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Postoperative Complications After Gynecologic Surgery

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Abstract

Objective—To estimate the association of age, medical comorbidities, functional status, and unintentional weight loss (as a marker of frailty) with postoperative complications in women undergoing major gynecologic surgery.

Methods—We conducted a cross-sectional analysis of the American College of Surgeons National Surgical Quality Improvement Program 2005-2009 participant use data files were used to analyze gynecologic procedures. The primary outcome was composite 30-day major postoperative complications.

Results—A total of 22,214 women were included in our final analysis. The overall prevalence of composite 30 day major postoperative complications was 3.7% (n=817). Age 80 years or older (adjusted odds ratio (OR)=1.8(95% Confidence Interval (CI) 1.25,2.58)), dependent functional status (adjusted OR= 2.37(95% CI 1.53,3.68)), and unintentional weight loss (adjusted OR = 2.49(95% CI 1.48,4.17)) were significantly associated with postoperative morbidity after adjusting for diabetes mellitus (adjusted OR= 1.44(95% CI 1.15,1.79)), known bleeding disorder (adjusted OR= 2.29 (95% 1.49,3.52)), morbid obesity (adjusted OR= 1.77(95% CI 1.45,2.17)), ascites (adjusted OR= 3.27(95% CI 2.18,4.90)), preoperative systemic infection (adjusted OR= 3.02(95% CI 2.03,4.48)), procedures for gynecologic cancer (adjusted OR= 1.60(95% CI 1.27,2.0)), disseminated cancer (adjusted OR= 2.57(95% CI 1.64,4.03)), emergency procedures (adjusted OR = 1.82(95% CI 1.18,2.79)), operative time greater than 4 hours vs. less than 1 hour (adjusted OR = 2.91(95%CI 2.18,3.89)) and wound class 4 vs. 1(adjusted OR= 4.28(95%CI 1.82,10.1).

Conclusion—Age 80 years or older, medical comorbidities, dependent functional status, and unintentional weight loss are associated with increased major postoperative complications after gynecologic procedures.

Introduction

Any surgical procedure carries risks of complications. The risk of postoperative complications depends on individual characteristics, including: age, medical comorbidities, and functional status.(1-5) There has been a growing trend in the surgical literature to report mortality and morbidity after surgery with preoperative risk adjustment to facilitate meaningful comparisons of surgical outcomes between different surgeons and hospitals.(1, 2, 6) The occurrence of mortality and morbidity after gynecologic surgery is often not

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reported with preoperative risk adjustments for these individual characteristics. In addition, the occurrence of complications after gynecologic procedures is often reported from medical billing datasets. Heisler et al. demonstrated that postoperative complications were more likely to be found through a formal chart review process than coding data from medical billing.(7) Therefore, an analysis of a reliable and valid dataset that collects information on gynecologic procedures from a formal chart review process examining preoperative medical comorbidities would lend valuable insight to our understanding of postoperative complications from these procedures.

Improved understanding of the effect of age, medical comorbidities, functional status, and unintentional weight loss (as a marker of frailty) with postoperative outcomes (30 day major postoperative complications and 30 day mortality) in women undergoing gynecologic surgery would impact decisions to perform an elective surgery, preoperative medical risk assessments, and optimization of preoperative medical status. The primary objective of this study is to estimate the association of age, medical comorbidities, functional status, and unintentional weight loss (as a marker of frailty) with postoperative complications in women undergoing major gynecologic surgery.

Materials and Methods

We performed a cross-sectional analysis of the 2005 to 2009 American College of Surgeons National Surgical Quality Improvement Program participant use data files. The American College of Surgeons National Surgical Quality Improvement Program is a national program for surgical quality assessment and improvement.(1) The American College of Surgeons National Surgical Quality Improvement Program collects extensive information by a formal chart review process sampling patients undergoing surgical procedures. Trained nurse abstractors collect data on the first 40 cases performed within consecutive 8-day cycles from general surgery and vascular surgery or a multi-specialty model. This dataset has been validated by previous studies.(1, 8) Over 100 variables are collected on each patient, including: preoperative characteristics, surgical information, and 30-day postoperative complications. To ensure the quality of data within the dataset and reduce potential bias, inter-rater reliability audits are conducted by the American College of Surgeons National Surgical Quality Improvement Program with an overall disagreement rate of 1.8% and hospitals with an audit disagreement of greater than 5% are excluded from the dataset. To maintain follow-up and avoid missing data the American College of Surgeons National Surgical Quality Improvement Program excludes hospitals with 30 day follow-up rates of less than 80%. Further information on the American College of Surgeons National Surgical Quality Improvement Program is available at: <http://www.acsnsqip.org>. This study was exempt from review by the Institutional Review Board as it involved research of an existing dataset from a public source. Exemption status was verified in writing from the Yale Human Investigation Committee.

