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UTILIZATION OF APICAL VAGINAL SUPPORT PROCEDURES AT TIME OF INPATIENT HYSTERECTOMY PERFORMED FOR BENIGN CONDITIONS: A NATIONAL ESTIMATE

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Abstract

Background—Apical vaginal support is considered the keystone of pelvic organ support. Level I evidence supports re-establishment of apical support at time of hysterectomy, regardless of whether the hysterectomy is performed for prolapse. National rates of apical support procedure performance at time of inpatient hysterectomy have not been well described.

Objective—To estimate trends and factors associated with use of apical support procedures at time of inpatient hysterectomy for benign indications in a large national database.

Study Design—The National Inpatient Sample was used to identify hysterectomies performed from 2004–2013 for benign indications. ICD-9 codes were used to select both procedures and diagnoses. The primary outcome was performance of an apical support procedure at time of hysterectomy. Descriptive and multivariable analyses were performed.

Results—There were 3,509,230 inpatient hysterectomies performed for benign disease between 2004 and 2013. In both non-prolapse and prolapse groups, there was a significant decrease in total

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number of annual hysterectomies performed over the study period ($p < 0.0001$). There were 2,790,652 (79.5%) hysterectomies performed *without* a diagnosis of prolapse, and an apical support procedure was performed in only 85,879 (3.1%). There was a significant decrease in the proportion of hysterectomies with concurrent apical support procedure (high of 4.0% in 2004 to 2.5% in 2013, $p < 0.0001$). In the multivariable logistic regression model, increasing age, hospital type (urban teaching), hospital bed size (large and medium), and hysterectomy type (vaginal and laparoscopically-assisted vaginal) were associated with performance of an apical support procedure.

During the study period, 718,578 (20.5%) inpatient hysterectomies were performed *for prolapse diagnoses* and 266,743 (37.1%) included an apical support procedure. There was a significant increase in the proportion of hysterectomies with concurrent apical support procedure (low of 31.3% in 2005 to 49.3% in 2013, $p < 0.0001$). In the multivariable logistic regression model, increasing age, hospital type (urban teaching), hospital bed size (medium and large), and hysterectomy type (total laparoscopic and laparoscopic supracervical) were associated with performance of an apical support procedure.

Conclusions—This national database study demonstrates that apical support procedures are not routinely performed at time of inpatient hysterectomy regardless of presence of prolapse diagnosis. Educational efforts are needed to increase awareness of the importance of re-establishing apical vaginal support at time of hysterectomy regardless of indication.

Keywords

apical support procedure; hysterectomy; uterovaginal prolapse

INTRODUCTION

Nearly 500,000 hysterectomies are performed annually in the United States making it one of the most frequently performed surgeries in women.¹ The vast majority of hysterectomies are performed for benign conditions, and only 17% are performed for prolapse.² At time of total hysterectomy, the most critical component of apical utero-vaginal support is compromised.³ Unless specific procedures are performed to reattach the vaginal cuff to the uterosacral ligament complex, level I support is lost in non-prolapse cases and not re-established in prolapse cases, potentially predisposing women to future vaginal vault prolapse.^{4, 5} Multiple procedures have been described to re-suspend the vaginal apex at the time of hysterectomy, but despite level I evidence recommending apical support re-establishment⁶, regional data demonstrated that an apical support procedure (ASP) is performed in only 3% of cases *without* and 55% of cases *with* a diagnosis of uterovaginal prolapse.^{7–9}

Uterovaginal prolapse (UVP) is a multifactorial disorder that occurs when uterine and vaginal support becomes weakened or damaged allowing descensus of vaginal compartments in response to normal intra-abdominal pressure.¹⁰ With the aging population, rates of UVP and surgical intervention are expected to increase by almost 50% by the year 2050.¹¹ Despite best surgical practices, the rate of reoperation after UVP surgery remains high, and is estimated to be almost 30%.¹² Women who have a hysterectomy for prolapse

are at higher risk of future prolapse than women who have a hysterectomy for a non-prolapse indication.¹²

Since re-establishing apical support at the time of hysterectomy in patients without UVP has been shown to prevent future prolapse, and apical support procedures are the treatment for UVP, the objective of this study was to use a large national database to describe national trends in the proportion of ASP performance at time of hysterectomy for non-oncologic indications. Cases performed *not* for prolapse and *for* prolapse were examined separately. Our primary outcome was rate of concurrent ASP at time of hysterectomy. Secondary outcomes included concomitant surgeries, socioeconomic factors, and regional and hospital characteristics.

