwide.

The denominator population in the study was limited to full-time employees and their dependents who were not in capitated plans, had eligibility in all months of 2012 and >1 month in 2013, and had pharmacy coverage during all months of eligibility. The study population included women aged 18 to 64 years with a 2013 claim for one of four hysterectomy types (open, laparoscopic, laparoscopic-assisted, and vaginal) identified by International Classification of Diseases Ninth Edition (ICD-9) and/or Current Procedural Terminology/Healthcare Common Procedure Coding System (CPT) codes in Table 1.

Open hysterectomy cases were required to be inpatient, identified using the place of service code 21. In addition, open hysterectomy inpatient cases were required to be coded with one of the following open hysterectomy Diagnosis-Related Group (DRG) codes: 734, 735, 736, 737, 738, 739, 740, 741, 742, or 743.

Outpatient laparoscopic, laparoscopic-assisted, and vaginal hysterectomies were required to be outpatient, identified using a place of service code of 11 (office), 22 (outpatient hospital), or 24 (ambulatory surgical center).

Cancer cases were identified based on the following ICD-9 codes appearing in any position of the index surgery claim: 179, 180.x, 182.x, 233.1, 233.2, or 236.0. Inpatient open hysterectomies without a cancer diagnosis, but with a DRG code indicating malignancy (736, 737, 738, 739, 740, or 741), were excluded because we could not reliably designate them as cancer or noncancer cases. Robotic assistance cases were excluded using ICD-9 add-on procedure codes 17.41-17.45 and 17.49 or CPT code S2900. Cases coded with more than one of the four hysterectomy types on the index procedure claim were excluded from the analysis.

We calculated the average allowed facility and professional costs during the hysterectomy stay for inpatient cases and on the day of surgery for outpatient hysterectomy cases, as well as all costs in the 30 days after discharge for inpatient cases and 30 days after the procedure date for outpatient cases. We identified readmissions that initiated within 30 days of the discharge/procedure date for each case and calculated a rate of readmission per hysterectomy type and the cost contribution of readmission per case. To adjust for random variation in outlier costs, we capped each 30-day readmission allowed amount at $100,000.

To compare the cost between inpatient open hysterectomy and outpatient laparoscopic, assisted laparoscopic, and vaginal hysterectomy, we adjusted for potential explanatory variables, including age, comorbidities, presence of cancer, and U. S. census region. To account for differences in the contribution of cancer cases, the outpatient hysterectomy cancer case contribution was adjusted to reflect the same contribution as the inpatient open hysterectomy cancer case contribution. An adjustment was also made to account for regional reimbursement differences when comparing outpatient hysterectomy and inpatient open hysterectomy costs. The cost adjustment—which was made for both procedure costs (inpatient stay or outpatient surgery day) and post-procedure 30-day costs—was based on member residence by major U.S. geographic census region. A specific region was not identified for 2% of the cases, so we also included an "unidentified" category region. To control for regional variation in provider fee schedule rates, outpatient hysterectomy costs were adjusted to reflect the same contribution of cases per region as that of the inpatient open hysterectomy.

We used a federally certified risk adjustment methodology developed by the U.S. Department of Health and Human Services (HHS) to account for differences in age and comorbidity when comparing the cost of inpatient open hysterectomy to outpatient hysterectomy. The methodology uses a hierarchical condition category (HCC) system to categorize diagnosis codes by severity for calculating "metal-level" risk scores (i.e., platinum, gold, silver, bronze, and catastrophic) (CDC 2013), which are intended to predict cost in the subsequent year. The risk adjuster does not adjust for differences in the severity of the underlying uterine condition.

Using 2012 MarketScan data, we identified the HHS-HCC gold metal-level risk score for each individual patient using 12 months of claims data prior to the hysterectomy admission date or outpatient procedure date. The gold metal level was chosen to best reflect the risk score for an average commercially insured population. Using individual risk scores, we calculated the mean risk score for each hysterectomy type. Using linear regression, we modeled the relationship between post-procedure 30-day costs (after applying a $100,000 outlier cap to readmissions) and the risk score for each hysterectomy type. For each hysterectomy type, we calculated the ratio between the inpatient open hysterectomy and the outpatient hysterectomy post-procedure 30-day costs predicted by the regression analysis. We adjusted the outpatient hysterectomy post-procedure 30-day costs by multiplying this ratio by the outpatient costs that already included the adjustments for regional and cancer differences and readmission outliers.