The target population for this study included women over the age of 16 years who underwent gynecologic surgery. One variable in the American College of Surgeons National Surgical Quality Improvement Program is the specialty of the primary surgeon. Women were considered for potential inclusion in this analysis based on this variable signifying the specialty of the primary surgeon was gynecology. A total of 23,569 women were categorized in the dataset as undergoing procedures performed by a gynecologic surgeon. Women were excluded from analysis for the following reasons: 1) classification of male gender with gynecologic procedure, 2) current pregnancy, 3) previous operation within 30 days of current procedure, or 4) Physicians' Current Procedural Terminology Coding System, 4th edition (CPT-4) code inconsistent with gynecologic procedure.

Gynecologic procedures were grouped into the following categories based on CPT-4 coding of the primary procedure: procedures for gynecologic cancer (procedures including radical dissection, lymphadenectomy, or debulking), benign hysterectomy, laparotomy, procedures for prolapse and/or urinary incontinence, vaginal procedures, and laparoscopy. For further information on procedure categorization based on CPT-4 codes please refer to Table 1. Cases were categorized based on their primary CPT-4 code. Multiple CPT-4 codes were listed for multiple women. To account for concomitant procedures, procedural difficulty was accounted for by considering two variables: total work relative value unit (RVUs) and total operative time.

Preoperative risk factors for postoperative morbidity and mortality were explored including age, medical comorbidities, and markers of frailty. Women were dichotomized into the two age categories (< 80 years, and ≥80 years old) due to a non-linear association between age and the log-odds of postoperative complications. Preoperative medical comorbidities were explored. Preoperative functional status was defined as a woman's ability to perform activities of daily living including "bathing, feeding, dressing, toileting, and mobility." Functional status was categorized as either "independent" or "dependent". Unintentional weight loss, a marker of frailty, was defined as weight loss of greater than 10% over the previous 6 months. Additional preoperative variables included in the dataset were explored. These variables included; race, ethnicity, smoking status, American Society of Anesthesia (ASA) classification, type of anesthesia, emergency surgery, wound classification, total work RVU, and operative time.

Scheduled surgeries, including procedures for the valid indications including cancer, are considered elective by the American College of Surgeons National Surgical Quality Improvement Program. Emergency surgery is defined by the American College of Surgeons National Surgical Quality Improvement Program as a surgical procedure performed within 12 hours of onset of preoperative symptoms.

The primary outcome was composite 30 day major postoperative complications. Components included the following outcome measures: 1) mortality, 2) vascular morbidity, 3) wound morbidity, 4) venous thromboembolic event morbidity, 5) respiratory morbidity, 6) infectious morbidity, and 7) renal morbidity. Two additional process measures were included: return to the operating room and postoperative blood transfusion within the first 72 hours after surgery. Mortality was defined as mortality within 30 days of the index surgical procedure from any cause. Vascular morbidity was defined as cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction defined as an acute transmural myocardial infarction diagnosed with new-Q waves on electrocardiogram stroke or cerebral vascular accident, or a postoperative non-medication related coma for greater than 24 hrs after surgery. Wound morbidity was defined as a deep wound surgical site infection of fascial or muscle layers, organ space surgical site infection, or wound dehiscence. Venous thromboembolic event morbidity was defined as pulmonary embolism or deep vein thrombosis. Respiratory morbidity was defined as prolonged mechanical ventilation >48 hours after surgery or unplanned re-intubation. Infectious morbidity was defined as pneumonia, sepsis, or septic shock. Renal morbidity included acute renal failure with need for dialysis or progressive renal insufficiency defined as a rise in creatinine of >2 mg/dl from preoperative value. Return to the operating room was defined as a women returning to a surgical operating room for a surgical intervention of any kind within 30 days of surgery. Postoperative blood transfusion required any transfusion of packed red blood cells or whole blood given within the first 72 hours after the women left the operating room. Unfortunately, gynecologic specific complications, namely urinary tract injuries and conversion from a minimally-invasive surgery to laparotomy, were not available from the dataset for analysis. Urinary tract infections and superficial surgical site infections were not considered major

postoperative complications as these are common complications easily treated with oral antibiotics.