METHODS

This study examined inpatient hysterectomies performed for benign indications in adult women aged 18 and older from 2004–2013 using discharge data from the National (Nationwide) Inpatient Sample (NIS), Healthcare Utilization Project (HCUP), Agency for Healthcare Research Quality. The NIS is a national, publically available, de-identified dataset that yields national estimates of hospital inpatient stays.¹³ International Classification of Diseases 9th edition, Clinical Modification (ICD-9) procedure codes were used to select hospitalizations coded for supracervical or subtotal abdominal, total abdominal, and vaginal hysterectomies (68.31, 68.39, 68.41, 68.49, 68.51, 68.59 from 2006 to 2013). Prior to 2007, the ICD-9 hysterectomy codes (68.4 and 68.5) did not distinguish laparoscopic from open procedures; thus, from 2004–2006 the code for laparoscopy (54.21) was used together with 68.4 and 68.5 to specify the operative approach. Patients were excluded if the hospitalization was coded for a urogenital malignancy (179.0–184.9, 188.0–189.9, 198.x), or bowel or other intra-abdominal malignancy (ICD-9 codes 152.0–159.9, 197.4–197.8, 209.0x, 209.1x, 209.24–209.27, 209.74, 236.x). Patients were divided into two categories: those who received a hysterectomy with no diagnosis of UVP and those with a diagnosis of UVP (ICD-9 618.01–618.89), and the groups were analyzed separately. Patients in each category were analyzed according to receipt of an apical suspension or obliterative procedure [ICD-9 codes for vaginal suspension (70.64, 70.77, 70.78), uterine suspension (69.22), obliteration (70.4, 70.8), and repair of enterocele (70.92)] compared to those who did not receive any apical suspension. UVP was identified using ICD-9 codes for uterine prolapse (618.1, 618.2, 618.3, 618.4, 618.89, 618.01, 618.02 and 618.04). We chose UVP as a proxy for apical descent given the limitations of a database utilizing ICD-9 codes.

Analysis

Demographics including age, race, socioeconomic status, and type of health insurance, as well as hospital characteristics, including ownership type, rural/urban location, teaching status, and hospital size were compared between groups (hysterectomy performed *without* a diagnosis of prolapse and hysterectomy *for* prolapse). The updated trend weights, available from the Healthcare Cost and Utilization Project (HCUP) website, were used to weight observations, taking into account the design change of the NIS in 2012¹⁴. The statistical methodology was chosen because of the complex sampling design of the NIS¹⁵, which

requires weighting of observations in order to obtain national estimates and use of survey statistical methods to accurately calculate standard errors. Unadjusted odds ratios (OR) were calculated for demographic data, diagnoses, and concomitant procedures for those who did not receive an apical support procedure compared to those who did receive an apical support procedure. Variables with $p < 0.10$ were included in the initial multivariable logistic regression model, taking into account clustering by hospital and year, and weighting of the observations using the updated trend weights.¹⁵ All statistical analyses were performed in SAS Enterprise Guide version 7.1 (Cary, NC). This study was considered exempt by the Human Research Protection Office of Washington University in St. Louis.

RESULTS

During the ten-year study period 3,509,230 inpatient hysterectomies were performed for benign conditions including 2,790,652 (79.5%) without a diagnosis of UVP and 718,578 (20.5%) performed *for* UVP (Table 1). Demographic characteristics of women undergoing a hysterectomy are demonstrated in Table 1. The majority of women were non-Hispanic white (*no* UVP 50.6%; UVP 61.7%), privately insured (*no* UVP 73.0%; UVP 63.6%), and received care at a large hospital (*no* UVP 61.2%; UVP 60.2%), and/or privately owned non-profit (*no* UVP 71.5%; UVP 73.9%) hospital. Throughout the study period there was a significant decrease in total hysterectomies performed annually regardless of prolapse diagnosis (Figure 1).

