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Original Article

Racial/Ethnic Differences in the Risk of Surgical Complications and Posthysterectomy Hospitalization among Women Undergoing Hysterectomy for Benign Conditions

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ABSTRACT **Study Objective:** Evaluate whether 30- and 90-day surgical complication and postoperative hospitalization rates after hysterectomy for benign conditions differ by race/ethnicity and whether the differences remain after controlling for patient, hospital, and surgical characteristics.

Design: Retrospective cohort study using administrative data. The exposure was race/ethnicity. The outcomes included 5 different surgical complications/categories and posthysterectomy inpatient hospitalization, all identified through 30 and 90 days after hysterectomy hospital discharge, with the exception of hemorrhage/hematoma, which was only identified through 30 days. To examine the association between race/ethnicity and each outcome, we used logistic regression with clustering of procedures within hospitals, adjusting for patient and hospital characteristics and surgical approach.

Setting: Multistate, including Florida and New York.

Patients: Women aged ≥18 years who underwent hysterectomy for benign conditions using State Inpatient Databases and State Ambulatory Surgery Databases.

Interventions: Hysterectomy for benign conditions.

Measurements and Main Results: We included 183 697 women undergoing hysterectomy for benign conditions from January 2011 to September 2014. In analysis, adjusting for surgery route and other factors, black race was associated with increased risk of 30-day digestive system complications (multivariable adjusted odds ratio [aOR], 1.98; 95% confidence interval [CI], 1.78−2.21), surgical-site infection (aOR, 1.34; 95% CI, 1.18−1.53), posthysterectomy hospitalization (aOR, 1.31; 95% CI, 1.22−1.40), and urologic complications (aOR, 1.16; 95% CI, 1.01−1.34) compared with white race. Asian/Pacific Islander race was associated with increased risk of 30-day urologic complications (aOR, 1.48; 95% CI, 1.08−2.03), intraoperative injury to abdominal/pelvic organs (aOR, 1.46; 95% CI, 1.23−1.75), and hemorrhage/hematoma (aOR, 1.33; 95% CI, 1.06−1.67) compared with white race. Hispanic ethnicity was associated with increased risk of 30-day posthysterectomy hospitalization (aOR, 1.11; 95% CI, 1.02−1.20) compared with white race. All findings were similar at 90 days.

Conclusion: Black and Asian/Pacific Islander women had higher risk of some 30- and 90-day surgical complications after hysterectomy than white women. Black and Hispanic women had higher risk of posthysterectomy hospitalization.

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Intervention strategies aimed at identifying and better managing disparities in pre-existing conditions/comorbidities could reduce racial/ethnic differences in outcomes. Journal of Minimally Invasive Gynecology (2021) 00, 1−11. © 2021 AAGL. All rights reserved.

Keywords: Adverse outcomes; Disparities; Healthcare cost and utilization project; Minimally invasive surgery

Hysterectomy is the most commonly performed nonobstetric surgical procedure in women, with almost 400 000 procedures performed for benign gynecologic conditions annually [1]. Compared with minimally invasive gynecologic surgery (MIGS) (vaginal, laparoscopic, and robot-assisted), abdominal hysterectomy is associated with poorer outcomes, including longer length of hospital stay [2], surgical complications [2,3], and hospital readmissions [4,5]. Because adverse outcomes may be avoidable and are major drivers of healthcare costs [6,7], they are important measures of healthcare quality [5,8].

Studies, including our prior work, have reported that nonwhite women, and black women in particular, are less likely to undergo MIGS [5,9−12] and have worse postoperative outcomes, even after controlling for surgical approach [5,9−11]. It is possible, however, that the reported differences in outcomes can be explained, at least partially, by pre-existing conditions not controlled for in prior studies and hospital factors not accounted for. In addition, analyses based on composite medical and surgical complication variables fail to provide information about significant risk factors by complication type [9,10,13].

For these reasons, it remains unclear whether race/ethnicity independently predict poorer outcomes. The objectives of this study were to determine (1) whether surgical complication and posthysterectomy hospitalization rates within 30 and 90 days of hysterectomy for benign conditions differ by race/ethnicity and (2) whether the differences in outcomes remain after controlling for patient, hospital, and surgical characteristics, including procedure type/route of surgery.

Materials and Methods

Data Source

We performed a retrospective cohort study using hospital discharge data from the Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project, State Inpatient Databases (SID), and State Ambulatory Surgery Databases (SASD). The SID (inpatient stays) and SASD (ambulatory/observation stays) are state-specific files that contain all inpatient and ambulatory surgery billing records from acute care, nonfederal community hospitals [14]. These databases contain encrypted person identifiers to track patients over time within a state. Because the SID and SASD allow follow-up of all individuals who seek care at any acute care, nonfederal hospital within a state, information for a patient who received follow-up care at another in-state hospital other than where their surgery was performed is captured in the data. Individuals could not be identified in the dataset; therefore, the Washington University Human Research Protection Office considered this study exempt from institutional review.

Study Population

We included women aged ≥18 years who underwent hysterectomy for benign gynecologic conditions from 2011 through the third quarter of 2014 from the Florida and New York SID and SASD. Data from Florida and New York were used because they had race/ethnicity information, SID and SASD data, and encrypted person identifiers to follow patients over time, and they are geographically large and racially and ethnically diverse. Only hysterectomies performed ≤1 day of admission were included to avoid procedures related to an adverse event during the hospitalization [12]. Only encounters in which the hysterectomy procedure was performed in the person's home state were included to avoid missing outcomes for women who returned to their home state for follow-up care. We excluded hysterectomies performed for a complication of delivery, as previously described [12]. In addition, to maintain our focus on hysterectomies for benign conditions, we excluded encounters coded for uterine, cervical, ovarian, colon/abdominal, bladder/kidney, or metastatic cancer, as previously described [12]. However, a woman might have been identified with a nonabdominal malignancy or metastatic cancer for other reasons (e.g., breast cancer).

Hysterectomy Route and Surgery Date

Hysterectomy procedures were classified as either abdominal, vaginal, or laparoscopic (including robotic), using *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) procedure codes in the SID or Current Procedural Terminology (CPT) codes in the SASD (Supplemental Table 1) [12]. Most women with a diagnosis of conversion to open surgery had a procedure code for abdominal surgery (n = 3893, 93.9%). We defined a procedure as inpatient if the length of stay was ≥1 day and outpatient if the length of stay was <1 day. If more than 1 procedure date for hysterectomy was recorded, we used the first procedure date.

Exposure

Our primary exposure was race/ethnicity and categorized as white, black, Hispanic, Asian/Pacific Islander (PI), Native American/Other, and missing. It was collected through patient self-report or hospital staff observation.

When race and ethnicity were reported as separate data elements, ethnicity took precedence over race [15].

Outcomes

Five different surgical complications/categories within 30 and 90 days after hysterectomy were identified from the SID and SASD using *ICD-9-CM* diagnosis and procedure codes (Supplemental Table 1). We chose to focus on racial/ethnic differences in potentially avoidable surgical complications with incidence of ≥1% that have significant implications for postoperative morbidity, quality of life, and healthcare expenditures. They included digestive system complications (including paralytic ileus), hemorrhage/hematoma, surgical-site infection, intraoperative injury to abdominal/pelvic organs (including accidental laceration, repair of ureter, suture of laceration of bladder, and closure of cystostomy), and urologic complications (including ureteric stricture, ureteric obstruction, hydroureter, ureteral fistula, unspecified disorder of kidney and ureter, urethral stricture, urethral fistula, and urinary obstruction). All complications were identified during the hysterectomy admission and in readmissions (SID) or revisit encounters (SASD) through 30 and 90 days after surgery, with the exception of hemorrhage/hematoma, which was only identified through 30 days. Subsequent surgical procedures within 90 days after hysterectomy were identified using *ICD-9-CM* and CPT-4 procedure codes as defined by the Centers for Disease Control and Prevention National Healthcare Safety Network [16]. They were used to censor observations for complications and hospitalizations attributable to subsequent surgeries.

Posthysterectomy inpatient hospitalizations were identified in the SID from index hysterectomy hospital discharge through 30 and 90 days. Hospitalizations overlapping the hysterectomy admissions or hospitalizations ≤1 day of the hysterectomy discharge in which the discharge status was transfer to an acute care hospital were collapsed into a single admission (hysterectomy hospitalization). This was done because these postoperative admissions would be considered transfers from the acute care surgical admission to another hospital. To maintain our focus on nonelective hospitalizations, we excluded the most common elective posthysterectomy hospitalizations from analysis (encounter for chemotherapy and rehabilitation procedures). Among women with a posthysterectomy hospitalization, we identified the primary reason for posthysterectomy hospitalization using the primary *ICD-9-CM* diagnosis code.

Patient and Hospital Characteristics

Age, race/ethnicity, year of surgery, insurance status, residence status, median household income for zip code as defined by the Healthcare Cost and Utilization Project, and *ICD-9-CM* diagnosis codes for benign indications for hysterectomy were identified using information from the index surgical encounter [12]. We included concomitant gynecologic procedures performed at the time of hysterectomy, defined by *ICD-9-CM* and CPT-4 procedure codes, as potential operative risk factors (Supplemental Table 1). Women could have >1 indication for surgery and/or concurrent procedure [12]. Comorbidities (defined using the Elixhauser classification [17] and comorbidity index [18]), previous abdominopelvic surgery, adhesions, and tobacco use were identified during the hysterectomy encounter and hospitalization(s) in the year before the hysterectomy [12].

Hospital identifiers in the SID and SASD were linked to American Hospital Association Annual Survey data (American Hospital Association, Chicago, IL) to identify hospital location (rural or urban), teaching status (association with a medical school), and hospital bed size (small, ≤300; medium, 300−600; and large ≥600). Total annual hospital hysterectomy procedure volume was based on all hysterectomies performed for any indication and was calculated using the unique hospital identifier in the SID and SASD. Hysterectomy volume was categorized as low (1−50), medium (51−200), and high (≥201) [12]. Hospitals were also stratified into quintiles on the basis of the proportion of hospitalizations of black patients among all hospitalizations at the individual hospitals, ranging from quintile 1 (0%−2% black) to quintile 5 (>15% black) [12].