Descriptive statistics, Student's *t* test, χ^2 , Wilcoxon rank sum test, and Fisher's exact test were performed as appropriate. The primary outcome, composite 30 day major postoperative complications, was analyzed as a dichotomous variable (Yes/No). The relationship of both age and BMI were explored with postoperative complications. In both cases, when age and BMI were considered as continuous variables, a significant association with major postoperative complications was not found. However, a non-linear relationship was seen between postoperative complications when age ≥ 80 years old and BMI > 40 kg/m² were considered as dichotomous variables. These two dichotomous classifications are clinically significant as age ≥ 80 years old commonly represents the definition of a geriatric patient and BMI > 40 kg/m² is classified as morbid obesity by the National Institutes of Health.(9) Preoperative medical diseases, dependent functional status, unintentional weight loss, race, ethnicity, smoking status, type of anesthesia, and emergency surgery were explored as dichotomous variables (Yes/No). ASA classification, wound classification, and operative time were analyzed as categorical variables. Total work RVUs were analyzed as continuous variables. Logistic regression models were conducted to further explore the associations of preoperative predictors with 30 day postoperative morbidity. Variables were identified for inclusion in the final model based on univariate analysis ($p < 0.10$). These variables were then added to the regression analysis model in a stepwise fashion using likelihood ratio testing. The likelihood ratio test statistic was used to compared to the chi-squared distribution of the model and a p-value calculated. Only variables with a p-value of < 0.05 based on likelihood ratio testing were included in the final model; therefore some variables identified on univariate analysis were not included in the final regression model as they did not significantly impact the analysis. The goodness-of-fit of the model was confirmed with the Hosmer-Lemeshow test ($p > 0.05$). Finally, we conducted a stratified analysis of procedures for gynecologic cancer and benign gynecologic procedures as we expected the higher complications in women undergoing procedures for gynecologic cancer. Two separate logistic regression models were built to estimate the association between preoperative variables and postoperative complications in 1) women undergoing benign gynecologic procedures and 2) women undergoing procedures for gynecologic cancer. Statistical analysis was performed using STATA 11.0 (StataCorp, College Station, TX) and SAS 9.2 (SAS Institute, Inc, Cary, NC).

Results

A total of 22,214 women were included in our final analysis. Women were excluded from analysis for the following reasons: 1) classification of male gender (n=51), 2) current pregnancy (n=416), 3) previous operation within 30 days of current procedure (n=185), and 4) CPT-4 code inconsistent with gynecologic procedure (n= 703).

The overall prevalence of composite 30 day major postoperative complications was 3.7% (n=817). This included: mortality (.17%, n=38), cardiac arrest (.06%, n=14), myocardial infarction (.05%, n=11), stroke (.03%, n=6), coma > 24 hrs after surgery (.01%, n=3), pneumonia (.3%, n=66), sepsis (.54%, n=121), septic shock (.18%, n=39), prolonged mechanical ventilation > 48 hours (.20%, n=45), unplanned intubation (.27%, n=60), pulmonary embolism (.28%, n=62), deep vein thrombosis (.18%, n=40), deep wound surgical site infection (.32%, n=71), organ space surgical site infection (.61%, n=136), wound dehiscence (.38%, n=84), acute renal failure (.08%, n = 17), progressive renal insufficiency (.1%, n = 23), postoperative blood transfusion (.18%, n=40), and return to the operating room (1.65%, n=366). Women could have more than one postoperative complication; however they were counted only once in the composite morbidity category.

Of the 817 women experiencing a major postoperative complication, 609 women (74.5%) experienced only one postoperative complication. Three or more complications were experienced by 86 women. The postoperative mortality of women experiencing 3 or more complications was 25.6% (22/86) compared with 0.07% (16/22,112) women experiencing 2 or less complications ($p < 0.001$). Results of univariate analysis of preoperative predictors are listed in Table 2.

Age ≥ 80 years (adjusted OR = 1.8 (95% CI 1.25, 2.58)), dependent functional status (adjusted OR = 2.37 (95% CI 1.53, 3.68)), and unintentional weight loss (adjusted OR = 2.49 (95% CI 1.48, 4.17)) were significantly associated with postoperative morbidity after adjusting for diabetes mellitus (adjusted OR = 1.44 (95% CI 1.15, 1.79)), known bleeding disorder (adjusted OR = 2.29 (95% CI 1.49, 3.52)), morbid obesity (adjusted OR = 1.77 (95% CI 1.45, 2.17)), ascites (adjusted OR = 3.27, (95% CI 2.18, 4.90)), preoperative systemic infection (adjusted OR = 3.02, (95% CI 2.03, 4.48)), procedures for gynecologic cancer (adjusted OR = 1.60 (95% CI 1.27, 2.00)), disseminated cancer (adjusted OR = 2.57 (95% CI 1.64, 4.03)), emergency procedures (adjusted OR = 1.82 (95% CI 1.18, 2.79)), operative time and wound class. The full logistic regression model is listed in Table 3. ASA classification and total work RVU were not included in the final model due to collinearity with preoperative medical disease categories and operative time, respectively.

