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Failure to rescue after major gynecologic surgery

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Abstract

Objective—There is growing recognition that, in addition to occurrence of perioperative complications, the treatment of patients with complications influences outcome. We examined complications, failure to rescue (death in patients with a complication), and mortality rates for women who underwent abdominal hysterectomy.

Study Design—Women who underwent abdominal hysterectomy from 1998-2010 and whose data were recorded in the Nationwide Inpatient Sample were identified. Hospitals were stratified based on risk-adjusted mortality rates into 5 quintiles, and rates of complications and failure to rescue were examined.

Results—A total of 664,229 women who had been treated at 741 hospitals were identified. The overall mortality rate for the cohort was 0.17%. The risk-adjusted, hospital-level mortality rate ranged from 0—1.12%. The complication rate was 6.5% at the hospitals with the lowest mortality rates, 9.9% at the second quintile hospitals, 9.5% at both the third and fourth quintile hospitals, and 7.9% at the hospitals with the highest mortality rates. In contrast to complications, the failure-to-rescue rate increased with each successive risk-adjusted mortality quintile. The failure-to-rescue rate was 0% at the hospitals with the lowest mortality rates and increased with each successive quintile to 1.1%, 2.1%, 2.7%, and 4.4% in the hospitals with the highest mortality rates ($P < .0001$).

Conclusion—For women who underwent abdominal hysterectomy, hospital complication rates correlated poorly with mortality rates; failure-to-rescue is strongly associated with in-hospital mortality rates. The treatment of complications, not the actual development of a complication, is the most important factor to use to predict death after major gynecologic surgery.

Keywords

complications; failure to rescue; gynecology; hysterectomy; mortality rate

The measurement and reporting of quality has become a major focus of medicine in the United States.¹⁻⁴ For women, hysterectomy is 1 of the most commonly performed surgical

procedures and an ideal target for quality improvement initiatives.⁵ In spite of the frequency of hysterectomy, systematic efforts to improve quality have been largely lacking.⁶

For many surgical procedures, complication rates have been used as a surrogate for quality.¹⁻³ Perioperative complications are often associated with substantial pain and suffering, are costly to treat, and can be associated with devastating long-term consequences.⁷ Further, for some diseases like cancer, complications can delay downstream treatments and ultimately compromise long-term outcomes.^{8,9} Although the major complication rate after hysterectomy is modest compared with other high-risk procedures, an appreciable number of women still experience significant complications at the time of the procedure.¹⁰

Despite the importance of complications, there is growing recognition that perhaps the most important determinant of outcomes is not the occurrence of a complication, but rather the treatment of patients with complications.¹¹⁻¹⁵ In a large analysis of patients who underwent general and vascular surgery, complication rates were similar at hospitals with high and low mortality rates. However, death in patients with complications was nearly twice as high in hospitals with a high mortality rate, compared with hospitals with low mortality rates.¹² The concept of failure to rescue or death after a complication has now gained prominence as an important determinant of outcome for patients who undergo surgery.¹¹⁻¹⁵

To date, failure to rescue has received little attention in gynecologic surgery. We performed a population-based analysis to examine factors that are associated with poor outcome in women who undergo major gynecologic surgery. The primary objective of our study was to determine whether complication rates correlate with hospital-level mortality rates in women who undergo hysterectomy. Specifically, we examined hospital-level rates of complications, failure to rescue, and death in women who undergo abdominal hysterectomy.

Methods

Data

Data from the Nationwide Inpatient Sample (NIS), which was developed and is maintained by the Agency for Healthcare Research and Quality, were analyzed. NIS includes a random sample of 20% of all hospital discharges from the United States and is the largest all-payer inpatient care database in the United States. The sampling scheme for NIS includes all nonfederal, general, and specialty-specific hospitals from across the United States. Hospitals that are sampled include not only academic but also community facilities. NIS captured approximately 8 million hospital stays from 45 states in 2010.¹⁶ The study was deemed exempt by the Columbia University Institutional Review Board.