Hysterectomy *Without* Diagnosis of Prolapse

Of the 2,790,652 hysterectomies performed for benign indications with no UVP diagnosis during the study period, 85,879 (3.1%) included an ASP. Top indications for surgery were abnormal uterine bleeding (58.7%) and pelvic pain (13.7%). The majority of hysterectomies were performed via the total abdominal hysterectomy route (68.2%), compared with laparoscopic-assisted vaginal hysterectomy (14.4%), total vaginal hysterectomy (11.8%), and total laparoscopic hysterectomy (5.6%). Over the study period, there was a significant decrease in the proportion of hysterectomies with concurrent ASP (high of 4.0% in 2004 to 2.5% in 2013, $p < 0.0001$) (Figure 1). When concomitant prolapse procedures were analyzed, if no ASP was performed, 3,930 (0.1%) received a concomitant anterior colporrhaphy, 3,264 (0.1%) a posterior colporrhaphy, and 3,953 (0.1%) an anterior and posterior colporrhaphy. When an ASP was performed, 916 (1.0%) received a concomitant colporrhaphy, 1,238 (1.4%) a posterior colporrhaphy, and 2,037 (2.3%) an anterior and posterior colporrhaphy.

Univariable logistic regression analysis was performed, and factors with $p < 0.1$ were included as candidate variables for multivariable regression. In the multivariable analysis (Table 2), we included only factors that can be identified preoperatively. Factors associated with performance of an ASP were increasing age, hospital type, hospital bed size, and route of hysterectomy. Patients aged 65 and older were 2.0–2.3 times as likely to undergo an ASP at time of benign hysterectomy. Patients undergoing hysterectomy for benign indications were less likely to receive a concurrent ASP if their procedure was performed at a rural (OR 0.7, CI 0.6–0.8) or small bed size (OR 0.8, CI 0.7–0.9) hospital. Apical support procedures were more likely to be performed in patients undergoing laparoscopic-assisted vaginal

hysterectomy (OR 2.9, CI 2.5–3.3), and total vaginal hysterectomy (OR 5.1, CI 4.5–5.7) when compared to total abdominal hysterectomy.

Hysterectomy for Diagnosis of Prolapse

During the study period, 718,578 (20.5%) hysterectomies were performed for the diagnosis of uterovaginal prolapse (Table 1). The most common secondary diagnoses for hysterectomy were abnormal uterine bleeding (23.6%) and pelvic pain (5.3%). The majority of hysterectomies were performed vaginally (64.4%), compared with laparoscopic-assisted vaginal (15.0%), total abdominal (13.4%), and total laparoscopic (2.2%) routes. An ASP was performed in 266,743 (37.1%) hysterectomies. Over the course of the study period, there was a significant increase in the proportion of hysterectomies with ASP performed (low of 31.3% in 2005 to 49.4% in 2013, $p < 0.0001$) (Figure 1). When concomitant prolapse procedures were analyzed, if no ASP was performed 92,965 (20.6%) received a concomitant anterior colporrhaphy, 45,948 (10.2%) a posterior colporrhaphy, and 142,720 (31.6%) an anterior and posterior colporrhaphy. When an ASP was performed, 36,607 (13.7%) received a concomitant colporrhaphy, 36,259 (13.6%) a posterior colporrhaphy, and 103,278 (38.7%) an anterior and posterior colporrhaphy.

Univariable logistic regression analysis was performed, and factors with $p < 0.1$ were included as candidate variables for multivariable regression. On multivariable analysis, increasing age, hospital type, bed size, and hysterectomy route were associated with increased likelihood of performance of an ASP (Table 2). Procedures performed in rural (OR 0.5, CI 0.4–0.5), urban non-teaching (OR 0.6, CI 0.5–0.6), and small (OR 0.8, CI 0.7–0.8) or medium (OR 0.9, CI 0.8–0.9) size hospitals were associated with lower likelihood of ASP at the time of hysterectomy. Total laparoscopic (OR 1.3, CI 1.2–1.5) or laparoscopic supracervical hysterectomies (OR 3.2, CI 2.8–3.6) were associated with ASP performance, while laparoscopic-assisted vaginal (OR 0.7, CI 0.6–0.8) and vaginal (OR 0.8, CI 0.7–0.8) routes were associated with lower likelihood of having an ASP performed at time of hysterectomy.

