Surgical Costs Associated with the Treatment of Uterine Fibroids

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science

University of Washington

2019

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Program Authorized to Offer Degree:

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Abstract

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Introduction

Uterine fibroids, or leiomyomas, are benign tumors that arise from smooth muscle tissue in the uterine cavity and lining. The true prevalence of uterine fibroids is difficult to determine due to only symptomatic women presenting for treatment, however, a large scale study found that the self-reported prevalence in the United States (US) is about 6.9% and the age-standardized incidence rates of fibroids confirmed by ultrasound or hysterectomy were 9.2 per 1,000 person-years overall. There are many pharmacologic treatments that are approved and used in practice for the treatment of uterine fibroids, including: hormone contraceptives, gonadotropin-releasing hormone (GnRH) agonists, GnRH antagonists, among other less used agents. The mainstay of curative therapies are surgical procedures with hysterectomies being the true curative option. Therefore, the focus of this thesis was on the all cause long-term surgical

procedure costs associated with each of the procedures. The surgical procedures addressed and analyzed in this study were open and laparoscopic hysterectomies, open and laparoscopic myomectomies, uterine artery embolization, magnetic resonance-guided focused ultrasound (MRgFUS), and endometrial ablation. There are differential rates in recurrence of uterine fibroids among the surgery types that could also require a re-intervention by a physician. Because of this, this study is designed to compare the costs among the different surgery types with different risks of re-intervention rates.

Objective

The primary objective of this study was to describe and compare the long-term all cause direct costs associated with subjects' first surgical procedure for uterine fibroids of the seven surgical interventions or interventional radiology procedures.

Methods

A retrospective cohort study design was utilized to compare the long-term all cause costs associated with the seven major surgical types for the treatment of uterine fibroids in a large database with claims for the commercially insured population of the United States. Patients were described based on their first surgical procedure for the treatment of uterine fibroids. Multivariate regression analysis was utilized to determine the statistical significance of the differences of costs for the different surgical cohorts. All cause total costs, all cause medical costs, all cause pharmacy costs, all cause outpatient costs, and all cause inpatient costs were collected for the seven surgical cohorts over a nine-year time frame from 2008 through 2016. All cause total costs were the sum of all cause medical, all cause pharmacy, all cause outpatient, and all cause inpatient costs.

Results

81,910 women were included in the study: total abdominal hysterectomy (21,796), laparoscopic hysterectomy (16,206), total abdominal myomectomy (4,889), laparoscopic myomectomy (25,504), uterine artery embolization (1,521), endometrial ablation (11,890), MRgFUS (105). The surgical cohort with the highest all cause total costs was the MRgFUS cohort ($90,992), followed endometrial ablation ($47,892), laparoscopic myomectomy ($47,219), laparoscopic hysterectomy ($41,703), total abdominal myomectomy ($28,044), and total abdominal hysterectomy ($25,791). The all cause total costs surgical costs were statistically significantly different from another.

Discussion

This study provides insight on the differences in overall long-term costs that are associated with the first surgical procedure chosen by women with uterine fibroids. This information can be used to better inform decision-making for clinicians, patients, and payers. Given the small number of participants in the MRgFUS surgical cohort, further research should be performed to better describe patients who pursue this treatment option.

Conclusions

Uterine fibroid surgery using MRgFUS had the highest all cause total costs among seven different surgical cohorts. Future research should be performed to determine the impact that re-intervention has on total costs.

Introduction

Uterine fibroids, or leiomyomas, are benign tumors that arise from smooth muscle tissue in the uterine cavity and lining.[1] Because the growth of these tumors is dependent on estrogen and progesterone levels, these fibroids mostly affect women of reproductive age. There are four different subtypes of uterine fibroids as classified by the International Federation of Gynecology and Obstetrics (FIGO): intramural myomas, submucosal myomas, subserosal myomas, and cervical myomas (Figure 1).[2] The true prevalence of uterine fibroids is difficult to determine due to only symptomatic women presenting for treatment, however, a large scale study found that the self-reported prevalence in the United States (US) is about 6.9%.[3] The age-standardized incidence rates of fibroids confirmed by ultrasound or hysterectomy were 9.2 per 1,000 person-years overall.[4] Further, the age-standardized incidence rates were 30.6 per 1,000 person-years in African American women and 8.9 per 1,000 person-years in Caucasian women. Other factors that influence the development of uterine fibroids are vitamin D deficiency, parity, timing of menarche, contraceptive use, obesity, alcohol use, smoking, and diet.[5-11]