## RESULTS

We identified 21,926 cases in the 2013 MarketScan database that met the inclusion criteria for the four hysterectomy types (Table 2). Of these, 6,060 cases were inpatient open; 10,175 cases, outpatient laparoscopic; 3,415 cases, outpatient laparoscopic-assisted; and 2,276 cases, outpatient vaginal.

The mean age of the patients was significantly different when comparing inpatient open with outpatient laparoscopic and laparoscopic-assisted hysterectomies ($P<.001$ for both comparisons), but not when comparing inpatient open with outpatient vaginal hysterectomies ($P=.055$). The difference in the distribution of cases from the 10 geographic regions and the distribution of cancer cases was statistically significant when comparing inpatient open with outpatient hysterectomies ($P<.001$). The mean HHS-HCC gold metal-level risk score was statistically significantly different when comparing inpatient open with outpatient laparoscopic and vaginal hysterectomies ($P=.03$ and $P<.001$, respectively), but not when comparing inpatient open with outpatient laparoscopic-assisted hysterectomies ($P=.05$).

We excluded 4,640 cases due to the presence of a malignant DRG code for a noncancer case, robotic assistance, or multiple surgery types and no robotic assistance (Table 3). There were 114 inpatient open hysterectomy noncancer cases with a malignant DRG code, 2,666 cases with robotic assistance (26 open, 2,427 laparoscopic, 210 assisted laparoscopic, and three vaginal hysterectomies), and 1,860 cases with multiple surgery types and no robotic assistance (1,732 open and laparoscopic, 118 open and assisted laparoscopic, and 10 open and vaginal hysterectomies).

After adjusting for age, comorbidities, geographic region, and cancer, average allowed facility and professional surgical procedure costs were statistically significantly lower for all outpatient hysterectomies compared with inpatient open hysterectomies (Table 4).

Average allowed facility and professional surgical procedure costs were statistically significantly different for inpatient open hysterectomies than for outpatient hysterectomies (cost differences of $1,064 for laparoscopic, $2,684 for laparoscopic-assisted, and $4,522 for vaginal; $P<.001$ for all comparisons). Average allowed costs in the 30 days "post anchor" discharge for inpatient open hysterectomies were statistically significantly higher than costs in the 30 days after the procedure date for outpatient laparoscopic hysterectomies (cost difference of $206; $P=.01$), but not statistically significantly different than those for outpatient laparoscopic-assisted and vaginal hysterectomies (cost differences of $80 and $61, respectively; $P=.47$ and $P=.64$, respectively). Readmission rates within 30 days following surgery were statistically significantly different for inpatient open hysterectomies (3.05/1,000 cases) than for outpatient laparoscopic (2.1/1,000 cases) and laparoscopic-assisted hysterectomies (2.17/1,000 cases) ($P<.001$ and $P=.01$, respectively), but not for vaginal hysterectomies (2.46/1,000

**TABLE 1**
**Codes used to identify hysterectomy type**

| Hysterectomy | ICD-9 procedure codes[a] | CPT codes[b] |
|---|---|---|
| Inpatient open | 68.3, 68.39, 68.4, 68.49, 68.69 | 58150, 58152, 58180 |
| Outpatient laparoscopic | 68.31, 68.41, 68.61 | 58541, 58542, 58543, 58544, 58570, 58571, 58572, 58573 |
| Outpatient assisted laparoscopic | 68.51, 68.71 | 58550, 58552, 58553, 58554 |
| Outpatient vaginal | 68.5, 68.59, 68.79 | 58260, 58262, 58263, 58267, 58270, 58275, 58280, 58290, 58291, 58292, 58293, 58294 |

Source: Authors' analysis of 2012 and 2013 Truven Health Analytics MarketScan
[a] ICD-9=International Classification of Diseases, Ninth Edition
[b] CPT=Current Procedural Terminology/Healthcare Common Procedure Coding System