Statistical Analyses

We created categories for missing information for race/ethnicity (0.63%) and hospital-level variables (0.52%). We considered a priori all variables for inclusion in our analyses on the basis of clinical significance, including those known to be independent risk factors; after that, we considered their statistical significance. Bivariate logistic regression was conducted to assess differences in patient, hospital, and surgical characteristics between white and other racial/ethnic groups. Multivariable analyses were performed for the association between race/ethnicity and each of the outcomes using SAS PROC GENMOD (SAS Institute Inc., Cary, NC) with binomial distribution and logit link function. We used the repeated statement for the hospital identifier to account for clustering of procedures within hospitals. All statistically significant variables in bivariate analysis were included in the multivariable models. To create parsimonious models and avoid overfitting, we only retained the variables that remained significant after controlling for other factors in the final models. Although we tested the interaction between race/ethnicity and surgical approach, it was not statistically significant and therefore not included in the final models. Furthermore, we conducted 5 sensitivity analyses restricted to a single hysterectomy route and the most important surgical route −complication combinations from a clinical perspective. All statistical analyses were performed with SAS v.9.4 (SAS Institute Inc.). All tests were 2-sided, with statistical significance set at $\alpha = 0.05$.

Table 1

Characteristics of women undergoing hysterectomy from the State Inpatient Databases and State Ambulatory Surgery Databases (Florida and New York), January 1, 2011, to September 30, 2014*

Patient, hospital, and surgical characteristics	White (n = 106 307)	Black (n = 34 474)	Hispanic (n = 28 482)	Asian/PI (n = 3307)
Surgical route				
Abdominal	25 673 (24.15)	17 665 (51.24)	9713 (34.10)	1476 (44.63)
Vaginal	38 816 (36.51)	6273 (18.2)	9417 (33.06)	780 (23.59)
Laparoscopic	41 818 (39.34)	10 536 (30.56)	9352 (32.83)	1051 (31.78)
Median age, yrs (quartile 1−quartile 3)	47 (41−55)	45 (41−50)	46 (42−52)	47 (43−52)
Patient residence				
Large metropolitan area	54 937 (51.68)	27 101 (78.61)	24 172 (84.87)	2818 (85.21)
Small metropolitan area	39 159 (36.84)	6454 (18.72)	3278 (11.51)	437 (13.21)
Rural area	8365 (7.87)	557 (1.62)	861 (3.02)	38 (1.15)
Other	3846 (3.62)	362 (1.05)	171 (0.60)	14 (0.42)
State				
Florida	61 659 (58.00)	20 479 (59.40)	19 587 (68.77)	1150 (34.77)
New York	44 648 (42.00)	13 995 (40.60)	8895 (31.23)	2157 (65.23)
Indications for hysterectomy†				
Myomas	52 701 (49.57)	29 217 (84.75)	18 363 (64.47)	2410 (72.88)
Abnormal uterine bleeding	53 766 (50.58)	18 952 (54.97)	14 237 (49.99)	1485 (44.90)
Pain/endometriosis	55 139 (51.87)	12 681 (36.78)	13 258 (46.55)	1302 (39.37)
Ovary-related benign conditions	28 458 (26.77)	6310 (18.30)	6576 (23.09)	700 (21.17)
Genital prolapse	23 892 (22.47)	2996 (8.69)	5806 (20.38)	519 (15.69)
Menopause	6365 (5.99)	1513 (4.39)	1295 (4.55)	131 (3.96)
Prophylactic	6658 (6.26)	858 (2.49)	1026 (3.60)	132 (3.99)
Non−ovary-related benign conditions	5075 (4.77)	1206 (3.50)	1174 (4.12)	135 (4.08)
Cervical dysplasia	3170 (2.98)	632 (1.83)	802 (2.82)	85 (2.57)
Concomitant procedures†				
Operations on ovary	31 497 (29.63)	11 606 (33.67)	8840 (31.04)	1158 (35.02)
Apical support‡	14 230 (13.39)	2332 (6.76)	3344 (11.74)	326 (9.86)
Incontinence surgery	10 126 (9.53)	987 (2.86)	2623 (9.21)	221 (6.68)
Anterior/posterior colporrhaphy	7122 (6.70)	654 (1.90)	2049 (7.19)	163 (4.93)
Anterior colporrhaphy	3947 (3.71)	359 (1.04)	823 (2.89)	75 (2.27)
Lysis of adhesions of ovary and/or fallopian tube	3396 (3.19)	854 (2.48)	810 (2.84)	85 (2.57)
Posterior colporrhaphy	2146 (2.02)	172 (0.50)	453 (1.59)	34 (1.03)
Myomectomy	536 (0.50)	430 (1.25)	185 (0.65)	25 (0.76)
Pre-existing conditions/comorbidities†				
Adhesions	19 405 (18.25)	8437 (24.47)	5998 (21.06)	678 (20.50)
Alcohol abuse	475 (0.45)	196 (0.57)	61 (0.21)	§
Chronic pulmonary disease	11 031 (10.38)	3558 (10.32)	2924 (10.27)	192 (5.81)
Coagulopathy	826 (0.78)	289 (0.84)	176 (0.62)	19 (0.57)
Congestive heart failure	498 (0.47)	222 (0.64)	123 (0.43)	§
Chronic blood loss/deficiency anemias	12 753 (12.00)	11 358 (32.95)	6083 (21.36)	702 (21.23)
Depression	10 262 (9.65)	1405 (4.08)	1703 (5.98)	74 (2.24)
Diabetes with/without complications	7114 (6.69)	3828 (11.10)	2810 (9.87)	343 (10.37)
Drug abuse	692 (0.65)	418 (1.21)	97 (0.34)	§
Fluid and electrolyte disorders	3377 (3.18)	1720 (4.99)	884 (3.10)	127 (3.84)
Hypertension	25 729 (24.20)	13 183 (38.24)	7496 (26.32)	800 (24.19)
Hypothyroidism	11 309 (10.64)	1396 (4.05)	2123 (7.45)	244 (7.38)
Liver disease	726 (0.68)	170 (0.49)	211 (0.74)	26 (0.79)
Lymphoma‖	184 (0.17)	38 (0.11)	29 (0.10)	§
Metastatic cancer‖	425 (0.40)	74 (0.21)	78 (0.27)	11 (0.33)
Obesity	11 647 (10.96)	6235 (18.09)	3050 (10.71)	115 (3.48)
Other neurologic disorders	2129 (2.00)	518 (1.50)	375 (1.32)	24 (0.73)
Paralysis	209 (0.20)	108 (0.31)	42 (0.15)	§

Table 1

Continued

	White (n = 106 307)	Black (n = 34 474)	Hispanic (n = 28 482)	Asian/PI (n = 3307)
Peripheral vascular disease	552 (0.52)	129 (0.37)	153 (0.54)	[§]
Prior abdominopelvic surgery	5511 (5.18)	1249 (3.62)	1161 (4.08)	77 (2.33)
Psychoses	2142 (2.01)	549 (1.59)	424 (1.49)	16 (0.48)
Pulmonary circulation disease	384 (0.36)	221 (0.64)	79 (0.28)	[§]
Renal failure	654 (0.62)	297 (0.86)	174 (0.61)	12 (0.36)
Rheumatoid arthritis/collagen vascular disease	1855 (1.74)	520 (1.51)	441 (1.55)	26 (0.79)
Smoking	21 575 (20.29)	3790 (10.99)	2451 (8.61)	129 (3.90)
Solid nonabdominal tumor without metastasis[‖]	1697 (1.60)	265 (0.77)	342 (1.20)	46 (1.39)
Valvular disease	2597 (2.44)	423 (1.23)	414 (1.45)	35 (1.06)
Weight loss	443 (0.42)	122 (0.35)	104 (0.37)	[§]

	White (n = 106 307)	Black (n = 34 474)	Hispanic (n = 28 482)	Asian/PI (n = 3307)
Comorbidity index, median (IQR)	0 (0.00−7.00)	0 (0.00−9.00)	0 (0.00−8.00)	0 (0.00−8.00)
Hospital setting				
Inpatient	88 462 (83.21)	30 952 (89.78)	23 798 (83.55)	2834 (85.70)
Outpatient	17 845 (16.79)	3522 (10.22)	4684 (16.45)	473 (14.30)
Hospital location[¶]				
Rural	6628 (6.23)	401 (1.16)	788 (2.77)	28 (0.85)
Urban	98 997 (93.12)	33 966 (98.53)	27 599 (96.90)	3271 (98.91)
Teaching hospital[¶]				
No	47 173 (44.37)	11 795 (34.21)	12 458 (43.74)	826 (24.98)
Yes	58 452 (54.98)	22 572 (65.48)	15 929 (55.93)	2473 (74.78)
Bed size[¶]				
0−299	39 150 (36.83)	9637 (27.95)	10 221 (35.89)	1099 (33.23)
300−599	40 677 (38.26)	13 630 (39.54)	8567 (30.08)	1100 (33.26)
≥600	25 798 (24.27)	11 100 (32.20)	9599 (33.70)	1100 (33.26)
Hospital volume				
1−50	5410 (5.09)	1492 (4.33)	1118 (3.93)	103 (3.11)
51−200	29 427 (27.68)	9065 (26.30)	8510 (29.88)	868 (26.25)
>200	71 470 (67.23)	23 917 (69.38)	18 854 (66.20)	2336 (70.64)

IQR = interquartile range; PI = Pacific Islander.

* Data for Native American/Other (n = 9962) and missing race/ethnicity (n = 1165) are not presented. With the exception of age and comorbidity index, values are given in number (%).

† Columns for indications for hysterectomy, concomitant procedures, and pre-existing conditions/comorbidities will not sum to 100% because women could have >1 of these conditions.

‡ Includes uterine suspension, obliterative procedure, vaginal suspension, and repair of enterocele.

§ Values <11 cannot be reported according to Agency for Healthcare Research and Quality Healthcare Cost and Utilization Project guidelines.