In hysterectomies with a diagnosis of UVP we combined codes for uterovaginal prolapse (618.1, 618.2, 618.3, 618.4, 618.89) and cystocele and rectocele (618.01, 618.02, 618.04). We compared these groups by route of hysterectomy and found that 72% of women with a diagnosis of UVP (618.1–.4) have a vaginal hysterectomy and 32.2% had an ASP. In the women with a prolapse diagnosis of cystocele and/or rectocele (618.01–.04), 81.6% had a vaginal hysterectomy and 38.5% had an ASP. Women with a diagnosis of cystocele and/or rectocele had a higher proportion of hysterectomies performed by the vaginal route and had a higher proportion of ASPs than women with a diagnosis of UVP. Thus, we believed it reasonable to analyze these codes together as coding cystocele and/or rectocele alone likely represents a lack of recognition of apical support loss.

COMMENT

Although there is increasing awareness that apical support is critical to overall pelvic support, the majority of inpatient hysterectomies performed in the United States between 2004–2013 did not include an apical support procedure. Overall, only 3.1% of

hysterectomies performed from 2004 to 2013 for non-UVP indications and 37.1% of those *with* a diagnosis of UVP incorporated a procedure to re-suspend the vaginal apex. This is despite level I evidence that an apical support procedure at time of hysterectomy not for prolapse can prevent future post-hysterectomy vaginal vault prolapse.⁶ Cruikshank et al. in a 1999 randomized surgical trial found that use of a modified-McCall's procedure results in a significantly lower rate of UVP than a simple Moscovitz-type or simple peritoneal vaginal closure at two years.⁶ These findings were later referenced in guidelines developed for prevention of post-hysterectomy vaginal vault prolapse by the American Association of Gynecologic Laparoscopists (AAGL) and Royal Congress of Obstetricians and Gynaecologists (RCOG) in conjunction with the British Society of Urogynaecology (BSUG). These organizations recommend performance of an ASP at time of hysterectomy for non-UVP benign indication to prevent post-hysterectomy vaginal vault prolapse. Specifically, both guidelines recommend performance of a McCall culdoplasty during vaginal hysterectomy (level B evidence) and uterosacral ligament suspension (USLS) during abdominal hysterectomy (level B evidence).^{16, 17} Additionally, AAGL recommends USLS at time of laparoscopic hysterectomy (C evidence) and RCOG/BSUG endorse USLS as an alternate to a McCall culdoplasty during vaginal hysterectomy (B evidence).¹⁷

In 2007 an American College of Obstetricians and Gynecologists practice bulletin stated that hysterectomy alone is inadequate treatment for uterovaginal prolapse.¹⁸ In 2008, the International Consultation on Incontinence Committee on Surgery for Pelvic Organ Prolapse reiterated that "the apex is the keystone to pelvic organ support" and "because of the significant contribution of the apex to anterior vaginal support, the best surgical correction of the anterior and posterior wall may fail unless the apex is adequately supported"¹⁹. A more recent clinical review by Walters and Ridgeway emphasized that transvaginal hysterectomy alone, without apical prolapse repair, is not an appropriate operation to treat significant uterovaginal prolapse.¹⁰ A recent study using Medicare data showed that 10-year reoperation rates for pelvic organ prolapse were significantly lower when a concomitant apical support procedure is performed at time of initial surgery.⁵ Despite this, apical support procedures appear to be underutilized as shown in this and other studies.^{5, 9, 20, 21}

Across medical and surgical specialties, studies are now suggesting there is better adherence to evidence based guidelines at high-volume centers, and surgical and mortality outcomes are improved when guidelines are followed.^{21–24} This is consistent with the findings of our study, using a nationally representative database, that demonstrates an ASP is most likely to be performed at a large and urban teaching hospital, of which many are high-volume centers. The NIS includes data from all hospital categories (i.e. large, small, rural, urban) and does not specify surgeon volume or specialty. While there are often a higher proportion of high volume surgeons and surgeons with advanced surgical training at large academic centers,²⁵ the vast majority of hysterectomies for benign conditions are performed by general gynecologists. Thus, recognition of the importance of reestablishment of apical support across specialties is crucial to meet current treatment standards.