Women typically present only when they are symptomatic with three groups of symptoms that aid in the diagnosis of uterine fibroids.[3] These symptoms are: heavy and prolonged bleeding, bulk symptoms (pelvic pressure and/or pain), and reproductive dysfunction (i.e. infertility). Additional symptoms that women can present with include painful menses, prolapsed fibroids, endocrine abnormalities, and fibroid torsion.

There are many pharmacologic treatments that are approved and used in practice for the treatment of uterine fibroids, including: hormone contraceptives, gonadotropin-releasing hormone (GnRH) agonists, GnRH antagonists, among other less used agents.[12] Pharmacologic

treatment, however, tends to be ineffective in the management of uterine fibroids in women and typically only diminishes symptoms or slows the growth of these fibroids.

The mainstay of curative therapy is the removal of the fibroids surgically, with hysterectomies being the medically preferred option of these procedures.[13] There are differential rates in recurrence of uterine fibroids among the surgery types that could also require re-intervention by a physician. Although a hysterectomy would essentially remove a woman's risk or recurrence of uterine fibroids and would eliminate the risk of re-intervention for uterine fibroids, not all women decide to pursue this option due to risks of the surgery and because they might wish to preserve their childbearing potential. The other surgery options do not remove risk of recurrence and could require re-intervention and additional surgical procedures at a later time. Therefore, this study was designed to compare the costs of the different surgery types, accounting for the long-term costs of possible re-intervention.

The two main surgical procedures that are recommended by the American Family Physician (AFP) treatment and diagnosis guidelines are hysterectomies and myomectomies.[1] The AFP also recommends two interventional radiologic procedures: uterine artery embolization and magnetic-focused guided ultrasound (MRgFUS). Another procedure that is not directly recommended by the AFP but will be assessed in this analysis because of the frequency of performance in clinical practice is endometrial ablation. In the United States, hysterectomies account for 70% of the surgical procedures performed for the treatment of uterine fibroids.[14] A hysterectomy involves the complete or partial removal of the uterus, therefore removing all uterine fibroids and eliminating the chance of recurrence. Hysterectomies are indicated for women who have severe symptoms and for those who might be at risk of other uterine diseases that could be decreased or eliminated by the removal of the uterus. A main consideration for this

surgical procedure, however, is whether the woman is at childbearing age and if they wish to attempt to conceive a child in the future. Incidence rates differ for each of the different procedures. Total abdominal hysterectomy incidence was found to be 71.8% for all persons who pursued surgery with a diagnosis of uterine fibroids.[14]

Myomectomies are an option for women who would like to try to preserve their childbearing potential.[15] This procedure involves the surgical or endoscopic removal of the uterine fibroids.[1] This procedure, however, has been estimated to have a 15-30% recurrence of uterine fibroids due to abnormal myocytes remaining in the uterus and forming more uterine fibroids after time.[16] Further, a study has recently shown that about 10% of women who choose to undergo a myomectomy will ultimately have a hysterectomy performed within five to ten years following the initial myomectomy procedure.[17] The overall incidence of myomectomies was 22.0% of all women who pursued surgery with a diagnosis of uterine fibroids.[14]

Uterine artery embolization (UAE) is the first interventional radiologic procedure type recommended by the AFP for women who have uterine fibroids.[1] This procedure is less invasive but is not recommended for women who want to preserve full childbearing potential as long-term pregnancy outcomes are inconclusive. This procedure eliminates the blood supply to the fibroids and has been found to result in about 30-46% shrinkage of the fibroids.[18] A recent retrospective cohort study found that the re-intervention rate after five years of following the women who had UAE performed was 24%.[19] Additionally, there was found to be an overall incidence of 4.04% in all women who pursued surgery with a diagnosis of uterine fibroids.[14]