‖ Hysterectomies performed for encounters coded for uterine, cervical, ovarian, colon/abdominal, bladder/kidney, or metastatic cancer were excluded. However, a woman could have been identified with a nonabdominal malignancy for other reasons (e.g., breast cancer). A woman with breast cancer, for example, with lymph node metastases will be coded for metastatic cancer according to the Elixhauser algorithm and thus could explain the presence of women coded for metastatic cancer in our study population.

¶ 0.52% had missing values for hospital characteristics.

Results

A total of 214 935 women aged ≥18 years in the Florida and New York SID and SASD were coded for hysterectomy ≤1 day of admission from January 2011 to September 2014. The analytic cohort included 183 697 women who underwent hysterectomy for benign indications. This was done after excluding 1681 women with a delivery complication or history of delivery outcome and 29 557 women with a diagnosis of gynecologic, colon/abdominal, bladder/kidney, or metastatic cancer (Supplemental Fig. 1).

Patient and hospital characteristics are presented in Table 1. Most of the women who underwent hysterectomy for benign conditions were white (58%), followed by black (19%), Hispanic (16%), and Asian/PI (2%) women. Fifty-eight percent of the population were from Florida and 42% from New York. Most of the women underwent

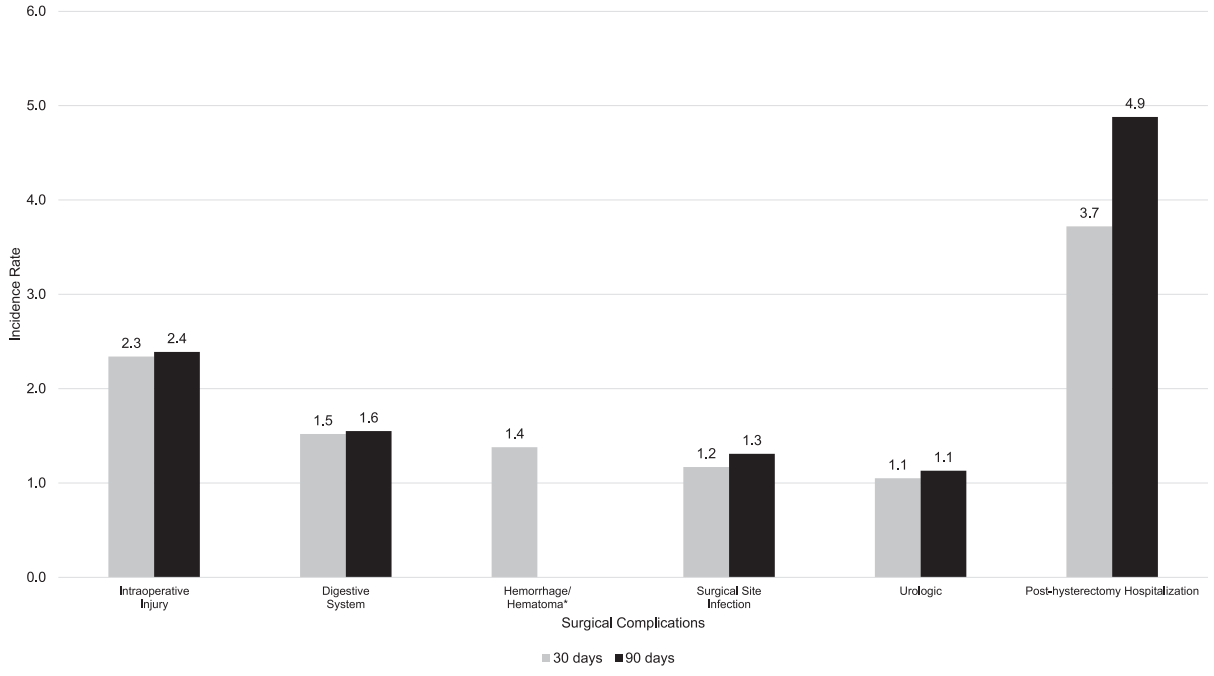
hysterectomy during an inpatient hospitalization (black, 90%; Asian/PI, 86%; Hispanic, 84%; and white, 83%). More Asian/PI (85%), Hispanic (85%), and black (79%) women resided in a large metropolitan area than white women (52%), and more Asian/PI (75%) and black women (65%) underwent hysterectomy at a teaching hospital than Hispanic (56%) and white women (55%). More black (51%), Asian/PI (45%), and Hispanic women (34%) underwent abdominal hysterectomy than white women (24%). Compared with white women, black, Hispanic, and Asian/PI race/ethnicity were associated with significantly increased risk of several comorbidities. These included chronic blood loss/deficiency anemias (black, odds ratio [OR], 3.27; 95% confidence interval [CI], 3.12−3.43; Asian/PI, OR, 1.95; 95% CI, 1.79−2.13; Hispanic, OR, 1.78; 95% CI, 1.67−1.89), hypertension (black, OR, 1.83; 95% CI, 1.75−1.91), obesity (black, OR, 1.74; 95% CI, 1.65−1.84), diabetes (black, OR, 1.69; 95% CI, 1.61−1.78; Asian/PI, OR, 1.61; 95% CI, 1.41−1.83; Hispanic, OR, 1.50; 95% CI, 1.41−1.60), and adhesions (black, OR, 1.42; 95% CI, 1.36−1.48; Hispanic, OR, 1.27; 95% CI, 1.19−1.34; Asian/PI, OR, 1.22; 95% CI, 1.10−1.35).

The incidence of 30- and 90-day surgical complications is shown in Fig. 1. For 30-day complications, intraoperative injury to abdominal/pelvic organs was most common (2.3%), followed by digestive system complications (1.5%), hemorrhage/hematoma (1.4%), surgical-site infection (1.2%), and urologic complications (1.1%). The incidence of 90-day complications was similar. The incidence of 30-day posthysterectomy hospitalization was 3.7% and 90-day hospitalization was 4.9% (Fig. 1). Posthysterectomy hospitalization was highest after abdominal hysterectomy (30-day, 4.5%; 90-day, 5.7%) and lowest after vaginal hysterectomy (30-day, 3.3%; 90-day, 4.5%). The laparoscopic 30-day hospitalization rate was 3.4% (90-day, 4.5%). Among women with a posthysterectomy hospitalization, the most common indications for 30-day posthysterectomy hospitalization were surgical-site infection (24%), digestive system complications (8%), and hemorrhage/hematoma (7%). The reasons for posthysterectomy hospitalization were similar at 90 days (Table 2).

The incidence of 30-day surgical complications and posthysterectomy hospitalization by surgical approach and race/ethnicity are presented in Fig. 2, with 90-day outcomes in Supplemental Fig. 2. Compared with other groups, Asian/PI women had the highest incidence of intraoperative injury to abdominal/pelvic organs identified within 30 days after abdominal (4.0%), vaginal (3.7%), and laparoscopic procedures (3.1%). Compared with other groups, black women had the highest incidence of 30-day posthysterectomy hospitalization (abdominal, 5.2%; laparoscopic, 4.2%; and vaginal, 4.0%), digestive system complications (abdominal, 4.9%; laparoscopic, 1.2%; and vaginal, 0.9%), and surgical-site infection (abdominal, 2.4%; laparoscopic, 1.2%; and vaginal, 1.1%). The incidence of all

Fig. 1

Incidence of 30- and 90-day surgical complications and posthysterectomy hospitalization from the state inpatient databases and state ambulatory surgery databases (Florida and New York), January 1, 2011, to September 30, 2014. *90-day results for hemorrhage/hematoma are not reported.



*90-day results for hemorrhage/hematoma are not reported.

Table 2

Primary diagnoses among women with a posthysterectomy hospitalization within 30 days and 90 days

Primary diagnoses	30 d n = 6830	90 d n = 8972
Intraoperative surgical complications		
Intraoperative injury to abdominal/pelvic organs	167 (2.45)	185 (2.06)
Foreign body left in during a procedure	*	*
Surgical complications		
Surgical-site infection	1649 (24.14)	1758 (19.59)
Digestive system	536 (7.85)	545 (6.07)
Hemorrhage/hematoma	511 (7.48)	N/R
Bowel obstruction	230 (3.37)	294 (3.28)
Wound dehiscence	114 (1.67)	191 (2.13)
Pelvic/cuff cellulitis	106 (1.55)	137 (1.53)
Septicemia	101 (1.48)	142 (1.58)
Seroma	73 (1.07)	82 (0.91)
Urologic	35 (0.51)	46 (0.51)
Medical complications		
Perioperative pulmonary embolism/deep vein thrombosis	342 (5.01)	394 (4.39)
Pneumonia	71 (1.04)	103 (1.15)
Chest pain	52 (0.76)	122 (1.36)
Acute kidney failure	40 (0.59)	55 (0.61)
Acute respiratory failure	22 (0.32)	30 (0.33)
Atrial fibrillation	17 (0.25)	37 (0.41)
Cerebrovascular accident	16 (0.23)	30 (0.33)
Myocardial infarction/cardiopulmonary disease	16 (0.23)	36 (0.40)
Syncope and collapse	12 (0.18)	31 (0.35)
Other complications		
Postoperative/abdominal pain	216 (3.16)	267 (2.98)
Gastrointestinal†	188 (2.75)	278 (3.10)
Urinary tract infection	120 (1.76)	155 (1.73)
Fever	119 (1.74)	123 (1.37)
Fistula	55 (0.81)	90 (1.00)
Pyelonephritis	55 (0.81)	86 (0.96)
Clostridium difficile infection	48 (0.70)	67 (0.75)
Hernia	22 (0.32)	25 (0.28)

N/R = not reported.

* Values <11 cannot be reported according to the Healthcare Cost and Utilization Project guidelines.

† Diverticulitis, dehydration, acute pancreatitis, constipation, nausea, vomiting, other.