Demographic and clinical characteristics

The data for women who were 18 years old and who underwent abdominal hysterectomy between 1998 and 2010 were analyzed. Abdominal hysterectomy was defined by *International Classification of Diseases, 9th revision*, codes 68.3, 68.39, 68.4, 68.49, and 68.9 and was classified further as either a total or subtotal (supracervical) hysterectomy. To enhance the reliability of our estimates, only hospitals that had performed at least 400 abdominal hysterectomies were included. Concomitant procedures that were performed at the time of abdominal hysterectomy and that included oophorectomy (either unilateral or bilateral), anterior colporrhaphy, posterior colporrhaphy, antiincontinence procedures, small-bowel resection, large-bowel resection, and lymphadenectomy were recorded with the use of *International Classification of Diseases, 9th revision*, coding.¹⁷⁻²⁰ Surgical indications included leiomyoma, endometriosis, abnormal bleeding, benign ovarian neoplasms, pelvic

organ prolapse, uterine cancer, and ovarian cancer. Patients may have had multiple indications for surgery.¹⁷⁻¹⁹

Race was classified as white, black, Hispanic, and other; age was grouped into 10-year increments. Household income was classified by the NIS as low, medium, high, or highest. Insurance status at the time of hysterectomy was categorized as private, Medicare, Medicaid, self-pay, other, and unknown. The presence of comorbid medical conditions was measured with the Elixhauser Comorbidity Index. Patients were categorized based on the number of medical comorbidities into 0, 1, and 2, as previously described.²¹ Area of residence was categorized as either urban or rural, and location was classified as northeast, midwest, west, or south. The hospital in which each patient underwent surgery was classified as either a teaching or nonteaching facility and, based on size, as a small, medium, or large facility.

Complications, failure to rescue, and risk-adjusted mortality rates

Risk-adjusted mortality rates for each hospital were estimated as previously reported.^{11,13,15} Logistic regression models were used to estimate the probability of death for each patient. These models included all of the clinical and demographic characteristics, indications for surgery, and concomitant procedures. The predicted probabilities of all patients at a given hospital were then summed to determine the expected mortality rate for each hospital. The risk-adjusted mortality rate for a given hospital was then calculated by multiplying the ratio of the observed to expected mortality rate by the overall mortality rate of the entire study cohort. Hospitals were then classified into 5 quintiles based on their risk-adjusted mortality rates (lowest risk-adjusted to highest risk-adjusted mortality rate). In this stratification, there were 284 hospitals without any observed deaths. These 284 hospitals made up the lowest risk-adjusted mortality quintile. Stratification of the remaining hospitals into the risk-adjusted mortality quintiles was performed so that approximately equal numbers of hospitals were included in each quintile.

Major perioperative complications were analyzed. For the analysis, complications were divided into 2 groups: medical complications (myocardial infarction, cardiopulmonary arrest, renal failure, respiratory failure, venous thromboembolism, hemorrhage, cerebrovascular accident, shock, gastrointestinal bleed) and infectious complications (wound complications, abscess, pneumonia, bacteremia/sepsis).^{11,15} An analysis of any complication, which is a composite measure that included both medical and infectious complications, was also performed.¹⁵ *Failure to rescue* was defined as death in a patient with any of the recorded complications.^{11,15} For each hospital, the overall complication rate and the rate of failure to rescue were determined by dividing the number of patients with a complication or death after a complication, respectively, by the total number of women who underwent an abdominal hysterectomy at that institution.

Statistical analysis

Frequency distributions for categorical variables were compared across the risk-adjusted mortality quintiles with χ^2 tests. The complication rates and rate of failure to rescue are reported descriptively over time and across the risk-adjusted mortality quintiles. Separate analyses were performed for the overall complication rate and failure to rescue and for medical and infectious complications and death after these complications, respectively. To verify the reliability of our estimates, we performed a sensitivity analysis in which the hospitals were grouped into 4 quartiles. The analysis of risk-adjusted mortality rates, complications, and failure to rescue was repeated in this analysis. A probability value of $< .05$ was considered statistically significant. All analyses were conducted with SAS software (version 9.3; SAS Institute, Cary, NC). All statistical tests were 2-sided.

Results

A total of 664,229 women who underwent abdominal hysterectomy were identified. The overall mortality rate for the cohort was 0.17%. The risk-adjusted mortality rate across the 741 hospitals ranged from 0—1.12%. When stratified into 5 quintiles, there were 284 hospitals without any deaths. The risk-adjusted mortality rates ranged from 0.35—1.12% for the highest mortality quintile of hospitals (Table 1).

Table 1 displays the characteristics of the cohort that are stratified by hospital-level risk-adjusted mortality rates. Although the absolute differences between mortality groups were low for most covariates, all of the characteristics were statistically significantly different across the groups. Compared with the hospitals with the highest mortality rates, the hospitals with the lowest mortality rates had a lower percentage of black patients (11.8% vs 14.8%), fewer Medicaid recipients (7.1% vs 9.3%), and fewer women with ≥ 2 comorbidities (4.2% vs 6.0%; $P < .0001$ for all). Compared with hospitals in the second, third, and fourth mortality groups, centers in the highest mortality quintile were more often small hospitals (9.3%; $P < .0001$) and nonteaching facilities (50.1%; $P < .0001$).