**TABLE 2**
**Patient characteristics for hysterectomy types**

| | Inpatient open | Outpatient laparoscopic | | Outpatient assisted laparoscopic | | Outpatient vaginal | |
|---|---|---|---|---|---|---|---|
| | | Amount | *P* value | Amount | *P* value | Amount | *P* value |
| **Number of cases** | 6,060 | 10,175 | | 3,415 | | 2,276 | |
| **Incidence** | 0.0354% | 0.0595% | | 0.0200% | | 0.0133% | |
| **Age (yr.)** | | | | | | | |
| Mean | 45.2 | 44.3 | <.001[a] | 43.7 | <.001[a] | 44.9 | .05[a] |
| Median | 45 | 44 | | 44 | | 44 | |
| Range | 18–64 | 18–64 | | 21–64 | | 20–64 | |
| Distribution | | | | | | | |
| 18–24 | 0.1% | 0.4% | <.001[b] | 0.4% | <.001[b] | 0.5% | <.001[b] |
| 25–34 | 6.4% | 8.9% | | 10.6% | | 10.1% | |
| 35–44 | 39.3% | 43.0% | | 44.0% | | 41.3% | |
| 45–54 | 44.4% | 38.4% | | 36.5% | | 33.3% | |
| 55–64 | 9.8% | 9.3% | | 8.6% | | 14.8% | |
| **Average HHS-HCC risk score[c]** | 1.86 | 1.74 | 0.03[a] | 1.72 | 0.051[a] | 1.45 | <.001[a] |
| **Regional distribution** | | | | | | | |
| Pacific | 11.5% | 10.4% | <.001[b] | 7.8% | <.001[b] | 7.4% | <.001[b] |
| East South Central | 12.4% | 12.5% | | 16.4% | | 15.7% | |
| West South Central | 11.2% | 10.3% | | 10.0% | | 7.6% | |
| Mountain | 5.0% | 7.4% | | 6.5% | | 10.3% | |
| New England | 3.6% | 4.0% | | 2.2% | | 3.6% | |
| South Atlantic | 22.2% | 23.8% | | 20.5% | | 18.4% | |
| West North Central | 4.4% | 6.8% | | 6.7% | | 10.0% | |
| East North Central | 17.8% | 17.1% | | 22.9% | | 20.9% | |
| Middle Atlantic | 10.2% | 5.8% | | 4.7% | | 4.1% | |
| Unidentified | 1.6% | 2.0% | | 2.1% | | 1.9% | |
| Puerto Rico | 0.1% | 0.0% | | 0.1% | | 0.0% | |
| **Cancer distribution** | | | | | | | |
| Yes | 6.6% | 5.2% | <.001[b] | 3.5% | <.001[b] | 3.6% | <.001[b] |
| No | 93.4% | 94.8% | | 96.5% | | 96.4% | |

Source: Authors' analysis of 2012 and 2013 Truven Health Analytics MarketScan
[a] *P* value is calculated using the student's *t* test.
[b] *P* values are calculated using the chi-square test.
[c] US Department of Health and Human Services Hierarchical Conditional Category gold metal-level risk score.

cases) (*P*=.16). The adjusted readmission average allowed cost per case was significantly higher for inpatient open hysterectomies ($577/case) than for outpatient laparoscopic hysterectomies ($362/case) (*P*=.002), but not for outpatient laparoscopic-assisted ($457/case) and vaginal hysterectomies ($501/case) (*P*=.200 and *P*=.51, respectively).

## DISCUSSION

Our study findings, which elucidate the difference in cost and readmission rates between inpatient open hysterectomy and three types of outpatient hysterectomy, have important implications for employers and healthcare payers. Specifically, we identified that inpatient open hysterectomy is associated with statistically significantly higher average allowed costs than outpatient laparoscopic, assisted laparoscopic, and vaginal hysterectomy, as well as statistically significantly higher readmission rates than outpatient laparoscopic and assisted laparoscopic hysterectomy. In addition, we found that the statistically significant cost differences between open hysterectomy and outpatient hysterectomy procedures persisted after adjustments were made for explanatory variables, comorbidities, presence of cancer, and geographic region.