Magnetic-focused guided ultrasound (MRgFUS) is the second interventional radiologic procedure recommended by the AFP for women with uterine fibroids.[1] This procedure involves administering thermoablative ultrasound energy to the uterine fibroids to destroy the tissue. This

procedure has the advantage that it can be performed in an out-patient setting. More research needs to be performed to determine the long-term clinical outcomes of re-intervention rates for MRgFUS procedures as this is a more recently developed procedure, however, one study found that re-intervention rates for women who underwent this procedure after 24 months was about 18%.[20]

Endometrial ablation is a surgical procedure that can be performed on women who have significant bleeding symptoms from uterine fibroids.[21] This procedure involves the surgical destruction of the endometrium that is indicated to treat prolonged and heavy bleeding as a result from uterine fibroids. One major limitation of this procedure is that it does not affect or eliminate subserosal or intramural leiomyomas. The overall incidence of this procedure in all women who pursued surgery with a diagnosis of uterine fibroids was 2.15%.[14] This procedure in theory should eliminate a woman's chance of becoming pregnant in the future as it destroys the endometrium, however, pregnancies have been reported after endometrial ablation.[22] This is an important consideration with all available procedures, as options to retain childbearing potential will likely self-select women into choosing certain procedures.

The primary objective of this study was to describe and compare the long-term all cause direct costs associated with subjects' first surgical procedure for the treatment of uterine fibroids. All cause total direct costs, all cause medical costs, and all cause pharmacy costs were compared among seven different surgical interventions or interventional radiology procedures.

Methods

A retrospective study design was utilized to determine the surgical costs associated with the treatment of uterine fibroids. The Truven Health MarketScan® databases were used to gather cost and clinical information about the patient population from January 1, 2008 through

December 31, 2016. The Marketscan® databases contain integrated patient-level data and provides inpatient, outpatient, and prescription claims data about the commercially insured population in the United States.

Women were classified into seven different cohorts based on their first surgical procedure for the treatment of uterine fibroids. The seven surgical cohorts were: total abdominal hysterectomy, laparoscopic hysterectomy, total abdominal myomectomy, laparoscopic myomectomy, uterine artery embolization, endometrial ablation, and MRgFUS. Women were included based on certain pre-specified inclusion criteria. Additionally, the time of inclusion was determined as the index date of the first surgical procedure after a clear diagnosis of uterine fibroids. The index date for the patient must have been between January 1, 2008 and December 31, 2016 in order to be included in the study. Figure 2 in the appendix shows the index date criterion and follow-up. Patients were followed in the study until they died, were no longer commercially insured in the database, or met exclusion criteria to qualify them as no longer eligible for the study.

Women were included in the study if they were between the ages of 15 and 49 years old. Further, women were only incluced if they had a Current Procedural Terminology (CPT-4) code during the study time horizon for one of the seven surgical procedures and had a corresponding International Classification Diagnosis (ICD-9 or ICD-10) code for uterine fibroids prior to the surgical procedure. We also required subjects to have 12 months of continuous insurance eligibility both before and after the date of the first surgical procedure (index date). Appendix Table 1 displays the ICD-9, ICD-10, and CPT-4 codes that were utilized to identify study subjects. We excluded women who had a diagnosis of certain myometrial lesions (leiomyoma variant, metastatic myometrial lesions), certain endometrial lesions (endometrial carcinoma or

hyperplasia, carcinosarcoma, endometrial stromal sarcoma), pregnancy, or hematometra within one month of the index date.

The primary outcome that was measured in this study was the all cause direct costs associated with each of the surgery types. We adjusted costs from each calendar year for inflation to 2017 using the Medical Care Component of the U.S. Consumer Price Index (CPI). Costs were measured for 12 months from the index date or date of death, whichever came first. Costs were also stratified by calendar year within each cohort to examine whether there were temporal changes in costs by surgical approach.