In addition to the association with surgical volume, ASP performance was found to be significantly associated with route of hysterectomy. In indications *not* for prolapse, an ASP is 5 times *more* likely to be performed when the hysterectomy is performed via the vaginal

route and 2.9 times more likely when the hysterectomy is via the laparoscopic-assisted vaginal route. Surprisingly, when a hysterectomy is performed *for* UVP, an ASP is 25% *less* likely to be performed when the *vaginal route* is used when compared to the total abdominal route. We suspect that this may be due to a lack of recognition of apical support loss in the cases of hysterectomy *not* for UVP. One of the traditional criteria in surgical decision making for performing a vaginal hysterectomy is adequate uterine descent.^{7, 26} We posit that if there is enough uterine descent to perform a vaginal hysterectomy, then there is likely significant apical support loss in most cases. Unfortunately, there are no current guidelines that describe the level of apical descent at which an ASP should be performed. In hysterectomies for UVP where a vaginal route is used but an ASP is not performed, we believe this is likely due to a lack of recognition of the role of apical support loss in anterior and posterior vaginal prolapse. This may lead to misdiagnosis of isolated anterior and/or posterior compartment prolapse. In a large review of the literature on surgical treatment of pelvic organ prolapse, the International Consultation on Incontinence Prolapse Committee stated, “recognition of apical support defects is one of the biggest problems in the evaluation of pelvic support defects.”¹⁹ The role of apical support loss in anterior and/or posterior vaginal wall prolapse has been well described.^{27–31}

The greatest strength of this study is the use of a large, validated, national database, which enables generalization of our findings to the practice patterns of physicians across the United States. This data set captures providers and patients over time and region, allowing for the study of socioeconomic, biodemographic, and regional factors and their interplay with surgical practice. Furthermore, this is the first study, to our knowledge, examining the trend of ASP performance at time of hysterectomy not for prolapse that illustrates the ongoing lack of recognition of the importance of apical support to overall vaginal support.

This study is limited by its retrospective design, and inherent limitations of databases using hospital-supplied diagnosis and procedure codes. These codes are generated by coding personnel, not the surgeon, which can lead to misclassification and transcription errors.³² As ICD-9 codes are primarily used for hospital billing, this data may not adequately capture the true extent of procedures performed. However, since the codes are used for hospital billing, if a diagnosis or procedure is described in the medical record it is likely to be listed as part of that patient’s hospitalization and/or surgery. In discussion with practicing hospital coders at different institutions this is consistent with their practice. In addition, ICD procedure codes and Current Procedural Terminology (CPT) codes are distinctly different. For example, the CPT codes for a vaginal hysterectomy include an enterocele repair (i.e. McCall’s culdoplasty), whether it was performed or not, whereas the ICD codes are separate for each procedure. In our opinion, it is more likely that reestablishment of apical support at time of vaginal hysterectomy would be correctly identified using ICD codes than CPT codes based on current coding nomenclature. However, even if data from this administrative database underestimates re-establishment of apical support at time of hysterectomy *not* for prolapse 20-fold, the proportion would still be only 60%. If it underestimates the proportion of re-establishment of apical support at time of hysterectomy *for* UVP 2-fold, the proportion would still be only 74%. An additional limitation of this study is that a growing number of hysterectomies are performed outpatient, and are not

reflected in the NIS database. While we would expect ASP performance to be comparable in both inpatient and outpatient hysterectomies, this comparison has not been published.