The findings in previous U.S. studies investigating the cost difference between open hysterectomy and minimally invasive hysterectomy procedures have been inconsistent. For example, in a study based on claims data from a large fee-for-service U.S. managed-care health plan, the unadjusted average costs for patients undergoing open, laparoscopic, and vaginal hysterectomy were $12,086, $10,868, and $9,544, respectively ($P$<.05) (Warren 2009). After adjustment was made for differences in patient mix, there was no statistically significant difference between open and laparoscopic hysterectomy, but the expense associated with vaginal hysterectomy was significantly lower than that for open hysterectomy (mean difference, $1,270; $P$<.05) (Warren 2009). In contrast, a combined retrospective cohort study conducted in a U.S. suburban private practice found that laparoscopic-assisted vaginal hysterectomy was associated with higher average hospital charges ($15,186) than open abdominal hysterectomy ($13,089) and total vaginal hysterectomy ($10,146) (Lenihan 2004). A third U.S. study—this one using decision modeling to compare costs in women undergoing surgery for endometrial cancer—found that intraoperative costs were higher with laparoscopic than open hysterectomy, whereas postoperative costs were higher with open than laparoscopic hysterectomy (Barnett 2010).

Few studies have compared the readmission rates and the cost of readmission of open hysterectomy and minimally invasive outpatient hysterectomy procedures. In fact, our finding that readmission rates within 30 days following surgery were statistically significantly different for inpatient open hysterectomy than those for outpatient laparoscopic and assisted laparoscopic hysterectomy can only be compared with data from one other previously published study. In that study, which was based on claims data from a large fee-for-service U.S. managed-care health plan, no significant difference was found between

**TABLE 3**
**Development of study population**
Total denominator population: 17,111,313 members

| | Inpatient open | Outpatient laparoscopic | Outpatient laparoscopic assisted | Outpatient vaginal |
|---|---|---|---|---|
| **Total cases identified** | 6,200 | 14,334 | 3,743 | 2,289 |
| Noncancer cases with a malignant DRG code | | | | |
| Number | 114 | — | — | — |
| % of total cases identified | 1.84 | 0.00 | 0.00 | 0.00 |
| Cases with robotic assistance[a] | | | | |
| Number | 26 | 2,427 | 210 | 3 |
| % of total cases identified | 0.42 | 16.93 | 5.61 | 0.13 |
| Cases with multiple surgeries and no robotic assistance | | | | |
| Number | — | 1,732 | 118 | 10 |
| % of total cases identified | 0.00 | 12.08 | 3.15 | 0.44 |
| Study cases | | | | |
| Number | 6,060 | 10,175 | 3,415 | 2,276 |
| % of total cases identified | 97.74 | 70.99 | 91.24 | 99.43 |

Source: Authors' analysis of 2012 and 2013 Truven Health Analytics MarketScan
[a] Cases with robotic assistance may also be coded with multiple types of surgeries.
DRG=diagnosis-related group.