Baseline demographic information was collected, including: age, region of residence, health plan, type of insurance plan, sex, prescription drug coverage, and Charlson Comorbidity Index (CCI) score. These baseline characteristics were analyzed to determine if there were any statistically significant differences between the seven cohorts. The main outcome that was assessed was all cause direct medical costs for the patients in the surgical cohorts. Total costs, medical only costs, prescription costs, outpatient costs, and inpatient costs were measured and analyzed between the surgical cohorts. All cause total costs were calculated as the sum of all cause medical, all cause pharmacy, all cause outpatient, and all cause inpatient costs.

Statistical analysis was performed in the study to determine statistical significance of the differential costs associated with the surgery types, using Statistical Analysis System (SAS) version 9.4. The categorical variables (age groups, region of residence in the US, type of health plan (employer or privately purchased), insurance plan type, whether patient had prescription drug insurance coverage, sex, and CCI score) were tested for differences using chi-squared testing with an alpha level of 0.05 as the threshold for determining statistical significance. The continuous and discrete baseline demographic variables were tested using analysis of variance

(ANOVA) testing with an alpha value of 0.05 as the threshold for determining statistical significance.

Differences in costs between the surgical cohorts was analyzed using a multivariable generalized linear regression model with a log link function and a gamma distribution. We utilized the gamma distribution to account for skewed cost data, with a small proportion of the population comprising a majority of the costs.[24] The surgical cohort chosen as the referent group for analysis was the total abdominal hysterectomy cohort as it had the highest number of participants. Analyses adjusted for the following patient characteristics: age, region of residence in the US, health plan, type of insurance plan, prescription drug insurance coverage, and categorical CCI score of the patient. We separately compared total costs, medical costs only, prescription costs only, outpatient services costs only, and inpatient services costs only among the seven different surgical cohorts.

Results

There were 81,910 women included in the study (**Table 1**). The number of participants in each surgical cohort were: total abdominal hysterectomy (21,796), laparoscopic hysterectomy (16,206), total abdominal myomectomy (4,889), laparoscopic myomectomy (25,504), uterine artery embolization (1,521), endometrial ablation (11,890), and MRgFUS (105). Baseline demographics of the seven surgical cohorts are shown in **Table 2**. Statistically significant differences were found in all of the baseline demographics.

After adjusting for the baseline demographic factors, the costs of each surgery option are shown in **Table 3**. The surgical cohort with the highest all cause total costs was the MRgFUS cohort ($90,992) and the lowest all cause total costs were for the total abdominal hysterctomy cohort ($25,791). This pattern was found for all other types of costs with the exception of

pharmacy costs. The surgical cohort with the highest pharmacy costs was the laparoscopic myomectomy cohort. All cause total costs for the surgical cohorts were: total abdominal hysterectomy ($25,791), laparoscopic hysterectomy ($41,703), total abdominal myomectomy ($28,044), laparoscopic myomectomy ($47,219), uterine artery embolization ($44,347), endometrial ablation ($47,892), and MRgFUS ($91,922). Appendix table 2 describes the full multivariable regression model and reports rate ratios for higher all cause total costs. The all cause total costs for the surgical cohorts differed (p-value <0.0001).

Discussion

Total abdominal hysterectomy was the least costly total all cause surgical cohort while MRgFUS was the most costly all cause surgical cohort. Differences were found in the baseline demographics for each surgical cohort but were expected prior to initiation of the study.

Re-intervention surgeries are a possibility among all of the surgical cohort groups, except total abdominal hysterectomy and laparoscopic hysterectomy, and likely contribute to the total cost differences that were found. Literature has found varying re-intervention rates among the surgical types. Re-intervention at five-years was 27% for total abdominal myomectomy, 7% for laparoscopic myomectomy, 27% for uterine artery embolization, and 25% for endometrial ablation.[26-29] Re-intervention at three-years for MRgFUS was 45%.[30] Higher rates of re-intervention could lead to higher costs for the surgical cohorts. Re-intervention rates and costs should be further researched to better understand the magnitude of effect this could have on the costs.