Major 30 day postoperative complications by procedure category are listed in Table 4. Procedures for gynecologic cancer identified by CPT-4 codes for radical dissection, lymphadenectomy, or debulking had the highest prevalence of major postoperative complications (9.8%, $n/N = 143/1,463$) and the highest postoperative mortality (1.1%, $n/N = 16/1,463$). Procedures for prolapse and/or urinary incontinence and laparoscopy had the lowest prevalence of overall complications (1.7% ($n/N = 66/3,849$) and 2.0% ($n/N = 11/548$), respectively).

We conducted a stratified analysis of women undergoing procedures for gynecologic cancer and women undergoing benign gynecologic procedures. Women who were ≥ 80 years old undergoing procedures for gynecologic cancer had the highest prevalence of 30 day major postoperative complications (17.5%, $n/N = 17/97$) and the highest 30 day postoperative mortality (7.2%, $n/N = 7/97$). In women undergoing benign gynecologic procedure ($n = 20,751$), we found age ≥ 80 years, dependent functional status, unintentional weight loss, diabetes mellitus, known bleeding disorders, morbid obesity, preoperative systemic infection, ascites, current smoker, emergency procedures and operative time to be associated with the occurrence of postoperative complications. (Table 5) In women undergoing procedures for gynecologic cancer ($n = 1,463$), we found dependent functional status, preoperative systemic infection, ascites, known bleeding disorders, and disseminated cancer to be associated with the occurrence of postoperative complications. (Table 6)

Discussion

We found the prevalence of major postoperative complications after gynecologic procedures to be 3.7%. The most common complications were postoperative systemic infections (pneumonia, sepsis, and septic shock), postoperative wound morbidity, and return to the surgical operating room within 30 days of surgery. Age ≥ 80 years old, medical comorbidities, dependent functional status, and unintentional weight loss were associated with increased postoperative complications after gynecologic surgery.

We found a similar prevalence of postoperative mortality and complications after gynecologic surgery compared with others. In an analysis of 1,722 women undergoing hysterectomy at Veterans Affairs Medical Centers from 1991 to 1997, Weaver et al. reported

the overall prevalence of all postoperative complications (including urinary tract infections) to be 9.0% and an overall mortality of 0.06%, however no preoperative predictors were analyzed in this study.(4) Our findings of a lower composite morbidity of 3.7% is not surprising as we excluded minor complications (urinary tract infections and superficial wound infections) and focused on major postoperative events.

Considering age in relation to the occurrence of postoperative complications after gynecologic procedures is important. Older women (aged 65 years or older) undergo surgical procedures more frequently than their younger counterparts.(10) When examining the prevalence of postoperative complications and mortality in women in the oldest age group (≥ 80 years) in the gynecology literature, low occurrences of postoperative mortality has been described. Parker et al. reported on 77 patients undergoing benign gynecologic procedures in women age ≥ 80 years with a prevalence of postoperative complications of 14.3% and no mortalities. (11) Stepp et al. examined the charts of 267 women ≥ 75 years undergoing gynecologic procedures for pelvic floor disorders with a prevalence of postoperative complications of 24% and a one year mortality of 1.1%.(12) Operative time, peripheral vascular disease, and known coronary artery disease were identified by Stepp et al. as predictors of postoperative complications.(12) Again, our prevalence of major postoperative complications was slightly lower than Stepp et al. because we did not include urinary tract infections and superficial wound infections. However, our findings of postoperative mortality of 1.3% in women ≥ 80 year old undergoing benign procedures are consistent.(12) In a large study of medical billing data from the National Inpatient Sample reviewing gynecologic procedures for pelvic floor disorders, Sung et al. reported overall in-patient mortality risk of 0.04% for women ≥ 80 years old.(13) However despite this low absolute mortality risk, women ≥ 80 years old had an increased odds of mortality compared to women < 60 years (adjusted OR = 13.9 (95% CI 5.90, 31.40).