**TABLE 4**
**Comparison of inpatient open and outpatient hysterectomy average allowed costs**

| | | Outpatient | | Inpatient open vs. adjusted outpatient | |
|---|---|---|---|---|---|
| **Hysterectomy type** | **Inpatient open** | **Original** | **Adjusted[c]** | **Difference** | ***P* value[d]** |
| **Laparoscopic total allowed episode costs[a]** | **$17,631** | **$16,419** | **$16,361** | **$1,270** | **<.001** |
| Anchor average allowed cost | $16,313 | $15,319 | $15,249 | $1,064 | <.001 |
| Facility | $12,828 | $11,835 | $11,750 | $1,078 | <.001 |
| Professional | $3,485 | $3,484 | $3,499 | –$14 | .66 |
| 30-day post-anchor average allowed cost | $1,318 | $1,100 | $1,112 | $206 | .01 |
| Readmissions per 100 anchor cases | 3.05 | 2.10 | 2.10 | 0.95 | <.001 |
| Readmission average allowed cost/case[b] | $577 | $359 | $362 | $215 | .002 |
| **Assisted laparoscopic total allowed episode costs[a]** | **$17,631** | **$14,637** | **$14,867** | **$2,764** | **<.001** |
| Anchor average allowed cost | $16,313 | $13,439 | $13,629 | $2684 | <.001 |
| Facility | $12,828 | $10,339 | $10,482 | $2346 | <.001 |
| Professional | $3,485 | $3,100 | $3,147 | $338 | <.001 |
| 30-day post-anchor average allowed cost | $1,318 | $1,198 | $1,238 | $80 | .47 |
| Readmissions per 100 anchor cases | 3.05 | 2.17 | 2.17 | 0.89 | .01 |
| Readmission average allowed cost/case[b] | $577 | $424 | $457 | $121 | .20 |
| **Vaginal total allowed episode costs[a]** | **$17,631** | **$12,847** | **$13,049** | **$4,582** | **<.001** |
| Anchor average allowed cost | $16,313 | $11,720 | $11,791 | $4,522 | <.001 |
| Facility | $12,828 | $8,646 | $8,726 | $4,102 | <.001 |
| Professional | $3,485 | $3,074 | $3,066 | $419 | <.001 |
| 30-day post-anchor average allowed cost | $1,318 | $1,127 | $1,257 | $61 | .64 |
| Readmissions per 100 anchor cases | 3.05 | 2.46 | 2.46 | 0.59 | .16 |
| Readmission average allowed cost/case[b] | $577 | $430 | $501 | $76 | .51 |

Source: Authors' analysis of 2012 and 2013 Truven Health Analytics MarketScan
[a] Total allowed episode cost includes all claims for the initiating "anchor" surgery case and the 30 days after discharge.
[b] Readmission average allowed cost per case reflects the cost of all readmissions spread across all cases, not the average cost of a readmission.
[c] Outpatient average cost calculation for each cohort assumes the same regional and cancer contribution as inpatient open cases and reflects an adjustment for the difference in 2012 U.S. Department of Health and Human Services Hierarchical Conditional Category gold metal-level risk score between inpatient open and outpatient hysterectomies.
[d] *P* values were calculated using the student's *t* test.

conventional and minimally invasive hysterectomy in the unadjusted rate of hospital readmission 30 days after surgery (Warren 2009). Logistic regression showed that a patient undergoing open abdominal hysterectomy had a 0.013 ($P$<.001) and 0.008 ($P$<.01) higher probability of readmission at Day 30 than did a patient undergoing laparoscopic hysterectomy or vaginal hysterectomy, respectively (Warren 2009).

We focused solely on the differences in cost and readmission rates between inpatient open hysterectomy and three types of minimally invasive outpatient hysterectomies and did not analyze clinical outcomes. Results from previous studies that have compared laparoscopic hysterectomy with open abdominal hysterectomy when both are done on an inpatient basis have shown that the laparoscopic procedures have several advantages, including shorter length of stay (Warren 2009, Doganay 2011, Chalermchockchareonkit 2012, Park 2013, Scalici 2015, Wright 2012), less blood loss (Doganay 2011, Chalermchockchareonkit 2012, Oksuzoglu 2015, Park 2013), less tissue trauma (Oksuzoglu 2015), and fewer perioperative complications (Wright 2012) and postoperative complications (Warren 2009, Wright 2012, Scalici 2015, Chalermchockchareonkit 2012, Kumar 2014, Tinelli 2014). In contrast, the duration of operating time has generally been shown to be longer with laparoscopic than abdominal hysterectomy (Doganay 2011, Chalermchockchareonkit 2012, Ribeiro 2003, Scalici 2015, Kumar 2014, Garry 2004).