In this large national database study of hysterectomies performed for benign *non*-UVP and UVP indications, a strikingly low number of women had a concurrent ASP performed at time of hysterectomy. This highlights the need for continued education on the importance of level I support in overall pelvic organ support, risk factors for apical support loss, and the importance of re-establishing apical support at time of hysterectomy. For surgical management, we recommend development of evidence-based guidelines to aid surgeons in determining:

1. Level of apical support loss at which an advanced ASP should be performed
2. Hysterectomy route and surgical procedure(s) selection that have both acceptable prolapse and safety outcomes
3. When to consider referral to specialists with specific training in advanced apical support procedure performance.

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Condensation

National rates of apical support procedures performed at time of inpatient hysterectomy for benign indications (not for prolapse and for prolapse) are described.

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Figure 1. Hysterectomy and apical support procedure trend

Trend in performance of hysterectomies and concomitant apical support procedure proportion for benign indications from 2004–2013, stratified by diagnosis of uterovaginal prolapse, is shown. ASP: Apical Support Procedure

Table 1

Demographics of women undergoing hysterectomy for benign indications from 2004–2013

	No Prolapse (n = 2,790,652) Number (%)	Prolapse (n= 718,575) Number (%)
Age (median, interquartile range)	43.3 (38.0–48.2)	52.3 (43.4–64.1)
Race/Ethnicity		
Non-Hispanic White	1,413,458 (50.6)	443,312 (61.7)
Asian/Pacific Islander	52,743 (1.9)	9,878 (1.4)
Black	384,247 (13.8)	26,446 (3.7)
Hispanic White	252,001 (9.0)	70,731 (9.8)
Missing	611,258 (21.9)	147,226 (20.5)
Other	76,945 (2.8)	20,982 (2.9)
Insurance Type		
Private	2,036,256 (73.0)	457,158 (63.6)
Public/uninsured	611,589 (21.9)	233,271 (32.5)
Other/missing insurance	142,806 (5.1)	28,146 (3.9)
Hospital Type		
Urban teaching	1,135,935 (40.7)	288,996 (40.2)
Urban non-teaching	1,244,797 (44.6)	320,925 (44.7)
Rural	396,021 (14.2)	105,345 (14.7)
Hospital Size		
Large	1,707,574 (61.2)	432,882 (60.2)
Medium	726,697 (26.0)	190,989 (26.6)
Small	342,482 (12.3)	91,395 (12.7)
Hospital Ownership		
Private non-profit	1,996,252 (71.5)	531,074 (73.9)
Private for-profit	403,889 (14.5)	105,434 (14.7)
Government, non-fed	358,101 (12.8)	74,936 (10.4)
Indication for surgery		
Abnormal uterine bleeding	1,902,981 (58.7)	169,885 (23.6)
Pelvic pain	443,942 (13.7)	38,064 (5.3)
Other	35,992 (1.1)	9,174 (1.3)
Type of Hysterectomy		
Total abdominal	1,901,872 (68.2)	96,414 (13.4)
Laparoscopic-assisted vaginal	402,491 (14.4)	107,725 (15.0)
Total Vaginal	328,758 (11.8)	463,075 (64.4)
Total Laparoscopic	157,529 (5.6)	15,714 (2.2)
Laparoscopic supracervical *	–	18,501 (2.6)
Abdominal supracervical *	–	17,146 (2.4)

* Supracervical hysterectomies excluded from the non-prolapse group as level 1 support is not disrupted

Multivariate analysis of apical support procedure performance in women undergoing hysterectomy for benign indications with and without the diagnosis of prolapse