The overall complication rate was 8.5% and ranged from 6.2% in 1998 to 5.3% in 2010 ($P < .0001$; Figure 1). The complication rate was 6.5% at the hospitals with the lowest mortality rates, 9.9% at the second quintile hospitals, 9.5% at both the third and fourth quintile hospitals, and 7.9% at the highest mortality quintile hospitals ($P < .0001$) (Table 2). Similar trends in complications rates were noted for both medical complications and infectious complications. The rates of both medical and infectious complications were highest in the second to lowest risk-adjusted mortality quintile.

In contrast to complications, the failure-to-rescue rate increased with each successive risk-adjusted mortality quintile (Figure 2; Table 3). The overall failure-to-rescue rate was 0% at the hospitals with the lowest mortality rates and then increased with each successive quintile to 1.1%, 2.1%, 2.7%, and 4.4% in the hospitals with the highest mortality rates. Similar trends were noted for medical complications; the failure-to-rescue rate increased successively from 0–5.1%. Among patients with infectious complications, the rate of failure to rescue increased from 0% in the hospitals with the lowest mortality rates to 4.7% in the middle quintile to 8.1% at the hospitals with the highest mortality rates. In a sensitivity analysis in which hospitals were grouped into mortality quartiles, the findings were largely unchanged; mortality rates were associated with failure to rescue but not complications.

Comment

Failure to rescue is associated with outcome in women who undergo major gynecologic surgery. Complication rates correlate poorly with in-hospital mortality rates; hospitals with the highest risk-adjusted mortality rates had lower complication rates than hospitals with lower mortality rates. These data suggest that the treatment of complications, not the actual development of a complication, is the most important factor to use to predict death after major gynecologic surgery.

There is growing recognition of the importance of failure to rescue for a number of procedural disciplines.^{11–15,22–27} In a report of elderly patients who underwent 1 of 6 high-risk cardiac or oncologic procedures, Ghaferi et al¹¹ noted that complication rates were similar at hospitals with high and low mortality rates. However, the failure-to-rescue rate was more than twice as high at the highest, compared with the hospitals with the lowest, mortality rates. The authors concluded that the greatest improvement in survival could be achieved through reducing variation in failure to rescue at hospitals with high mortality rates. In addition to influencing the mortality rates after surgical procedures, failure to rescue

is also associated with outcomes in other scenarios, such as after trauma and in general medical patients.^{24,28,29}

To date, failure to rescue after gynecologic surgery has received relatively little attention. Our group previously examined the association between hospital procedural volume and failure to rescue in women who underwent ovarian cancer resection. In this analysis, overall mortality rates were lower at high-volume hospitals, but complication rates were also greater at high-volume, compared with low-volume, hospitals. In contrast, the failure-to-rescue rate was greater at low-volume centers; women who experienced a complication at a low-volume hospital were 48% more likely to die than those with a complication at a high-volume center. These data suggest that variation in failure to rescue may be one factor that is associated with the improved survival that is seen in women who are treated at high-volume centers.¹⁵ The current report extends these findings and suggests that the concept of failure to rescue is applicable to gynecologic surgery in general and is associated strongly with outcome for women who undergo abdominal hysterectomy.

Hysterectomy is unlike many of the other procedures in which failure to rescue has been studied in that the operation is associated with a much lower complication rate and a very small risk of death.¹⁰ In the study described earlier of cardiovascular and oncologic surgery, hospital-level complication rates for the 6 operations ranged from 14–48%, while mortality rates varied from 2–13%.¹¹ In our cohort, the overall complication rate was 8.5%; the in-hospital mortality rate was just 0.2%. Despite the low absolute rate of adverse events, there was substantial hospital-level variation in complications and mortality rates. Perhaps more importantly, the rates of failure to rescue were appreciably different across the quintiles and ranged from 0–4.4%. These findings demonstrate that, even for low morbidity procedures, the variation in the rate of failure to rescue is significant and that this variation is sufficient to perform comparisons across hospitals.