Although clinical guidelines recommend the use of minimally invasive hysterectomy over open hysterectomy for both benign indications and endometrial cancer, studies report a gap in utilization of laparoscopic hysterectomies including differences in rates based on age, race, median income, insurance type, and hospital characteristics (Lee 2014, Patel 2014). Based on a survey of surgeon attitudes and barriers to minimally invasive hysterectomy, barriers to performing laparoscopic hysterectomies included inadequate training, technical difficulty, and personal surgical experience, suggesting a need for more emphasis on training opportunities in minimally invasive surgical approaches to hysterectomy (Einarsson 2010). Some physician groups have implemented efforts to increase the proportion of non-open hysterectomies. A large multispecialty group in Southern California undertook a structured educational intervention with 12 medical centers to increase the proportion of non-open hysterectomies and reported a 120% increase in the rate of non-open hysterectomies (Esteban 2011). There is a lack of published studies addressing successful tactics to increase the shift from open to laparoscopic hysterectomy as well as a lack of recommended targets for the ideal distribution between open and laparoscopic hysterectomies.

We acknowledge several study limitations. First, coding inaccuracies may have biased the results. Second, we were unable to examine clinical outcomes. Third, hospital prices may have been susceptible to managed care penetration and competing hospital dynamics in particular regions. Fourth, our results remained susceptible to bias despite adjustments. For example, although we adjusted for the regional contribution of cases, cancer versus noncancer cases, and risk profile, our results could have been biased by hospital or professional reimbursement rates in particular regions not reflected in our regional segmentation, the impact of different disease diagnoses for which the procedures were performed, and differences in the clinical severity in patients receiving each of the four types of hysterectomy. Fifth, some inpatient open cases may not be indicated for minimally invasive surgery. Additionally, confounding variables beyond those for which adjustments were made (e.g., socioeconomic or racial differences, type of hospital, and skill of the surgeon) could also have biased the results. Sixth, our findings may not have been representative of all hospitals, other surgery types, and other payers (e.g., Medicare and Medicaid). Finally, we did not distinguish between emergency and elective surgery.

## CONCLUSIONS

Based on a large nationally representative commercial payer claim database, we found that on a risk adjusted basis inpatient open hysterectomies have statistically significantly higher average allowed costs than outpatient laparoscopic, laparoscopic-assisted, and vaginal hysterectomies and statistically significantly higher readmission rates than outpatient laparoscopic and laparoscopic-assisted hysterectomies.

Despite the advantages of these three types of outpatient laparoscopic hysterectomy, the utilization of inpatient open hysterectomy in our analysis was substantial. Further investigation of the barriers to wider adoption of minimally invasive hysterectomy and tactics that would enhance adoption may be warranted.

As payers move from the traditional fee-for-service payment system toward value-based payment models, shifting hysterectomy cases from an open to minimally invasive approach for indicated cases may provide an opportunity to reduce costs while improving quality.

**Corresponding author**

Kathryn Fitch, RN, MEd
Milliman Inc.
One Penn Plaza, 38th Floor
New York, NY 10119
Phone: (646) 473-3216
Fax: (646) 473-3299
Email: Kate.Fitch@milliman.com

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## REFERENCES

ACOG Committee. Opinion No. 444. Choosing the route of hysterectomy for benign disease. *Obstet Gynecol*. 2009;114(5):1156–1158.

AAGL advancing minimally invasive gynecology worldwide. AAGL position statement: route of hysterectomy to treat benign uterine disease. *J Minim Invasive Gynecol*. 2011;18(1):1–3.

Barnett JC, Judd JP, Wu JM, et al. Cost comparison among robotic, laparoscopic, and open hysterectomy for endometrial cancer. *Obstet Gynecol*. 2010;116(3):685–693.

CDC (Centers for Disease Control and Prevention). HHS-developed risk adjustment model algorithm instructions. https://www.cms.gov/CCIIO/Resources/Regulations-and-Guidance/Downloads/ra-instructions-4-16-13.pdf. Accessed July 26, 2016.

Chalermchockchareonkit A, Tekasakul P, Chaisilwattana P, et al. Laparoscopic hysterectomy versus abdominal hysterectomy for severe pelvic endometriosis. *Int J Gynecol Obstet*. 2012;116(2):109–111.

Colombo N, Petri E, Landoni F, et al. Endometrial cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol*. 2013;24(suppl 6):vi33–vi38.

Doganay M, Yildiz Y, Tonguc E, et al. Abdominal, vaginal and total laparoscopic hysterectomy: perioperative morbidity. *Arch Gynecol Obstet*. 2011;284(2):385–389.