In addition to age and medical comorbidities, we examined both functional status and unintentional weight loss (as a marker of frailty) with postoperative complications and mortality after gynecologic surgery. This association has been described in older patients undergoing general surgical procedures. Polanczyk et al. demonstrated a correlation of functional status with postoperative complications and in-hospital mortality in patients > 50 years old undergoing major noncardiac surgery.(14) In patients > 65 years old undergoing major surgery, markers of frailty were demonstrated to be predictive of both 6-month postoperative mortality and discharge to skilled nursing facilities. (15) These markers of frailty included: decreased cognition, poor nutrition (measure by lower serum albumin and hematocrit levels), recent unexplained falls, and dependent functional status for activities of daily living.(15) We found that functional status and unintentional weight loss (a marker of frailty) were associated with increased postoperative complications in gynecologic surgery, further supporting the need for evaluation of frailty and functional status during preoperative medical risk assessment.

We elected to examine all gynecologic procedures (including laparotomies, vaginal procedures, and procedures for gynecologic cancer) to be able to report on overall complications following gynecologic surgery. Overall, we found postoperative complications to be rare. Both laparotomies and procedures for gynecologic cancer had higher complications than vaginal procedures; however vaginal procedures were not without complications. Vaginal procedures including dilation and curettage, hysteroscopy, cervical excision procedures and benign trachelectomy consisted of 5% of the total procedures analyzed had a composite morbidity of 3.3%, very similar to the composite morbidity of 3.7% of all gynecologic procedures. Therefore, by including all gynecologic procedures in our analysis, our findings are applicable to all gynecologic surgeons.

Not surprisingly, we found increased postoperative complications in procedure for gynecologic cancer (procedures including radical dissection, lymphadenectomy, or debulking). These procedures are more difficult with longer operative times with higher work RVUs. When stratified analyses were conducted, women ≥ 80 years old undergoing benign gynecologic procedures had a prevalence of major postoperative complications of 5.5% and a mortality of 1.25%. These findings suggest that women ≥ 80 years can undergo benign gynecologic procedures without major postoperative complications; however increased complications were observed with increased operative time, medical comorbidities, and dependent functional status.

Our study has several limitations. First are the limitations inherent to secondary analyses of an existing dataset. Certain information that we would have liked to analyze was not recorded in the American College of Surgeons National Surgical Quality Improvement Program dataset. Because the American College of Surgeons National Surgical Quality Improvement Program collects information on a wide-range of procedures, postoperative outcome variables specific to morbidity from gynecologic procedures are not available. However, although the specific complications were not available for our analysis, the diversity of the postoperative complications and the consistency of the 30 day follow-up adds valuable insight into the true occurrence of complications after gynecologic procedures. Another limitation is the sample of gynecologic procedures that are obtained. The American College of Surgeons National Surgical Quality Improvement Program participation is voluntary.⁽¹⁾ Information on gynecologic procedures were only collected from hospitals that participated in the more complex multi-specialty model of the American College of Surgeons National Surgical Quality Improvement Program, not the general model of the program. This could result in selection bias of hospitals reporting gynecologic data. However, current participation of both models includes over 320 hospitals including both community based care facilities and tertiary care centers. The American College of Surgeons National Surgical Quality Improvement Program participant use data files do not allow for identification of participating hospital within the dataset and therefore we were not be able to account for the effect of clustering of observations within centers. However, previous investigators have demonstrated that the clustering effect from the American College of Surgeons National Surgical Quality Improvement Program is minimal and does not change the overall adjusted outcomes.^(1, 16)

In conclusion, we found that major complications following gynecologic procedures are rare. These results add valuable information to the literature regarding the occurrence of postoperative complications after gynecologic procedures. Age 80 years or older, medical comorbidities, and dependent functional status associated with increased postoperative complications. These findings suggest that age should be considered along with medical comorbidities and functional status when deciding to perform a gynecologic procedure.

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Table 1
Physicians' Current Procedural Terminology Coding System, 4th edition (CPT-4) codes
for gynecologic procedures