Given the substantial variation in failure to rescue and its association with mortality rates, our data suggest that it may be a good candidate quality metric for gynecologic surgery. Despite the increased awareness of quality and outcomes in many surgical fields, efforts to develop and implement quality measures after gynecologic surgery have lagged.^{2,6,30–32} A number of national efforts, which include the National Surgical Quality Improvement Project, have been created to examine and compare risk-adjusted outcomes across hospitals.^{1,33,34} Although the National Surgical Quality Improvement Project was used initially for general surgical procedures, such efforts are now also used for gynecologic surgery.³⁵ Although measuring complications is undoubtedly important, our data suggest that failure to rescue may be an even more important quality metric. Importantly, for hospitals with high failure-to-rescue rates, quality improvement measures that are targeted at patients with complications are an immediately actionable initiative that could improve outcomes.

Although our analysis benefits from the inclusion of a relatively large number of hospitals and patients, we recognize a number of important limitations. The primary purpose of claims data is for billing, and, as such, there is likely an under ascertainment of complications. To minimize this bias, we limited our analysis to only major postoperative complications that are likely to generate a claim, as previously reported.¹¹ Further, any underreporting of complications would likely have been balanced across the groups. A priori, we chose to limit our analysis only to hospitals that performed a minimum number of hysterectomies. We used a minimum procedure cut-point of 400 hysterectomies to enhance the reliability of our estimates because outcomes at hospitals with a very low volume might be spurious and not a true reflection of quality. We performed a series of sensitivity analyses using other cut-points, and our findings were largely unchanged. With this in mind, our findings may not be

generalizable to very low-volume centers and may require further validation. We recognize that it is impossible to completely capture a number of variables that likely impact the outcome of hysterectomy, the presence of adhesive disease, and uterine morphology. To partially overcome this limitation, we performed rigorous risk-adjustment for surgical indications and the performance of a wide variety of concomitant procedures. We also lack data on the actual treatment rendered for women with complications. Finally, we were able to examine only in-house complications and deaths. Further work is needed to examine the impact of complications and the treatment during the postoperative period after discharge on mortality rates.

A major unanswered question remains about the reason that there is so much variability in rescuing patients with complications. Although some data have suggested that hospital characteristics (such as teaching status, size, capacity, and nurse-to-patient ratio) and procedural volume influence deaths after a complication, a large amount of the variation in failure to rescue remains unexplained. In the long term, coordinated national efforts to measure failure to rescue may improve understanding in variations in failure to rescue. In the short term, targeted initiatives to improve the timely recognition and treatment of complications may have a significant impact on women who undergo hysterectomy.

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Figure 1. Complication and failure to rescue rates stratified by year of diagnosis

Figure 2. Complications and failure to rescue stratified by hospital risk-adjusted mortality quintiles

All complications, medical complications, and infectious complications are presented.

Table 1
Unadjusted characteristics of the study cohort, stratified by risk-adjusted mortality hospital quintile

Variable	Quintile					P value
	Lowest, n	Second, n	Third, n	Fourth, n	Highest, n	
Patients	193,904	149,212	132,561	108,605	79,947	
Hospitals	284	114	114	115	114	
Year of procedure						< .0001
1998	14,795 (7.6%)	10,219 (6.9%)	7783 (5.9%)	7590 (7.0%)	6656 (8.3%)	
1999	16,194 (8.4%)	13,194 (8.8%)	11,483 (8.7%)	8666 (8.0%)	7067 (8.8%)	
2000	15,395 (7.9%)	15,100 (10.1%)	13,182 (9.9%)	10,289 (9.5%)	5272 (6.6%)	
2001	19,301 (10.0%)	10,280 (6.9%)	12,752 (9.6%)	9860 (9.1%)	6209 (7.8%)	
2002	20,148 (10.4%)	17,886 (12.0%)	14,406 (10.9%)	9582 (8.8%)	6674 (8.4%)	
2003	19,193 (9.9%)	12,759 (8.6%)	11,395 (8.6%)	9984 (9.2%)	7884 (9.9%)	
2004	16,623 (8.6%)	13,921 (9.3%)	12,761 (9.6%)	8649 (8.0%)	6043 (7.6%)	
2005	14,922 (7.7%)	12,330 (8.3%)	9869 (7.4%)	10,047 (9.3%)	5763 (7.2%)	
2006	14,697 (7.6%)	9344 (6.3%)	9229 (7.0%)	7543 (7.0%)	9271 (11.6%)	
2007	12,057 (6.2%)	12,401 (8.3%)	9324 (7.0%)	7252 (6.7%)	6481 (8.1%)	
2008	11,521 (5.9%)	9114 (6.1%)	7884 (6.0%)	8080 (7.4%)	4905 (6.1%)	
2009	11,504 (5.9%)	6817 (4.6%)	8088 (6.1%)	5319 (4.9%)	4035 (5.1%)	
2010	7554 (3.9%)	5847 (3.9%)	4405 (3.3%)	5744 (5.3%)	3687 (4.6%)	
Age, y						< .0001
<40	51,131 (26.4%)	32,437 (21.7%)	26,623 (20.1%)	23,678 (21.8%)	19,549 (24.5%)	
40-49	90,698 (46.8%)	66,293 (44.4%)	57,954 (43.7%)	49,373 (45.5%)	37,780 (47.3%)	
50-59	32,353 (16.7%)	28,026 (18.8%)	25,721 (19.4%)	20,212 (18.6%)	13,465 (16.8%)	
60-69	11,134 (5.7%)	12,109 (8.1%)	11,913 (9.0%)	8336 (7.7%)	4979 (6.2%)	
70-79	6434 (3.3%)	7522 (5.0%)	7518 (5.7%)	5182 (4.8%)	3139 (3.9%)	
80	2154 (1.1%)	2825 (1.9%)	2832 (2.1%)	1824 (1.7%)	1035 (1.3%)	
Race						< .0001
White	93,605 (48.3%)	72,146 (48.4%)	60,664 (45.8%)	54,496 (50.2%)	37,820 (47.3%)	
Black	22,918 (11.8%)	24,363 (16.3%)	15,715 (11.9%)	17,355 (16.0%)	11,803 (14.8%)	