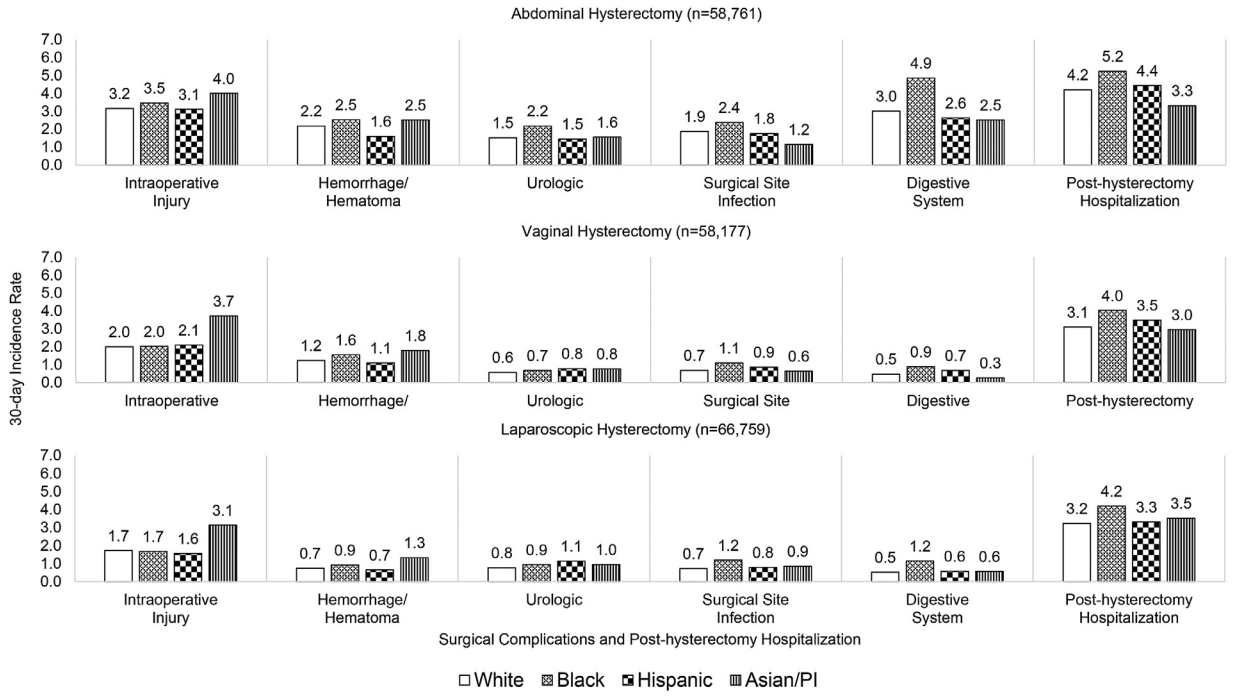
complications and posthysterectomy hospitalization at 90 days was similar.

In multivariable analyses (Table 3; see 90-day incidence and complete results in Supplemental Table 2), black race was independently associated with increased risk of 30-day digestive system complications (multivariable adjusted OR [aOR], 1.98; 95% CI, 1.78−2.21), surgical-site infection (aOR, 1.34; 95% CI, 1.18−1.53), posthysterectomy hospitalization (black, aOR, 1.31; 95% CI, 1.22−1.40), and urologic complications (aOR, 1.16; 95% CI, 1.01−1.34) compared with white race. Black race was not associated with 30-day risk of hemorrhage/hematoma. Asian/PI race was independently associated with increased risk of 30-day urologic complications (aOR, 1.48; 95% CI, 1.08−2.03), intraoperative injury to abdominal/pelvic organs (aOR, 1.46; 95% CI, 1.23−1.75), and hemorrhage/hematoma (aOR, 1.33; 95% CI, 1.06−1.67). Hispanic ethnicity was independently associated with significantly increased risk of 30-day posthysterectomy hospitalization (aOR, 1.11; 95% CI, 1.02−1.20).

In the same multivariable analyses, multiple comorbidities/pre-existing conditions were found to be associated with significantly increased risk of 30-day surgical complications and posthysterectomy hospitalization (Supplemental Table 2). Fluid and electrolyte disorders were associated with significantly increased risk of all outcomes, ranging from 3.49-fold for digestive system complications to 1.53-fold for posthysterectomy hospitalization. Adhesions were also associated with significantly increased risk of all outcomes. They ranged from 2.18-fold for intraoperative injury to abdominal/pelvic organs to 1.22-fold for posthysterectomy hospitalization. Chronic blood loss/deficiency anemias were associated with significantly increased risk of 1.27-fold for hemorrhage/hematoma, 1.22-fold for

Fig. 2

Incidence of 30-day surgical complications and posthysterectomy hospitalization by surgical approach and race/ethnicity from the state inpatient databases and state ambulatory surgery databases (Florida and New York), January 1, 2011 to September 30, 2014. PI = Pacific Islander.



digestive system complications, and 1.09-fold for posthysterectomy hospitalization. Coagulopathy was associated with significantly increased risk of 3.96-fold for hemorrhage/hematoma, 1.65-fold for intraoperative injury to abdominal/pelvic organs, 1.62-fold for digestive system complications, and 1.27-fold for posthysterectomy hospitalization. We found that chronic pulmonary disease was associated with significantly increased risk of 1.37-fold for digestive system complications, 1.33-fold for surgical-site infection, and 1.22-fold for posthysterectomy hospitalization. Obesity was associated with significantly increased risk of 1.49-fold for surgical-site infection and 1.11-fold for posthysterectomy hospitalization. Diabetes (1.16-fold) and hypertension (1.07-fold) were also associated with significantly increased risk of posthysterectomy hospitalization. Surgical approach and concomitant procedures were associated with increased risk of 30-day surgical complications and posthysterectomy hospitalization (Supplemental Table 2), consistent with previous reports [2]. All results were similar at 90 days. The results of the sensitivity analyses that focused on the most important surgical route−complication combinations from a clinical perspective are presented in Supplemental Table 3.

Discussion

This state-based analysis of women who underwent inpatient or outpatient hysterectomy for benign conditions found black women to have higher risk of 30- and 90-day digestive system complications, urologic complications, surgical-site infection, and posthysterectomy hospitalization than white women. Asian/PI women experienced higher risk of 30- and 90-day urologic complications, intraoperative injury to abdominal/pelvic organs, and hemorrhage/hematoma. Hispanic women were at higher risk of posthysterectomy hospitalization than white women.

Our finding of higher risk of complications among nonwhite women after hysterectomy is consistent with that of prior studies [9−11,19−21]. Our finding of posthysterectomy hospitalization in 3.7% of the women within 30 days of hysterectomy is also consistent with that of previous studies [4,8]. Black women had the highest 30- and 90-day posthysterectomy hospitalization incidence. Black race and Hispanic ethnicity were independently associated with posthysterectomy hospitalization, corroborated by previous studies [4,9]. Likewise, surgical-site infection was the most commonly coded complication of posthysterectomy hospitalization [4,8]. We examined surgical complications individually rather than in composite and thus are able to provide more information than previous studies about the association between race/ethnicity and individual surgical complications and other risk factors for these adverse outcomes [9,10].

Several comorbidities/pre-existing conditions contributed to increased risk of surgical complications. These included obesity, diabetes, blood loss/deficiency anemias,

Table 3

Bivariate odds ratios and multivariable adjusted odds ratios with 95% confidence intervals for 30- and 90-day surgical complications and posthysterectomy hospitalization by race/ethnicity from the State Inpatient Databases and State Ambulatory Surgery Databases (Florida and New York), January 1, 2011, to September 30, 2014

Surgical complications and posthysterectomy hospitalization	Bivariate OR (95% CI)	Multivariable aOR (95% CI)
Intraoperative injury to abdominal/pelvic organs*		
White	1.00 (reference)	1.00 (reference)
Black	1.00 (0.90−1.11)	0.91 (0.83−1.01)
Hispanic	0.96 (0.86−1.07)	0.94 (0.84−1.04)
Asian/Pacific Islander	1.55 (1.29−1.86)	1.46 (1.23−1.75)
Hemorrhage/hematoma†		
White	1.00 (reference)	1.00 (reference)
Black	1.45 (1.30−1.60)	1.09 (0.98−1.21)
Hispanic	0.94 (0.82−1.07)	0.82 (0.71−0.94)
Asian/Pacific Islander	1.56 (1.27−1.93)	1.33 (1.06−1.67)
Digestive system‡		
White	1.00 (reference)	1.00 (reference)
Black	2.65 (2.39−2.93)	1.98 (1.78−2.21)
Hispanic	1.19 (1.04−1.36)	1.10 (0.97−1.26)
Asian/Pacific Islander	1.23 (0.94−1.62)	0.99 (0.76−1.28)
Urologic§		
White	1.00 (reference)	1.00 (reference)
Black	1.26 (1.04−1.53)	1.16 (1.01−1.34)
Hispanic	0.93 (0.74−1.17)	0.92 (0.78−1.08)
Asian/Pacific Islander	1.60 (1.18−2.17)	1.48 (1.08−2.03)
Surgical-site infection‖		
White	1.00 (reference)	1.00 (reference)
Black	1.73 (1.53−1.95)	1.34 (1.18−1.53)
Hispanic	1.16 (1.02−1.33)	1.06 (0.92−1.22)
Asian/Pacific Islander	0.94 (0.66−1.34)	0.85 (0.60−1.22)
Postoperative hospitalization after hysterectomy¶		
White	1.00 (reference)	1.00 (reference)
Black	1.37 (1.29−1.46)	1.31 (1.22−1.40)
Hispanic	1.10 (1.02−1.19)	1.11 (1.02−1.20)
Asian/Pacific Islander	0.97 (0.80−1.18)	1.05 (0.86−1.27)

aOR = adjusted odds ratio; CI = confidence interval; OR = odds ratio.

* Adjusted for patient residence, surgical indication (non−ovary-related benign gynecologic disorders), pre-existing conditions/comorbidities (coagulopathy, fluid and electrolyte disorders, solid nonabdominal tumor without metastasis, weight loss, and adhesions), surgical approach, and concomitant procedures (operations on ovary).

† Adjusted for age, hospital state, insurance status, surgical indication (pain/endometriosis and ovary-related benign gynecologic disorders), pre-existing conditions/comorbidities (chronic blood loss/deficiency anemias, coagulopathy, fluid and electrolyte disorders, other neurologic disorders, psychoses, and pulmonary circulation disease), surgical approach, and concomitant procedures (operations on ovary and myomectomy).