Procedure category	CPT-4 codes
Procedures for gynecologic cancer	38562, 38570, 38571, 38572, 38589, 38780, 38760, 38765, 38770, 39560, 49203, 49204, 49205, 49255, 56630, 56631, 56632, 56633, 56634, 56637, 57106, 57107, 57109, 57110, 57111, 57531, 57550, 58200, 58210, 58240, 58285, 58943, 58548, 58950, 58951, 58952, 58953, 58954, 58956, 58957, 58958, 58960
Benign hysterectomy	
TAH	51925, 58150, 58152
SCH	58180
TVH	58260, 58262, 58263, 58267, 58270, 58275, 58280, 58290, 58291, 58292, 58293, 58294
LAVH	58550, 58552, 58553, 58554
TLH	58570, 58571, 58572, 58573
LASH	58541, 58542, 58543, 58544
Laparotomy	44005, 49000, 49010, 49020, 49402, 51900, 57296, 57540, 58140, 58146, 58410, 58520, 58540, 58700, 58720, 58740, 58750, 58752, 58760, 58770, 58805, 58822, 58920, 58925, 58940
Procedures for prolapse and/or urinary incontinence	45560, 51840, 51841, 51990, 51992, 57120, 57200, 57210, 57220, 57240, 57250, 57260, 57265, 57267, 57268, 57270, 57280, 57282, 57283, 57284, 57285, 57288, 57292, 57295, 57423, 57425, 57556, 58400
Vaginal procedures	53230, 56405, 56420, 56440, 56441, 56501, 56515, 56620, 56625, 56740, 56800, 56810, 57000, 57010, 57065, 57130, 57135, 57300, 57308, 57310, 57320, 57330, 57456, 57505, 57510, 57522, 57530, 57720, 58120, 58145, 58356, 58565, 58579
Laparoscopy	44180, 49321, 49322, 49329, 58350, 58578

TAH = total abdominal hysterectomy, SCH= supracervical hysterectomy, TVH = total vaginal hysterectomy, LAVH = laparoscopic assisted vaginal hysterectomy, TLH = total laparoscopic hysterectomy, LASH = laparoscopic supracervical hysterectomy

Table 2
Predictors of 30 day major postoperative complications (N =22,214)

	30 day major complication (n=817)	No major complication (n=21,397)	p-value
Age category			<.001
< 80 years old	778 (95.2)	20,939 (97.9)	
≥ 80 years old	39 (4.7)	458 (2.1)	
Race			.390
White	493 (60.3)	13,230 (61.8)	
Ethnicity			.066
Hispanic	113 (13.8)	3,475 (16.2)	
Hypertension	317(38.8)	6,235 (29.1)	<.001
Diabetes mellitus	109 (13.3)	1,586 (7.4)	<.001
History of CVA with neurologic deficit	9 (1.1)	109(0.5)	.030
Known bleeding disorder	31(3.8)	207 (1.0)	<.001
Steroid use for chronic condition	16 (2.0)	212 (1.0)	.010
Preoperative systemic infection			<.001
SIRS	35 (4.3)	187 (0.9)	<.001
Sepsis	12 (1.5)	38 (0.2)	<.001
Septic Shock	6 (0.7)	2 (0.01)	<.001
Preoperative blood transfusion > 4 units	3 (0.4)	16 (0.1)	.031
Steroid use for chronic condition	16 (2.0)	212 (1.0)	.010
Current smoker	183 (22.4)	3,939 (18.4)	.003
Current pneumonia	5(0.61)	3 (0.01)	<.001
Morbid obesity (BMI > 40 kg/m ²)	136 (16.7)	1,901 (8.9)	<.001
Prior myocardial infarction within 6 months	1 (0.1)	6 (0.03)	.231
New or exacerbated congestive heart failure	7 (0.9)	22 (0.1)	<.001
Prior percutaneous coronary intervention	12 (1.5)	233 (1.1)	.193
Prior cardiac surgery	15 (1.8)	157(0.7)	.002
Angina within 30 days of surgery	3 (.4)	40 (0.2)	.210
History of peripheral vascular disease (amputation)	3 (0.4)	39 (0.2)	.200
Rest pain in lower extremities	2 (0.2)	1 (0.004)	.004

	30 day major complication (n=817)	No major complication (n=21,397)	p-value
New York Heart Class III or IV	85 (10.4)	1,086 (5.1)	<.001
Chronic obstructive pulmonary disease	23 (2.8)	305 (1.4)	.001
Ventilator dependency	6 (0.7)	3 (0.01)	<.001
Acute or chronic dialysis	4 (0.5)	15 (0.07)	.005
Acute or chronic renal failure	3 (0.4)	10 (0.05)	.011
Ascites	49 (6.0)	133 (0.62)	<.001
Esophageal varices	1 (0.1)	3 (0.01)	.139
Unintentional weight loss of > 10% in last 6 months	25 (3.0)	96 (0.5)	<.001
Functional status(dependent for ADLs)	37 (4.5)	151 (0.7)	<.001
Current cancer			
Current radiation therapy within 30 days	3 (0.4)	17 (.08)	<.001
Current chemotherapy within 30 days	8(1.0)	88 (0.4)	.025
Known CNS tumor	0	5 (0.02)	.829
Disseminated cancer	35 (4.3)	127(0.6)	<.001
Procedure for gynecologic cancer	143 (17.5)	1,320 (6.2)	<.001
ASA			<.001
Class 1 or 2	497 (60.8)	17,340 (81.4)	
Class 3	292 (35.7)	3,891 (18.2)	
Class 4	36 (3.2)	165 (0.8)	
Class 5	2 (0.2)	1 (0.004)	
Emergency procedure	37 (4.5)	316 (1.5)	<.001
Work relative value unit (mean, ±SD)	17.3 (±6.8)	15.2 (±5.1)	<.001
Operative time			<.001
< 1 hour	136 (16.7)	5,655 (26.4)	
1-2 hours	280 (34.3)	8,842 (41.3)	
2-3 hours	195 (23.9)	4,177 (19.5)	
3-4 hours	109 (13.3)	1,713 (8.0)	
>4 hours	97 (11.9)	1,010 (4.7)	
Type of anesthesia (general)	794 (97.2)	20,246 (94.6)	.001
Wound class			<.001
1-Clean	9 (1.1)	364 (1.7)	
2-Clean/contaminated	765 (93.6)	20,656 (96.5)	
3-contaminated	17 (2.1)	205 (1.0)	