Differences in baseline demographics were found in all of the surgical cohorts, however, this was expected due to self-selection into the different cohorts according to patient preferences. Self-selection into different surgical cohorts could be based on personal reasons, such as child-

bearing potential preferences, and could have resulted in these differences seen. Age and demographics may also affect surgery choice.

There were statistically significant differences between surgeries in all of the cost outcomes of the study ($p<0.0001$). MRgFUS had the highest costs for all types of costs with the exception of pharmacy costs. This could be due to a few reasons. This cohort had a very small number of participants which could have biased the outcome results. Additionally, because this is a more recently developed surgical approach it could lead to higher costs. One prior study also found that MRgFUS had higher costs than hysterectomies.[24] Finally, due to the nature of possible re-intervention with procedures other than hysterectomies, it could be possible that the MRgFUS cohort had re-intervention surgical procedures that led to higher costs found in this cohort.

There are limitations to this study. The population that MarketScan® captures is limited to commercially insured people, and therefore excludes segments of the population that are also affected by uterine fibroids. Additionally, women outside of the 15-49 year old age range were not included in this study. This could represent a certain population that has abnormalities that would influence the costs. Women's fertility preferences could also cause them to select certain surgical procedures. Race and ethnicity are not captured by Truven MarketScan®, and have been shown to be impactful on the risk of developing uterine fibroids, therefore likely influencing costs.[4] Further research should be performed to assess the cost differential between races given there is a two to three fold higher prevalence of uterine fybroids in the African American population compared to other races. Another limitation is that we were unable to ascertain if the index date of first surgical procedure was truly the first surgical procedure pursued by the study participant. Future studies should evaluate pregnancy outcomes to determine the differential

costs associated with successful pregnancies after procedures that attempt to preserve childbearing potential.

Conclusions

This retrospective claims database study described the all cause health care costs associated with seven of the main surgical procedures utilized for the treatment of uterine fibroids. Further research needs to be performed to determine the impact of surgical re-intervention procedures on the costs associated with the seven surgeries. Additionally, because of the large impact that childbearing has on selection of surgical procedure, pregnancy outcomes should be researched among the seven surgical cohorts analyzed in this study.

Figure 1

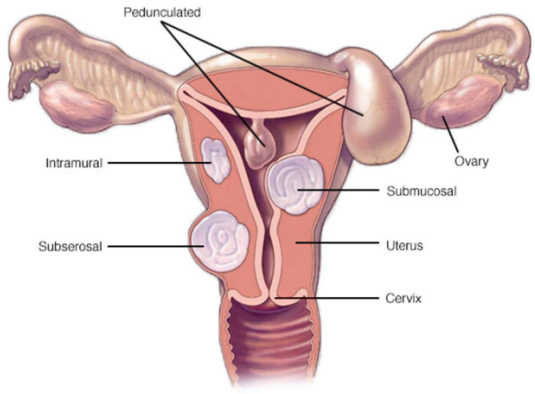

Figure 2

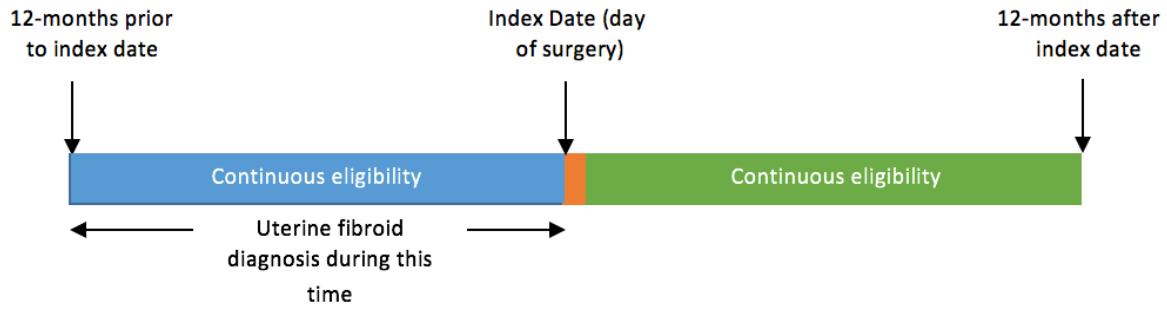

Table 1 – Study Attrition Table

Event/Exclusion	Number (N)
Number of patients with both procedure and diagnosis	991,241
Number of patients after age exclusion	762,817
Number of patients after eligibility exclusion	219,317
Number of patients with at least one claim	81,910