‡ Adjusted for age, year of surgery, surgical indication (myomas and abnormal uterine bleeding), pre-existing conditions/comorbidities (chronic blood loss/deficiency anemias, rheumatoid arthritis/collagen vascular disease, chronic pulmonary disease, coagulopathy, lymphoma, fluid and electrolyte disorders, metastatic cancer, weight loss, adhesions, and smoking), surgical approach, and concomitant procedures (operations on ovary and lysis of adhesions of ovary and/or fallopian tube).

§ Adjusted for hospital state, surgical indication (abnormal uterine bleeding and ovary-related benign gynecologic disorders), pre-existing conditions/comorbidities (chronic heart failure, lymphoma, fluid and electrolyte disorders, chronic renal failure, and adhesions), surgical approach, concomitant procedures (operations on ovary, myomectomy, and lysis of adhesions of ovary and/or fallopian tube), and complications during hysterectomy admission (intraoperative injury to abdominal/pelvic organs).

‖ Adjusted for age, hospital state, insurance status, pre-existing conditions/comorbidities (chronic pulmonary disease, depression, diabetes, fluid and electrolyte disorders, metastatic cancer, obesity, weight loss, adhesions, and smoking), surgical approach, concomitant procedures (operations on ovary and cystocele repair), and hospital bed size.

¶ Adjusted for age, year of surgery, insurance status, surgical indication (myomas and non−ovary-related benign gynecologic disorders of other female genital organs), pre-existing conditions/comorbidities (chronic blood loss/deficiency anemias, rheumatoid arthritis/collagen vascular disease, chronic heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes with/without complications, drug abuse, hypertension, liver disease, lymphoma, fluid and electrolyte disorders, other neurologic disorders, obesity, psychoses, pulmonary circulation disease, chronic renal failure, adhesions, prior abdominopelvic surgery, and smoking), concomitant procedures (operations on the ovary), complications during hysterectomy admission (intraoperative injury to abdominal/pelvic organs, digestive system, hemorrhage, urologic complications, bowel obstruction, wound dehiscence, seroma, foreign body left in during procedure, pulmonary embolism/deep vein thrombosis, and acute respiratory failure).

and adhesions. Black women disproportionately have pre-existing conditions associated with increased risk for adverse outcomes. Consistent with previous studies [22−24], the black women in our study had a higher prevalence of obesity and diabetes. Both conditions were associated with significantly increased risk of surgical-site infection and posthysterectomy hospitalization. Black women have larger uterine weight on average, which may make them more likely to have higher blood loss during surgery [25,26], and they have a higher prevalence of blood

loss/deficiency anemias [27]. Black women may be at higher risk of adhesions owing to a higher prevalence of pelvic inflammatory disease [28,29], and black and Asian/PI women are at higher risk of developing keloids, which can lead to denser intra-abdominal adhesions [30].

In this study, adhesions were associated with increased risk of all outcomes, including ≥2-fold increased risk of intraoperative abdominal/pelvic organ injury and urologic complications. Serious complications can result from intraoperative injury to abdominal/pelvic organs and urinary tract injuries (e.g., infection, fistula formation, and renal failure [31,32]), including higher risk for urologic complications and posthysterectomy hospitalization, as we demonstrated. This is important for Asian/PI women, who were at increased risk of intraoperative injury to abdominal/pelvic organs and urologic complications.

Multiple socioenvironmental factors contribute to racial/ethnic disparities in pre-existing conditions, including access to prevention and healthcare services, other policy-related factors, health behaviors (e.g., smoking, nutrition, and physical activity), and differential environmental exposures [33]. Medical optimization of pre-existing conditions could potentially reduce surgical complications and posthysterectomy hospitalization. For example, blood loss/deficiency anemias can be managed preoperatively with iron therapy, pharmacologic agents, or transfusion [34,35], and diabetes can be managed pre- and perioperatively with blood glucose control [36]. To ensure that patients are medically optimized for surgery, surgeons should involve a patient's primary care physician and specialist (e.g., endocrinologist for diabetes) as needed, and potentially delay elective and nonurgent/nonemergent surgeries until the patients are medically optimized. Intervention strategies targeted toward identifying and better managing disparities in pre-existing conditions have the potential to reduce differences in adverse outcomes, and, in the end, lower healthcare expenditures [7]. In addition, compared with abdominal surgery, MIGS is associated with fewer surgical complications [2,3,37,38] and posthysterectomy hospitalizations [4,5], and it should be performed when feasible, especially in black women, a population experiencing more surgical complications after open procedures.

Our use of all-payer state databases, including inpatient and outpatient hysterectomies, allowed us to evaluate race/ethnicity as an independent predictor of surgical complications and posthysterectomy hospitalization. By examining surgical complications individually, we were able to provide more information about race/ethnicity and other factors associated with 30- and 90-day adverse outcomes after hysterectomy than previous studies [9,10,39,40]. We controlled for several risk factors for surgical complications common among black women (e.g., abdominal hysterectomy [9,10,12], obesity [22], diabetes [23,24], hypertension [41], and chronic renal failure [41]), and included previously unaccounted for hospital factors.

One limitation of our study includes the lack of sensitivity of coding for complications and underlying conditions owing to reliance on data derived for billing purposes. In addition, we only had 1 year of prior hospital data to identify underlying risk factors; thus, residual confounding may account for some of the elevated risk of surgical complications and posthysterectomy hospitalization associated with black, Asian/PI, and Hispanic race/ethnicity. For example, obesity is undercoded in administrative data [42] and is both more prevalent among black women [22] and associated with surgical-site infection [43]. Furthermore, we could not control for some clinical (uterine size/weight [44]) and surgeon characteristics (e.g., training [45] and volume [46−48]) known to be associated with surgical complications.

In conclusion, we found that black and Asian/PI women had higher risk of some 30- and 90-day surgical complications after hysterectomy for benign conditions and that black and Hispanic women had higher risk of posthysterectomy hospitalization. Identifying and developing better strategies to manage disparities in pre-existing conditions/comorbidities could potentially reduce racial/ethnic differences in adverse outcomes after hysterectomy and arguably lower rather than raise healthcare costs. Future studies should examine racial/ethnic differences in outcomes using more recent data and from more states to determine whether differences in outcomes by race/ethnicity are narrowing or widening over time.

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Supplemental Table 1

International Classification of Diseases, Ninth Revision, Clinical Modification and Current Procedural Terminology codes

Category	Type of Code	Codes	Description
Concomitant Gynecologic Procedure Codes			
Anterior colporrhaphy	ICD9 PR	70.51, 70.54	Repair of cystocele
	CPT PR	57240, 57284, 57285, 57423	Repair of cystocele
Posterior colporrhaphy	ICD9 PR	70.52, 70.55	Repair of rectocele
	CPT PR	45560, 57250	Repair of rectocele
Anterior/posterior colporrhaphy	ICD9 PR	70.50, 70.53	Repair of cystocele and rectocele
	CPT PR	57260, 57265, 57267	Combined anteroposterior colporrhaphy
Incontinence surgery	ICD9 PR	57.85, 57.89	Operations on urinary bladder − Other repair of urinary bladder: Cystourethroplasty and plastic repair of bladder neck, Other repair of bladder
		59.3-59.6, 59.7x	Other operations on urinary tract − Plication of urethrovesical junction, Suprapubic sling operation, Retropubic urethral suspension, Paraurethral suspension, Other repair of urinary stress incontinence
	CPT PR	51990, 51992, 57220, 57288, 57289	Incontinence surgery
Apical support operations	ICD9 PR	69.22	Uterine suspension
	CPT PR	58400, 58410	Uterine suspension
	ICD9 PR	70.4, 70.8	Obliterative procedure
	CPT PR	57106, 57110, 57120	Obliterative procedure
	ICD9 PR	70.64, 70.77, 70.78, 70.9	Vaginal suspension
	CPT PR	57280, 57282, 57283, 57425	Vaginal suspension
	ICD9 PR	70.92	Repair of enterocele
	CPT PR	57268, 57270	Repair of enterocele
Operations on ovary	ICD9 PR	65.0x, 65.2x, 65.4x, 65.5x, 65.6x, 65.7x, 65.91, 65.93	Operations on ovary
	CPT PR	58660, 58661, 58662, 58700, 58720, 58800, 58805, 58900, 58925, 58940	Operations on ovary
Myomectomy	ICD9 PR	68.29	Uterine myomectomy
	CPT PR	58140, 58145, 58146	Myomectomy
Lysis of adhesions of ovary and/or fallopian tube	ICD9 PR	65.8x	Lysis of adhesions of ovary and fallopian tube
	CPT PR	58660, 58662, 58740	Lysis of adhesions of ovary
Intra-operative Surgical Complications			
Intraoperative injury to abdominal/pelvic organs	ICD9 DX	863.2x, 863.3x, 863.4x, 863.5x, 863.8x, 863.9x	Injury to gastrointestinal tract
		864.x	Injury to liver
		865.x	Injury to spleen
		866.x	Injury to kidney
		867.x	Injury to pelvic organs
		868.x	Injury to intra-abdominal organs
		902.x	Injury to blood vessels of abdomen and pelvic
		997.5	Complications affecting specified body systems, NEC - Urinary complications
		998.2	Other complications of procedures, NEC - Accidental puncture or laceration during a procedure
	ICD9 PR	56.8x, 56.95	Repair of ureter
		57.81	Suture of laceration of bladder
		57.82	Closure of cystostomy
	CPT PR	50600, 50605, 50630	Repair of ureter
		51860	Cystorrhaphy, suture of bladder wound, injury or rupture; simple
		51880	Closure of cystostomy (separate procedure)
Post-operative Surgical Complications			
Digestive system	ICD9 DX	997.4x	Complications affecting specified body systems, not elsewhere classified - Digestive system complications
		560.1	