	30 day major complication (n=817)	No major complication (n=21,397)	p-value
4-dirty	26 (3.20)	172 (0.8)	

All values listed as n(%) unless otherwise specified

CVA = cerebrovascular accident

SIRS = Systemic inflammatory response syndrome

SD = standard deviation

ADLs = activities of daily living

ASA = American Society of Anesthesiologist

Table 3
Predictors of 30 day major composite morbidity in gynecologic surgery (N=22,214)

Predictor	Adjusted OR (95% CI)
Age category	
< 80 years	1 (reference)
≥ 80 years	1.80 (1.25, 2.58)
Functional status(dependent for ADLs)	2.37 (1.53, 3.68)
Unintentional weight loss of > 10% in last 6 months	2.49 (1.48, 4.17)
Diabetes mellitus	1.44 (1.15, 1.79)
Known bleeding disorder	2.29 (1.49, 3.52)
Morbid obesity (BMI > 40 kg/m ²)	1.77 (1.45, 2.17)
Ascites	3.27 (2.18, 4.90)
Preoperative systemic infection	3.02 (2.03, 4.48)
Procedures for gynecologic cancer	1.60 (1.27, 2.00)
Disseminated cancer	2.57 (1.64, 4.03)
Emergency procedure	1.82 (1.18, 2.79)
Operative time	
< 1 hour	1 (reference)
1-2 hours	1.28 (1.04, 1.59)
2-3 hours	1.75 (1.39, 2.20)
3-4 hours	2.19 (1.68, 2.87)
>4 hours	2.91 (2.18, 3.89)
Wound Class	
1-Clean	1 (reference)
2-Clean/contaminated	1.99 (.99, 3.98)
3-contaminated	2.29 (.94, 5.53)
4-dirty	4.28 (1.82, 10.1)

OR= Odds Ratio

CI= Confidence interval

ADLs = Activities of daily living

Table 4
30 day major postoperative complications by procedure type (N = 22,214)