Table 2 – Baseline Demographics

Var [N (%)][a]	TAH	LH	TAM	LM	UAE	EA	MS	P-value
Number of Subjects								
#	21,796 (26.61)	16,206 (19.79)	4,888 (5.97)	25,504 (31.14)	1,521 (1.86)	11,890 (14.52)	105 (0.13)	
Age								
Mean (SD)								
15-29	99 (0.12)	123 (0.15)	397 (0.48)	1,258 (1.54)	15 (0.02)	121 (0.15)	6 (0.01)	<0.0001
30-39	3,051 (3.72)	2,631 (3.21)	2,742 (3.35)	9,236 (11.28)	305 (0.37)	2,371 (2.89)	30 (0.04)	
40-49	18,646 (22.76)	13,452 (16.42)	1,749 (2.14)	15,010 (18.32)	1,201 (1.47)	9,398 (11.47)	69 (0.08)	
Region								
North East	1,603 (1.96)	1,326 (1.62)	696 (0.85)	4,795 (5.85)	250 (0.31)	14,20 (1.73)	16 (0.02)	<0.0001
North Central	4,475 (5.46)	3,284 (4.01)	7,734 (0.94)	5,548 (6.77)	290 (0.35)	3,077 (3.76)	34 (0.04)	
South	13,352 (16.30)	9,136 (11.15)	2,719 (3.32)	10,984 (13.41)	747 (0.91)	5,399 (6.59)	33 (0.04)	
West	2,173 (2.65)	2,312 (2.82)	667 (0.81)	3,950 (4.82)	217 (0.26)	1,893 (2.31)	22 (0.03)	
Unknown	193 (0.24)	148 (0.18)	33 (0.04)	227 (0.28)	17 (0.02)	101 (0.12)	0 (0.00)	
Health Plan								
Employer	13,587 (16.59)	10,092 (12.32)	3,261 (3.98)	16,823 (20.54)	1,072 (1.31)	7,611 (9.29)	55 (0.07)	<0.0001
Health Plan	8,209 (10.02)	6,114 (7.46)	1,627 (1.99)	8,681 (10.60)	449 (0.55)	4,279 (5.22)	50 (0.0.06)	
Plan Type								
Comprehensive	281 (0.35)	213 (0.26)	48 (0.06)	423 (0.52)	25 (0.03)	197 (0.24)	1 (0.00)	<0.0001
EPO	184 (0.23)	153 (0.19)	64 (0.08)	301 (0.37)	19 (0.02)	111 (0.14)	2 (0.00)	
HMO	4,257 (5.24)	3,216 (3.96)	1,039 (1.28)	5,323 (6.55)	431 (0.53)	2,689 (3.31)	16 (0.02)	
POS	2,424 (2.98)	1,758 (2.16)	565 (0.70)	2,816 (3.47)	162 (0.20)	1,272 (1.57)	11 (0.01)	
PPO	13,280 (16.35)	9,926 (12.22)	2,828 (3.48)	15,035 (18.51)	162 (0.20)	1,272 (1.57)	11 (0.01)	
PPO w/ capitation	93 (0.11)	67 (0.08)	25 (0.03)	154 (0.19)	11 (0.01)	62 (0.08)	2 (0.00)	
CDHP	831 (1.02)	563 (0.69)	236 (0.29)	954 (1.17)	58 (0.07)	389 (0.48)	5 (0.01)	