Supplemental Table 1

Continued

Category	Type of Code	Codes	Description
			Intestinal obstruction without mention of hernia - Paralytic ileus
Hemorrhage/hematoma	ICD9 DX	620.7	Noninflammatory disorders of ovary, fallopian tube, and broad ligament - Hematoma of broad ligament
		623.6	Noninflammatory disorders of vagina - Vaginal hematoma
		665.7	Other obstetrical trauma - Pelvic hematoma
		998.11	Hemorrhage or hematoma or seroma complicating a procedure - Hemorrhage complicating a procedure
		998.12	Hemorrhage or hematoma or seroma complicating a procedure - Hematoma complicating a procedure
Surgical site infection	ICD9 DX	998.5x	Other complications of procedures, not elsewhere classified - Postoperative infection
		567.21, 567.22, 567.29, 567.31, 567.38, 567.39, 567.9	Peritonitis and retroperitoneal infections
Urologic	ICD9 DX	593.3	Stricture or kinking of ureter
		593.4	Other ureteric obstruction
		593.5	Hydroureter
		593.82	Ureteral fistula
		593.9	Unspecified disorder of kidney and ureter
		598.1, 598.2	Traumatic or postoperative urethral stricture
		599.1,	Urethral fistula
		599.60, 599.69	Urinary obstruction
Medical Complications*			
Perioperative pulmonary embolism	ICD9 DX	415.11	Iatrogenic pulmonary embolism and infarction
		415.13	Saddle embolus of pulmonary artery
		415.19	Other
Deep vein thrombosis	ICD9 DX	451.11	Femoral vein (deep) (superficial)
		451.19	Other
		451.2	Of lower extremities, unspecified
		451.81	Iliac vein
		451.9	Of specified site
		453.40	Acute venous embolism and thrombosis of unspecified deep vessels of lower extremity
		453.41	Acute venous embolism and thrombosis of deep vessels of proximal lower extremity
		453.42	Acute venous embolism and thrombosis of deep vessels of distal lower extremity
		453.8x	Acute venous embolism and thrombosis of other specified veins
Pneumonia	ICD9 DX	480.x	Viral pneumonia
		481.x	Pneumococcal pneumonia
		482.x	Other bacterial pneumonia
		483.x	Pneumonia due to other specified organism
		484.x	Pneumonia in infectious diseases classified elsewhere
		485.x	Bronchopneumonia, organism unspecified
		486.x	Pneumonia, organism unspecified
		510.0, 510.9	Empyema: with fistula; without mention of fistula
		513.0	Abscess of lung
		997.31	Ventilator associated pneumonia
Chest pain†	ICD9 DX	786.50	Chest pain, unspecified
		786.59	Discomfort in chest, pressure in chest, tightness in chest
Acute kidney failure	ICD9 DX	584.x	Acute kidney failure
Atrial fibrillation†	ICD9 DX	427.31	Atrial fibrillation
Syncope and collapse†	ICD9 DX	780.2	Syncope and collapse
Cerebrovascular accident†	ICD9 DX		Occlusion and stenosis of precerebral arteries

Supplemental Table 1

Continued

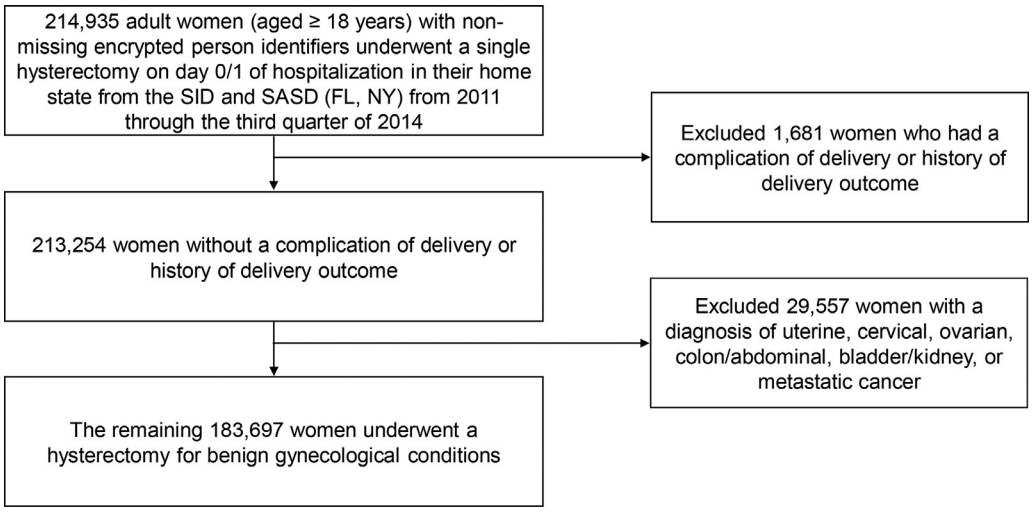
Category	Type of Code	Codes	Description
		433.01, 433.11, 433.21, 433.31, 433.81, 433.91	
		434.01, 434.11, 434.91	Occlusion of cerebral arteries
Acute myocardial infarction/Cardiopulmonary disease†	ICD9 DX	410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91	Acute myocardial infarction
		427.5	Cardiac dysrhythmias - Cardiac arrest
		997.1	Cardiac complications
Acute respiratory failure	ICD9 DX	518.5x	Pulmonary insufficiency following trauma and surgery
		518.81	Acute respiratory failure
		518.82	Other pulmonary insufficiency, not elsewhere classified
		518.84	Acute and chronic respiratory failure
		997.39	Other respiratory complications
Primary Diagnosis for Post-operative Hospitalization after Hysterectomy			
Surgical complications	ICD9 DX	See above	See all aforementioned surgical complication codes
Medical complications	ICD9 DX	See above	See all aforementioned medical complication codes
Fistula	ICD9 DX	619.0	Urinary-genital tract fistula, female
		998.6	Persistent postoperative fistula
Hernia	ICD9 DX	552.21	Incisional, with obstruction
Clostridium difficile infection	ICD9 DX	008.45	Clostridium difficile
Gastrointestinal	ICD9 DX	276.51	Dehydration
		562.11	Diverticulitis of colon without mention of hemorrhage
		564.00	Constipation, unspecified
		577.0	Acute pancreatitis
		787.01-787.03	Symptoms involving digestive system: Nausea and vomiting, Nausea alone, Vomiting alone
Urinary tract infection	ICD9 DX	595.0	Acute cystitis
		595.2	Other chronic cystitis
		595.9	Cystitis, unspecified
		598.0x	Urethral stricture due to infection
		599.0	Urinary tract infection, site not specified
		996.64	Infection due to indwelling urinary catheter
Post-operative/abdominal Pain	ICD9 DX	338.18	Other acute postoperative pain
	ICD9 DX	789.0x	Abdominal pain
Fever	ICD9 DX	780.60, 780.62	Fever: Fever, unspecified; Postprocedural fever
Pyelonephritis	ICD9 DX	590.1x	Acute pyelonephritis
		590.2	Renal and perinephric abscess
		590.3	Pyeloureteritis cystica
		590.8x	Other pyelonephritis or pyonephrosis, not specified as acute or chronic
		590.9	Infection of kidney, unspecified

* Restricted to the Healthcare Cost and Utilization Project State Inpatient Databases

† Restricted to the primary diagnosis

Supplemental Fig. 1

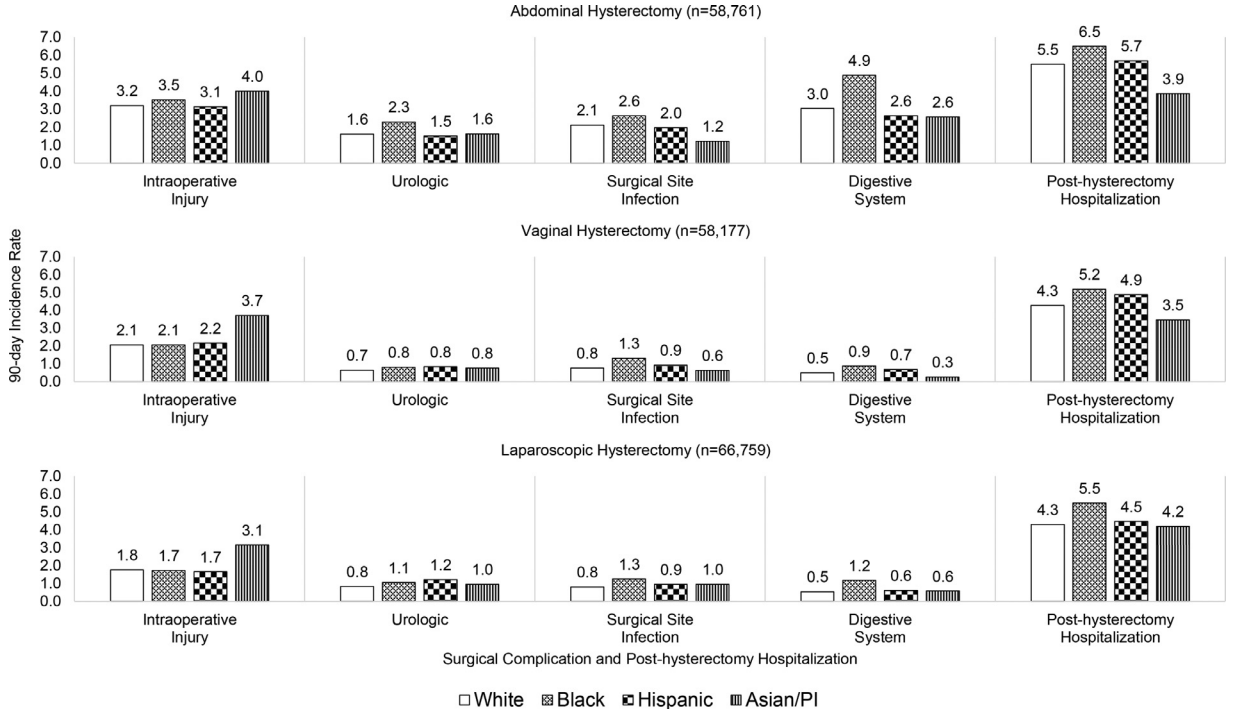
Data attrition diagram.