Table 2

Variable	No Prolapse			Prolapse		
	Adjusted Odds Ratio	95% Confidence Interval	p-value	Adjusted Odds Ratio	95% Confidence Interval	p-value
Age						
<45	REF			REF		
45–54	1.09	1.05–1.14	<0.0001	1.26	1.21–1.31	<0.0001
55–64	1.35	1.24–1.47	<0.0001	1.61	1.54–1.68	<0.0001
65–75	2.02	1.78–2.30	<0.0001	1.91	1.81–2.03	<0.0001
>75	2.25	1.90–2.65	<0.0001	2.08	1.94–2.23	<0.0001
Race/Ethnicity						
Non-Hispanic White	REF			REF		
Asian/Pacific Islander	0.78	0.66–0.92	0.0028	0.98	0.88–1.10	0.7567
Black	0.90	0.81–1.01	0.0618	0.99	0.91–1.07	0.7509
Hispanic White	1.08	0.96–1.20	0.2059	0.98	0.91–1.06	0.5975
Missing	1.40	1.19–1.64	<0.0001	1.03	0.94–1.14	0.5223
Other	0.90	0.78–1.05	0.1691	1.08	0.95–1.22	0.2539
Insurance Type						
Private	REF			REF		
Public/uninsured	0.87	0.81–0.93	<0.0001	0.98	0.93–1.02	0.3428
Other insurance/Missing	1.13	0.98–1.30	0.1032	1.18	1.07–1.29	0.0006
Hospital Type						
Urban teaching	REF			REF		
Urban non-teaching	0.89	0.78–1.02	0.0873	0.57	0.53–0.62	<0.0001
Rural	0.67	0.55–0.82	0.0003	0.46	0.41–0.52	<0.0001
Hospital Size						
Large	REF			REF		
Medium	0.87	0.76–1.00	0.0516	0.87	0.79–0.94	0.0011
Small	0.77	0.65–0.91	0.0026	0.76	0.69–0.84	<0.0001
Median Income by						

Variable	No Prolapse			Prolapse		
	Adjusted Odds Ratio	95% Confidence Interval	p-value	Adjusted Odds Ratio	95% Confidence Interval	p-value
Zip code						
76 th percentile	REF			REF		
51 st –75 th percentile	1.09	1.02–1.17	0.0165	0.91	0.86–0.95	<0.0001
26 th –50 th percentile	1.15	1.05–1.26	0.0025	0.88	0.83–0.94	<0.0001
25 th percentile	1.15	1.04–1.28	0.0054	0.81	0.75–0.87	<0.0001
Indication for Surgery						
AUB	0.94	0.89–0.99	.0175	0.70	0.68–0.72	<0.0001
Pelvic pain	1.21	1.15–1.28	<0.0001	0.83	0.79–0.87	<0.0001
Type of Hysterectomy				REF		
Total abdominal	REF					
Laparoscopic-assisted vaginal	2.85	2.51–3.25	<0.0001	0.68	0.62–0.75	<0.0001
Total vaginal	5.09	4.53–5.72	<0.0001	0.75	0.70–0.81	<0.0001
Total laparoscopic	1.14	0.93–1.40	0.2001	1.32	1.16–1.50	<0.0001
Laparoscopic supracervical				3.15	2.75–3.61	<0.0001
Abdominal supracervical				2.90	2.47–3.41	<0.0001
Elixhauser Comorbidities						
AIDS	–			2.59	1.09–6.13	0.0309
Chronic pulmonary disease	0.92	0.87–0.99	0.0173	–		
Depression	0.90	0.84–0.97	0.0057	1.11	1.05–1.17	0.0002
Diabetes	0.90	0.84–0.97	0.0071	–		
Fluid and electrolyte disorders				1.33	1.22–1.45	<0.0001
Hypertension	0.90	0.86–0.95	<0.0001	–		
Hypothyroidism				1.08	1.04–1.12	0.0001
Obesity	0.82	0.74–0.90	<0.0001	–		
Other neurological disorders	–			1.11	1.01–1.20	0.0297
Peripheral vascular disease	–			1.20	1.02–1.42	0.0265

* only significant variables included, except race/ethnicity in prolapse model

Table 3

ICD-9 Procedure Codes Used

Diagnosis	ICD-9 Code
Apical support procedure (ASP)	69.22, 70.4, 70.64, 70.77, 70.78, 70.92
Hysterectomy	68.31, 68.39, 68.4, 68.41, 68.49, 68.5, 68.51, 68.59
Anterior colporrhaphy (cystocele repair)	70.51, 70.54
Posterior colporrhaphy (rectocele repair)	70.52, 70.05
Anterior/posterior colporrhaphy (cystocele and rectocele repair)	70.50, 70.53