Type of Procedure	N	Composite 30 day major postoperative complications										Composite 30 day major morbidity (n=817)
		30 day mortality (n=38)	30 day vascular morbidity (n=30)	30 day wound morbidity (n=278)	30 day VTE morbidity (n=91)	30 day respiratory morbidity (n=82)	30 day infectious morbidity (n=199)	30 day renal morbidity (n = 37)	Blood transfusion (n=40)	Return to the operating room (n=366)		
Gynecologic cancer	1,463	16 (1.1)	6 (0.4)	40 (2.7)	28 (1.9)	23 (1.6)	41 (2.8)	14 (1.0)	6 (0.4)	44 (3.0)	143 (9.8)	
Benign hysterectomy	13,033	13 (0.1)	15 (0.1)	189 (1.5)	52 (0.4)	33 (0.3)	113 (0.9)	12 (0.1)	26 (0.2)	196 (1.5)	461 (3.5)	
TAH	4,719	7 (0.2)	10 (0.2)	89 (1.9)	32 (0.7)	18 (0.4)	62 (1.3)	9 (0.2)	14 (0.3)	88 (1.9)	228 (4.8)	
SCH	746	2 (0.3)	1 (0.1)	16 (2.1)	5 (0.7)	6 (0.8)	11 (1.5)	0 0	13 (0.4)	13 (1.7)	37 (5.0)	
TVH	3,067	1 (0.03)	2 (0.1)	33 (1.1)	3 (0.1)	1 (0.03)	20 (0.7)	1 (0.03)	5 (0.2)	29 (1.0)	73 (2.4)	
LAVH	2,089	2 (0.1)	2 (0.1)	33 (1.6)	7 (0.3)	7 (0.3)	13 (0.6)	2 (0.1)	3 (0.1)	32 (1.5)	70 (3.4)	
TLH	884	0 0	0 0	7 (0.8)	1 (0.1)	1 (0.1)	3 (0.3)	0 0	1 (0.1)	18 (2.0)	23 (2.6)	
LASH	1,528	1 (0.1)	0 0	11 (0.7)	4 (0.3)	0	4 (0.3)	0 0	0 0	16 (1.1)	30 (2.0)	
Laparotomy	2,109	8 (0.4)	3 (0.1)	27 (1.3)	4 (0.2)	15 (0.7)	25 (1.2)	6 (0.3)	4 (0.2)	51 (2.4)	96 (4.6)	
Prolapse and/or urinary incontinence	3,849	0 0	3 (0.1)	14 (0.4)	5 (0.1)	5 (0.1)	12 (0.3)	1 (0.03)	2 (0.1)	38 (1.0)	66 (1.7)	
Vaginal procedures	1,212	1 (0.1)	2 (0.2)	5 (0.4)	2 (0.2)	5 (0.4)	7 (0.6)	3 (0.3)	1 (0.1)	28 (2.3)	40 (3.3)	
Laparoscopy	548	0 0	1 (0.2)	3 (0.6)	0 0	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	9 (1.6)	11 (2.0)	

All values listed as n(row %)

VTE = venous thromboembolic event, TAH = total abdominal hysterectomy, SCH= supracervical hysterectomy, TVH = total vaginal hysterectomy, LAVH = laparoscopic assisted vaginal hysterectomy, TLH = total laparoscopic hysterectomy, LASH = laparoscopic supracervical hysterectomy, OR = operating room

30 day vascular morbidity includes: cardiac arrest, acute transmural myocardial infarction, cerebral vascular accident, or a postoperative non-medication related coma for greater than 24 hrs after surgery.

30 day wound morbidity includes: deep wound surgical site infection of fascial or muscle layers, organ space surgical site infection, or wound dehiscence.

30 day VTE morbidity includes: pulmonary embolism or deep vein thrombosis.

30 day respiratory morbidity includes: prolonged mechanical ventilation >48 hours after surgery or unplanned re-intubation

30 day infectious morbidity includes: pneumonia, sepsis, or septic shock.

30 day renal morbidity includes: acute renal failure with need for dialysis or progress renal insufficiency

Blood transfusion includes the transfusion of packed red blood cells or whole blood cells within 72 hours of completion of surgery.

Return to the operating room includes the return to the surgical operating room for any reasons within 30 days of surgery.

Table 5
Predictors of 30 day major composite morbidity following benign gynecologic surgery (N =20,751)

Predictor	Adjusted OR(95% CI)
Age category	
< 80 years	1 (reference)
≥ 80 years	1.91 (1.22, 3.00)
Functional status(dependent for ADLs)	1.77 (1.00, 3.18)
Unintentional weight loss of > 10% in last 6 months	4.22 (2.10, 8.47)
Diabetes mellitus	1.45 (1.14, 1.87)
Known bleeding disorder	2.45 (1.47, 4.07)
Morbid obesity (BMI > 40 kg/m ²)	1.95 (1.57, 2.41)
Preoperative systemic infection	2.59 (1.93, 3.49)
Ascites	6.57 (3.47, 12.43)
Current smoker	1.46 (1.21, 1.75)
Emergency procedure	1.82 (1.13, 2.90)
Operative time	
< 1 hour	1 (reference)
1-2 hours	1.22 (0.98, 1.52)
2-3 hours	1.68 (1.32, 2.14)
3-4 hours	2.23 (1.67, 2.98)
>4 hours	3.32 (2.42, 4.57)

OR= Adjusted Odds Ratio

CI= Confidence interval

ADLs = Activities of daily living

Table 6
Predictors of 30 day major composite morbidity following procedures for gynecologic cancer (N =1,463)

Predictor	Adjusted OR(95% CI)
Functional status(dependent for ADLs)	3.95 (1.87, 8.34)
Preoperative systemic infection	2.87 (1.57, 5.24)
Ascites	2.38 (1.44, 3.95)
Known bleeding disorder	2.62 (1.24, 5.51)
Disseminated cancer	2.98 (1.77, 5.01)

OR= Adjusted Odds Ratio

CI= Confidence interval

ADLs = Activities of daily living