HDHP	200 (0.25	163 (0.20)	52 (0.06)	335 (0.41)	16 (0.02)	100 (0.12)	0 (0.00)	
RX Drug Coverage								
No	1,001 (1.22)	812 (0.99)	200 (0.24)	1,312 (1.60)	57 (0.07)	646 (0.79)	5 (0.01)	0.0002
Yes	20,795 (25.39)	15,394 (18.79)	4,688 (5.72)	24,192 (29.53)	1,464 (1.79)	11,244 (13.73)	100 (0.12)	
CCI								
1	3,863 (20.60)	3,072 (16.38)	603 (3.21)	3,375 (17.99)	182 (0.97)	1,418 (7.56)	1 (0.01)	<0.0001
2	1,228 (6.55)	1,086 (5.79)	146 (0.78)	1,013 (5.40)	61 (0.33)	397 (2.12)	1 (0.01)	
3+	708 (3.77)	721 (3.84)	68 (0.36)	529 (2.82)	43 (0.23)	238 (1.27)	3 (0.02)	

[a] *Percentages are based on percentages of the overall demographic*
TAH = Total abdominal hysterectomy
LH = Laparoscopic hysterectomy
TAM = Total abdominal myomectomy
LM = Laparoscopic myomectomy
UAE = Uterine artery embolization
EA = Endometrial ablation
MS = Magnetic resonance-guided focused ultrasound

Table 3 – Costs by Surgery Type[a]

Var [N(SD)][b]	TAH	LH	TAM	LM	UAE	EA	MS	p-value
Total Costs	$25,791 ($47,410)	$41,703 ($62,681)	$28,044 ($43,094)	$47,219 ($60,023)	$44,347 ($73,200)	$47,892 ($73,434)	$90,992 ($137,424)	<0.0001
Medical Costs	$23,883 ($46,354)	$38,710 ($61,046)	$26,026 ($42,163)	$43,640 ($51,181)	$41,528 ($70,208)	$45,151 ($72,367)	$87,535 ($136,028)	<0.0001
Pharmacy Costs	$2,088 ($5,810)	$2,993 ($8,472)	$2,018 ($4,537)	$3,579 ($8,317)	$2,819 ($11,158)	$2,831 ($7,570)	$3,458 ($6,083)	<0.0001
Out-patient Costs	$10,250 ($17,839)	$14,048 ($25,623)	$9,511 ($13,252)	$14,211 ($18,785)	$14,615 ($27,919)	$14,051 ($20,688)	$26,159 ($30,389)	<0.0001
In-patient Costs	$13,633 ($37,976)	$24,662 ($49,290)	$16,515 ($37,600)	$24,930 ($51,775)	$27,363 ($60,270)	$31,100 ($64,545)	$61,375 ($124,266)	<0.0001

[a]All estimates were generated from a generalized linear model with a log link and gamma distribution, adjusted for demographic information (categorical age, region of the US, type of health plan, prescription drug coverage, and Charlson Comorbidity Index)
[b]All costs are in inflation adjusted US dollars to 2017

Table 4 – Total Unadjusted Costs by Surgery Type by Year

Year [N(SD)][a]	TAH	LH	TAM	LM	UAE	EA	MS
2008	$26,628 ($46,517)	$36,382 ($51,867)	$28,838 ($35,238)	$46,086 ($73,009)	$51,671 ($116,904)	$30,670 ($51,671)	$107,413 ($161653)
2009	$28,125 ($53,610)	$38,733 ($52,649)	$33,164 ($55,683)	$49,894 ($69,609)	$39,143 ($67,659)	$31,858 ($88,936)	$52,333 ($44,646)
2010	$26,285 ($46,391)	$39,598 ($57,044	$28,980 ($40,158)	$46,602 ($52,791)	$42,334 ($53,221)	$31,989 ($56,773)	$105,537 ($96,186)