Supplemental Fig. 2

Incidence of 90-day surgical complications and post-hysterectomy hospitalization by surgical approach and race/ethnicity from the State Inpatient and State Ambulatory Surgery Databases (FL, NY), 1/1/2011-9/30/2014*.

*90-day results for hemorrhage/hematoma are not reported.



Supplemental Table 2

(A-F) Multivariable-adjusted odds ratios and 95% confidence intervals of significant risk factors for 30- and 90-day surgical complications and post-hysterectomy hospitalization from the State Inpatient and State Ambulatory Surgery Databases (Florida, New York), January 1 2019, to September 30, 2014

A. Intra-operative Injury to Abdominal/Pelvic Organs

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Race/ethnicity		
White	1.00 [reference]	1.00 [reference]
Black	0.91 (0.83-1.01)	0.91 (0.83-1.01)
Hispanic	0.94 (0.84-1.04)	0.94 (0.85-1.04)
Asian/Pacific Islander	1.46 (1.23-1.75)	1.44 (1.21-1.72)
Native American or Other	1.08 (0.92-1.27)	1.07 (0.92-1.25)
Missing	1.03 (0.71-1.47)	1.00 (0.70-1.44)
Year of Surgery		
2011	1.00 [reference]	1.00 [reference]
2012	–	1.01 (0.94-1.09)
2013	–	0.95 (0.88-1.03)
2014	–	0.88 (0.78-0.99)
Patient Residence		
Large metropolitan area	1.21 (1.00-1.46)	1.23 (1.02-1.49)
Small metropolitan area	1.04 (0.87-1.26)	1.05 (0.88-1.27)
Not metropolitan or micropolitan/Missing	1.25 (0.94-1.67)	1.24 (0.93-1.65)
Micropolitan areas	1.00 [reference]	1.00 [reference]
Surgical Indication		
Non-ovary-related benign gynecologic disorders	0.81 (0.70-0.93)	0.81 (0.71-0.93)
Pre-existing Conditions/Comorbidities		
Coagulopathy	1.65 (1.30-2.10)	1.66 (1.31-2.10)
Fluid and electrolyte disorders	1.94 (1.67-2.25)	1.95 (1.68-2.25)
Solid non-abdominal tumor without metastasis	1.30 (1.03-1.63)	1.28 (1.02-1.61)
Weight loss	1.57 (1.10-2.25)	1.58 (1.10-2.27)
Adhesions	2.18 (2.00-2.38)	2.16 (1.99-2.34)
Surgical Approach		
Abdominal	1.07 (0.93-1.23)	1.06 (0.92-1.21)
Laparoscopic	0.79 (0.72-0.88)	0.80 (0.72-0.89)
Vaginal	1.00 [reference]	1.00 [reference]
Concomitant procedures		
Operations on ovary	1.48 (1.35-1.62)	1.46 (1.33-1.60)
Myomectomy	–	2.09 (1.41-3.12)

B. Hemorrhage/Hematoma

	aOR (95% CI) 30 days	aOR (95% CI)* 90 days
Age		
< 35	1.45 (1.25-1.69)	–
35-44	1.00 [reference]	–
45-54	0.76 (0.70-0.84)	–
55-64	0.53 (0.46-0.62)	–
65-74	0.58 (0.48-0.71)	–
≥75	0.58 (0.44-0.77)	–
Race/ethnicity		
White	1.00 [reference]	–
Black	1.09 (0.98-1.21)	–
Hispanic	0.82 (0.71-0.94)	–
Asian/Pacific Islander	1.33 (1.06-1.67)	–
Native American or Other	1.05 (0.88-1.25)	–

Supplemental Table 2

Continued

B. Hemorrhage/Hematoma

	aOR (95% CI) 30 days	aOR (95% CI)* 90 days
Missing	0.20 (0.05-0.79)	–
Hospital State		
Florida	0.81 (0.71-0.91)	–
New York	1.00 [reference]	–
Insurance Status		
Medicaid	1.22 (1.10-1.37)	–
Surgical Indication		
Pain/Endometriosis	0.90 (0.83-0.98)	–
Ovary-related benign gynecologic disorders	0.83 (0.75-0.92)	–
Genital prolapse	–	–
Pre-existing Conditions/Comorbidities		
Chronic blood loss/deficiency anemias	1.27 (1.15-1.41)	–
Coagulopathy	3.96 (3.24-4.84)	–
Depression	–	–
Fluid and electrolyte disorders	2.25 (1.94-2.61)	–
Other neurological disorders	1.38 (1.07-1.78)	–
Psychoses	1.40 (1.13-1.73)	–
Pulmonary circulation disease	2.80 (2.09-3.77)	–
Adhesions	–	–
Prior abdominopelvic surgery	–	–
Surgical Approach		
Abdominal	1.22 (1.10-1.35)	–
Laparoscopic	0.57 (0.50-0.64)	–
Vaginal	1.00 [reference]	–
Concomitant procedures		
Operations on ovary	1.48 (1.35-1.64)	–
Myomectomy	3.08 (2.32-4.09)	–

C. Digestive System

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Age		
< 35	0.89 (0.73-1.08)	0.90 (0.74-1.09)
35-44	1.00 [reference]	1.00 [reference]
45-54	1.08 (0.98-1.18)	1.07 (0.98-1.18)
55-64	1.17 (1.02-1.35)	1.15 (1.00-1.33)
65-74	1.54 (1.32-1.78)	1.50 (1.30-1.75)
≥75	1.80 (1.44-2.25)	1.77 (1.42-2.21)
Race/ethnicity		
White	1.00 [reference]	1.00 [reference]
Black	1.98 (1.78-2.21)	1.98 (1.78-2.20)
Hispanic	1.10 (0.97-1.26)	1.09 (0.96-1.24)
Asian/Pacific Islander	0.99 (0.76-1.28)	1.00 (0.76-1.30)
Native American or Other	1.27 (1.06-1.52)	1.26 (1.05-1.51)
Missing	0.99 (0.59-1.64)	1.04 (0.63-1.71)
Year of Surgery		
2011	1.00 [reference]	1.00 [reference]
2012	0.99 (0.90-1.10)	0.99 (0.90-1.09)
2013	0.89 (0.81-0.99)	0.89 (0.80-0.98)
2014	0.88 (0.79-0.99)	0.89 (0.79-0.99)
Surgical Indication		

Supplemental Table 2

Continued

C. Digestive System

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Fibroids	0.88 (0.79-0.97)	0.86 (0.78-0.95)
Abnormal uterine bleeding	0.87 (0.80-0.95)	0.87 (0.79-0.95)
Pre-existing Conditions/Comorbidities		
Chronic blood loss/deficiency anemias	1.22 (1.11-1.35)	1.23 (1.11-1.36)
Rheumatoid arthritis/collagen vascular disease	1.33 (1.06-1.68)	1.31 (1.04-1.65)
Chronic pulmonary disease	1.37 (1.23-1.52)	1.36 (1.23-1.52)
Coagulopathy	1.62 (1.27-2.06)	1.59 (1.25-2.01)
Lymphoma	2.61 (1.55-4.40)	2.73 (1.65-4.53)
Fluid and electrolyte disorders	3.49 (3.10-3.93)	3.50 (3.11-3.94)
Metastatic cancer	1.69 (1.07-2.68)	1.73 (1.10-2.71)
Weight loss	2.04 (1.47-2.82)	2.08 (1.52-2.85)
Adhesions	1.67 (1.53-1.82)	1.66 (1.53-1.81)
Smoking	1.16 (1.04-1.28)	1.17 (1.06-1.30)
Surgical Approach		
Abdominal	4.30 (3.65-5.07)	4.18 (3.56-4.93)
Laparoscopic	1.18 (1.00-1.40)	1.17 (0.99-1.38)
Vaginal	1.00 [reference]	1.00 [reference]
Concomitant Procedures		
Operations on ovary	1.70 (1.54-1.88)	1.69 (1.53-1.86)
Lysis of adhesions of ovary and/or fallopian tube	0.67 (0.52-0.87)	0.67 (0.52-0.88)

D. Urologic

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Race/ethnicity		
White	1.00 [reference]	1.00 [reference]
Black	1.16 (1.01-1.34)	1.18 (1.03-1.34)
Hispanic	0.92 (0.78-1.08)	0.90 (0.78-1.04)
Asian/Pacific Islander	1.48 (1.08-2.03)	1.41 (1.03-1.93)
Native American or Other	1.09 (0.86-1.38)	1.10 (0.88-1.38)
Missing	1.14 (0.65-2.00)	1.05 (0.61-1.82)
Hospital State		
Florida	3.31 (1.64-6.70)	3.10 (1.65-5.83)
New York	1.00 [reference]	1.00 [reference]
Surgical Indication		
Abnormal uterine bleeding	0.79 (0.68-0.91)	0.81 (0.71-0.92)
Ovary-related benign gynecologic disorders	1.27 (0.93-1.76)	–
Pre-existing Conditions/Comorbidities		
Congestive heart failure	2.52 (1.69-3.76)	2.26 (1.54-3.32)
Lymphoma	2.74 (1.27-5.90)	2.82 (1.37-5.81)
Fluid and electrolyte disorders	1.88 (1.27-2.79)	1.93 (1.33-2.80)
Peripheral vascular disease	–	1.51 (0.98-2.33)
Chronic Renal Failure	2.64 (1.81-3.85)	2.69 (1.85-3.92)
Adhesions	1.86 (1.29-2.70)	1.85 (1.31-2.62)
Surgical Approach		
Abdominal	1.52 (0.98-2.37)	1.44 (0.97-2.16)
Laparoscopic	1.26 (1.04-1.53)	1.22 (1.01-1.47)
Vaginal	1.00 [reference]	1.00 [reference]
Concomitant Procedures		
Operations on ovary	1.85 (1.46-2.34)	1.81 (1.43-2.29)
Myomectomy	2.41 (1.67-3.50)	2.22 (1.50-3.29)

Supplemental Table 2

Continued

D. Urologic

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Lysis of adhesions of ovary and/or fallopian tube	1.38 (0.97-1.96)	1.39 (1.02-1.92)
Complications during hysterectomy admission		
Intraoperative injury to abdominal/pelvic organs	3.32 (2.71-4.06)	3.37 (2.80-4.06)