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Einarsson JI, Matteson KA, Schulkin J, et al. Minimally invasive hysterectomies—a survey on attitudes and barriers among practicing gynecologists. *J Minim Invasive Gynecol.* 2010;17(2):167–175.

Esteban A, Wray T. Regional expansion of minimally invasive surgery for hysterectomy: implementation and methodology in a large multispecialty group. *Perm J.* 2011;15(4):42–46.

Garry R. Health economics of hysterectomy. *Best Pract Res Clin Obstet Gynaecol*. 2005;19(3):451–465.

Garry R, Fountain J, Mason S, et al. The eVALuate study: two parallel randomised trials, one comparing laparoscopic with abdominal hysterectomy, the other comparing laparoscopic with vaginal hysterectomy. *BMJ*. 2004;328(7432):129. Erratum in: *BMJ*. 2004;328(7438):494.

Kumar A, Pearl M. Mini-laparotomy versus laparoscopy for gynecologic conditions. *J Minim Invasive Gynecol.* 2014;21(1):109–114.

Lee J, Jennings K, Borahay MA, et al. Trends in the national distribution of laparoscopic hysterectomies from 2003 to 2010. *J Minim Invasive Gynecol*. 2014;21(4):656–661.

Lenihan JP, Kovanda C, Cammarano C. Comparison of laparoscopic-assisted vaginal hysterectomy with traditional hysterectomy for cost-effectiveness to employers. *Am J Obstet Gynecol*. 2004;190(6):1714–1722.

Oksuzoglu A, Seckin B, Turkcapar AF, et al. Comparison of tissue trauma after abdominal, vaginal and total laparoscopic hysterectomy. *Ginekol Pol*. 2015;86(4):268–273.

Park JY, Kim DY, Kim JH, et al. Laparoscopic versus open radical hysterectomy in patients with stage IB2 and IIA2 cervical cancer. *J Surg Oncol*. 2013;108(1):63–69.

Patel PR, Lee J, Rodriguez AM. Disparities in utilization of laparoscopic hysterectomies: a nationwide analysis. *J Minim Invasive Gynecol.* 2014;21(2):223–227.

Practice Bulletin No. 149: Endometrial cancer. *Obstet Gynecol*. 2015;125(4):1006–1026.

Ribeiro SC, Ribeiro RM, Santos NC, Pinotti JA. A randomized study of total abdominal, vaginal and laparoscopic hysterectomy. *Int J Gynecol Obstet*. 2003;83(1):37–43.

Roumm AR, Pizzi L, Goldfarb NI, Cohn H. Minimally invasive: minimally reimbursed? An examination of six laparoscopic surgical procedures. *Surg Innov*. 2005;12(3):261–287.

Scalici J, Laughlin BB, Finan MA, et al. The trend towards minimally invasive surgery (MIS) for endometrial cancer: an ACS-NSQIP evaluation of surgical outcomes. *Gynecologic Oncol*. 2015;136(3):512–515.

Stang A, Merrill RM, Kuss O. Hysterectomy in Germany. A DRG-based nationwide analysis, 2005–2006. *Dtsch Arztebl Int*. 2011;108(30):508–514.

Tinelli R, Litta P, Meir Y, et al. Advantages of laparoscopy versus laparotomy in extremely obese women (BMI>35) with early-stage endometrial cancer: a multicenter study. *Anticancer Res*. 2014;34(5):2497–2502.

Warren L, Ladapo JA, Borah BJ, Gunnarsson CL. Open abdominal versus laparoscopic and vaginal hysterectomy: analysis of a large United States payer measuring quality and cost of care. *J Minim Invasive Gynecol*. 2009;16(5):581–588.

Whiteman MK, Hillis SD, Jamieson DJ, et al. Inpatient hysterectomy surveillance in the United States, 2000–2004. *Am J Obstet Gynecol*. 2008;198(1):34.e1–7.

Wright JD, Herzog TJ, Neugut AI, et al. Comparative effectiveness of minimally invasive and abdominal radical hysterectomy for cervical cancer. *Gynecol Oncol*. 2012;127(1):11–17.