2011	$24,069 ($39,091)	$37,961 ($58,903)	$29,845 ($39,045)	$47,295 ($61,488)	$39,378 ($39,489)	$31,339 ($50,380)	$42,292 ($25,343)
2012	$28,396 ($62,372)	$44,111 ($72,666)	$26,945 ($34,557)	$46,709 ($50,027)	$50,722 ($69,721)	$30,490 ($75,123)	$165,533 ($294,458)
2013	$24,260 ($40,648)	$47,589 ($73,289)	$26,922 ($67,119)	$47,566 ($54,041)	$41,785 ($73,573)	$30,786 ($56,771)	$73,654 ($68,605)
2014	$26,831 ($45,012)	$49,969 ($74,548)	$24,760 ($30,241)	$47,990 ($55,229)	$48,634 ($68,153)	$30,053 ($55,047)	$130,468 ($241,078)
2015	$20,149 ($34,796)	$46,674 ($64,796)	$19,226 ($23,949)	$44,229 ($48,179)	$47,687 ($74,489)	$29,497 ($41,245)	$119,680 ($159,018)
2016	$17,821 ($29,009)	$39,760 ($46,450)	$16,304 ($22,628)	$38,565 ($36,705)	$20,286 ($17,343)	$23,919 ($31,677)	$103,938 ($75,440)

[a]All costs are in inflation adjusted US dollars to 2017

Appendices

Appendix Table 1 – ICD-9, ICD-10, and CPT-4 Codes

Inclusion Diagnoses	ICD-9 Code	ICD-10 Code
Leiomyoma of uterus	218.x	D25
Submucousal leiomyoma of uterus	218.0	D25.0
Intramural leiomyoma of uterus	218.1	D25.1
Subserosal leiomyoma of uterus	218.2	D25.2
Leiomyoma of uterus, unspecified	218.9	D25.9

Exclusion Diagnoses	ICD-9 Code	ICD-10 Code
Pregnancy	V22.1	Z34.x
Ectopic pregnancy	633.90	O00.9
Endometrial carcinoma	182.0	C54.1
Carcinosarcoma (malignant neoplasm of the endometrium)	171.9	C54.1
Endometrial stromal sarcoma (malignant neoplasm of corpus uteri)	182.0	C54.1
Hematometra	621.4	N85.7
Endometritis	615.x	N71.x

Procedures	CPT-4 Code
Total abdominal hysterectomy	58150
Total laparoscopic hysterectomy	58541-58544, 58548, 58570 – 58573
Total abdominal myomectomy	58140-58145
Vaginal (hysteroscopic) myomectomy	58545, 59546, 58555, 58558, 58559, 58561
Uterine artery embolization	37243
Endometrial ablation, thermal or hysteroscopic	58353, 58563
Magnetic-focused guided ultrasound	51702 or 77022

Appendix Table 2 – Generalized Linear Model for Total Costs

Parameter	Rate Ratio	Lower Limit of the Confidence Interval	Upper Limit of the Confidence Interval
Total abdominal hysterectomy	1.00	--	--
Laparoscopic hysterectomy	1.45	1.40	1.50
Total abdominal myomectomy	0.96	0.89	1.03
Laparoscopic myomectomy	1.57	1.46	1.57
Uterine artery embolization	0.50	1.48	1.85
Endometrial ablation	0.45	1.50	1.65
Magnetic resonance-guided focused ultrasound	0.97	1.08	5.68
Age category (15-29)	0.98	0.88	1.09
Age category (30-39)	1.06	1.02	1.10
Age category (40-49)	1.00	--	--
North East region	1.13	1.08	1.18
North Central region	1.05	1.01	1.09
South region	1.00	--	--
West region	1.18	0.87	1.23
Unknown region	0.99	0.87	1.19
Employer Health Plan	1.00	--	--
Purchased Health Plan	0.87	0.85	0.90
Comprehensive	1.11	1.00	1.24
EPO	0.97	0.84	1.12
HMO	0.97	0.93	1.00
POS	1.06	1.01	1.11
PPO	1.00	--	--
PPO w/ capitation	1.16	0.94	1.42
CDHP	0.95	0.88	1.03
HDHP	1.10	0.96	1.26
No RX Drug Coverage	0.96	--	--
RX Drug Coverage	1.00	0.89	1.04
CCI (1)	1.00	--	--
CCI (2)	1.35	1.30	1.39
CCI (3)	2.00	1.85	2.02

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