E. Surgical Site Infection

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Age		
< 35	1.21 (1.02-1.44)	1.17 (1.00-1.38)
35-44	1.00 [reference]	1.00 [reference]
45-54	0.82 (0.74-0.90)	0.80 (0.73-0.88)
55-64	0.68 (0.58-0.79)	0.69 (0.59-0.80)
65-74	0.63 (0.51-0.78)	0.63 (0.52-0.76)
≥75	0.82 (0.61-1.10)	0.76 (0.57-1.00)
Race/ethnicity		
White	1.00 [reference]	1.00 [reference]
Black	1.34 (1.18-1.53)	1.31 (1.17-1.48)
Hispanic	1.06 (0.92-1.22)	1.05 (0.92-1.19)
Asian/Pacific Islander	0.85 (0.60-1.22)	0.82 (0.58-1.18)
Native American or Other	1.00 (0.78-1.27)	1.00 (0.79-1.26)
Missing	0.99 (0.52-1.86)	1.02 (0.57-1.84)
Hospital State		
Florida	0.85 (0.74-0.98)	–
New York	1.00 [reference]	1.00 [reference]
Insurance Status		
Medicaid	1.24 (1.10-1.40)	1.28 (1.15-1.43)
Pre-existing Conditions/Comorbidities		
Chronic pulmonary disease	1.33 (1.17-1.50)	1.35 (1.21-1.51)
Depression	1.40 (1.23-1.59)	1.46 (1.30-1.64)
Diabetes	1.41 (1.24-1.60)	1.49 (1.32-1.67)
Fluid and electrolyte disorders	2.58 (2.21-3.01)	2.48 (2.15-2.86)
Metastatic cancer	1.77 (1.09-2.85)	1.95 (1.26-3.02)
Obesity	1.49 (1.32-1.68)	1.49 (1.34-1.66)
Weight loss	3.31 (2.42-4.53)	3.35 (2.49-4.50)
Adhesions	1.38 (1.24-1.53)	1.36 (1.23-1.50)
Smoking	1.28 (1.15-1.44)	1.34 (1.20-1.49)
Surgical Approach		
Abdominal	1.77 (1.53-2.04)	1.85 (1.62-2.10)
Laparoscopic	0.97 (0.84-1.12)	0.97 (0.85-1.12)
Vaginal	1.00 [reference]	1.00 [reference]
Concomitant Procedures		
Operations on ovary	1.34 (1.21-1.48)	1.33 (1.21-1.45)
Cystocele repair	0.57 (0.36-0.91)	–

Supplemental Table 2

Continued

E. Surgical Site Infection

	aOR (95% CI) 30 days	aOR (95% CI) 90 days
Hospital Bed Size		
0-299	1.00 [reference]	1.00 [reference]
300-599	1.09 (0.95-1.27)	1.09 (0.95-1.26)
≥600	1.34 (1.14-1.56)	1.32 (1.13-1.54)

F. Post-operative hospitalization after hysterectomy

	aOR (95% CI) 30 day	aOR (95% CI) 90 day
Age		
< 35	1.26 (1.14-1.39)	1.28 (1.16-1.40)
35-44	1.00 [reference]	1.00 [reference]
45-54	0.84 (0.80-0.90)	0.84 (0.80-0.89)
55-64	0.70 (0.63-0.77)	0.70 (0.64-0.77)
65-74	0.81 (0.73-0.90)	0.83 (0.76-0.91)
≥75	0.99 (0.85-1.16)	1.09 (0.95-1.25)
Race/ethnicity		
White	1.00 [reference]	1.00 [reference]
Black	1.31 (1.22-1.40)	1.25 (1.18-1.33)
Hispanic	1.11 (1.02-1.20)	1.10 (1.03-1.19)
Asian/Pacific Islander	1.05 (0.86-1.27)	0.95 (0.79-1.14)
Native American or Other	1.05 (0.90-1.23)	0.99 (0.87-1.12)
Missing	0.97 (0.69-1.35)	1.04 (0.78-1.39)
Year of Surgery		
2011	1.00 [reference]	1.00 [reference]
2012	1.00 (0.93-1.07)	1.00 (0.94-1.06)
2013	0.93 (0.87-1.01)	0.93 (0.87-0.98)
2014	0.91 (0.84-0.97)	0.90 (0.84-0.96)
Insurance Status		
Medicaid	1.29 (1.20-1.39)	1.32 (1.23-1.41)
Surgical Indication		
Fibroids	0.91 (0.86-0.96)	0.88 (0.84-0.93)
Non-ovary-related benign gynecologic disorders	0.86 (0.77-0.96)	–
Pre-existing Conditions/Comorbidities		
Chronic blood loss/deficiency anemias	1.09 (1.03-1.16)	1.10 (1.04-1.16)
Rheumatoid arthritis/collagen vascular disease	1.33 (1.13-1.56)	1.37 (1.18-1.59)
Congestive heart failure	1.41 (1.09-1.82)	1.55 (1.25-1.93)
Chronic pulmonary disease	1.22 (1.13-1.31)	1.29 (1.21-1.37)
Coagulopathy	1.27 (1.03-1.57)	1.27 (1.06-1.53)
Depression	1.27 (1.18-1.37)	1.37 (1.29-1.47)
Diabetes with/without complications	1.16 (1.06-1.26)	1.27 (1.18-1.37)
Drug abuse	1.72 (1.43-2.07)	1.94 (1.67-2.26)
Hypertension	1.07 (1.00-1.13)	1.12 (1.06-1.19)
Liver disease	1.54 (1.23-1.93)	1.63 (1.34-1.98)
Lymphoma	1.77 (1.13-2.77)	2.40 (1.63-3.53)
Fluid and electrolyte disorders	1.53 (1.36-1.72)	1.64 (1.48-1.81)
Metastatic cancer	–	1.44 (1.12-1.84)
Other neurological disorders	1.45 (1.26-1.67)	1.55 (1.37-1.75)
Obesity	1.11 (1.04-1.19)	1.10 (1.03-1.18)
Paralysis	–	1.42 (1.03-1.95)
Peripheral vascular disease	–	1.43 (1.12-1.81)
Psychoses	1.44 (1.26-1.66)	1.68 (1.51-1.87)

Supplemental Table 2

Continued

F. Post-operative hospitalization after hysterectomy

	aOR (95% CI) 30 day	aOR (95% CI) 90 day
Pulmonary circulation disease	1.52 (1.15-2.00)	1.52 (1.18-1.95)
Renal failure	1.46 (1.18-1.80)	1.52 (1.26-1.82)
Adhesions	1.22 (1.15-1.29)	1.17 (1.11-1.24)
Prior abdominopelvic surgery	1.26 (1.15-1.39)	1.26 (1.17-1.36)
Smoking	1.23 (1.14-1.33)	1.27 (1.20-1.35)
Concomitant Procedures		
Operations on ovary	1.30 (1.22-1.38)	1.26 (1.20-1.33)
Complications during hysterectomy admission		
Intraoperative injury to abdominal/pelvic organs	1.47 (1.24-1.75)	1.53 (1.34-1.75)
Digestive system	1.59 (1.33-1.89)	1.50 (1.26-1.78)
Hemorrhage	1.58 (1.29-1.94)	1.34 (1.10-1.63)
Urologic complications	1.41 (1.02-1.95)	1.52 (1.12-2.06)
Surgical site infection	–	1.33 (0.98-1.80)
Bowel obstruction	1.71 (1.18-2.49)	1.62 (1.10-2.39)
Wound dehiscence	2.10 (1.22-3.60)	1.75 (1.02-3.02)
Seroma	2.21 (1.12-4.38)	2.56 (1.38-4.74)
Foreign body left in during procedure	3.46 (1.32-9.11)	–
Pulmonary embolism/deep vein thrombosis	1.89 (1.15-3.09)	1.79 (1.18-2.72)
Acute respiratory failure	1.48 (1.14-1.90)	1.48 (1.20-1.82)
Acute myocardial infarction/cardiopulmonary arrest	–	3.87 (1.09-13.79)

– Not Significant
* 90-day results are not reported.

Supplemental Table 3

Sensitivity analyses of select surgical route-complication models: Multivariable adjusted odds ratios and 95% confidence intervals for race/ethnicity, after controlling for all other variables*

	Original Results	Sensitivity Analysis Results	
	aOR (95% CI)	Limited to Abdominal aOR (95% CI)	Limited to Laparoscopic aOR (95% CI)
Hemorrhage/Hematoma			
White	1.00 [reference]	1.00 [reference]	–
Black	1.09 (0.98-1.21)	1.05 (0.91-1.23)	–
Hispanic	0.82 (0.71-0.94)	0.76 (0.62-0.93)	–
Asian/Pacific Islander	1.33 (1.06-1.67)	1.15 (0.85-1.57)	–
Digestive System			
White	1.00 [reference]	1.00 [reference]	–
Black	1.98 (1.78-2.21)	2.02 (1.78-2.28)	–
Hispanic	1.10 (0.97-1.26)	1.07 (0.92-1.25)	–
Asian/Pacific Islander	0.99 (0.76-1.28)	1.01 (0.76-1.35)	–
Urologic			
White	1.00 [reference]	1.00 [reference]	1.00 [reference]
Black	1.16 (1.01-1.34)	1.17 (1.04-1.32)	1.15 (0.90-1.49)
Hispanic	0.92 (0.78-1.08)	0.80 (0.66-0.97)	1.07 (0.87-1.33)
Asian/Pacific Islander	1.48 (1.08-2.03)	1.40 (0.96-2.05)	1.64 (1.00-2.70)
Surgical Site Infection			
White	1.00 [reference]	1.00 [reference]	–
Black	1.34 (1.18-1.53)	1.22 (1.04-1.43)	–
Hispanic	1.06 (0.92-1.22)	1.02 (0.84-1.23)	–
Asian/Pacific Islander	0.85 (0.60-1.22)	0.72 (0.49-1.06)	–

* Models included all the variables controlled for in the original models