Variable	Quintile					P value
	Lowest, n	Second, n	Third, n	Fourth, n	Highest, n	
Hispanic	11,831 (6.1%)	9776 (6.6%)	10,581 (8.0%)	7663 (7.1%)	5903 (7.4%)	
Other	7862 (4.1%)	6609 (4.4%)	5108 (3.9%)	5139 (4.7%)	3116 (3.9%)	
Unknown	57,688 (29.8%)	36,318 (24.3%)	40,493 (30.6%)	23,952 (22.1%)	21,305 (26.7%)	
Income						< .0001
Low	28,960 (14.9%)	24,356 (16.3%)	15,239 (11.5%)	16,489 (15.2%)	13,094 (16.4%)	
Medium	49,564 (25.6%)	32,302 (21.7%)	26,481 (20.0%)	24,116 (22.2%)	19,834 (24.8%)	
High	50,183 (25.9%)	36,913 (24.8%)	35,726 (27.0%)	29,578 (27.2%)	22,294 (27.9%)	
Highest	61,254 (31.6%)	52,666 (35.3%)	52,807 (39.8%)	36,419 (33.5%)	23,317 (29.2%)	
Unknown	3943 (2.0%)	2975 (2.0%)	2308 (1.7%)	2003 (1.8%)	1408 (1.8%)	
Insurance						< .0001
Private	151,925 (78.4%)	108,294 (72.6%)	97,232 (73.4%)	79,349 (73.1%)	59,122 (74.0%)	
Medicare	16,476 (8.5%)	17,817 (11.9%)	16,870 (12.7%)	12,126 (11.2%)	7793 (9.8%)	
Medicaid	13,723 (7.1%)	11,327 (7.6%)	8668 (6.5%)	9136 (8.4%)	7442 (9.3%)	
Self-pay	5328 (2.8%)	5808 (3.9%)	3330 (2.5%)	3227 (3.0%)	2386 (3.0%)	
Other	5941 (3.1%)	5635 (3.8%)	6291 (4.8%)	4571 (4.2%)	3025 (3.8%)	
Unknown	511 (0.3%)	331 (0.2%)	161 (0.1%)	196 (0.2%)	179 (0.2%)	
Comorbidity						< .0001
0	162,397 (83.8%)	111,611 (74.8%)	97,157 (73.3%)	82,732 (76.2%)	64,075 (80.2%)	
1	23,312 (12.0%)	24,066 (16.1%)	22,714 (17.1%)	17,011 (15.7%)	11,098 (13.9%)	
2	8195 (4.2%)	13,535 (9.1%)	12,690 (9.6%)	8862 (8.2%)	4774 (6.0%)	
Region						< .0001
Northeast	17,974 (9.3%)	20,486 (13.7%)	19,361 (14.6%)	21,739 (20.0%)	16,032 (20.1%)	
Midwest	47,180 (24.3%)	25,030 (16.8%)	29,836 (22.5%)	24,451 (22.5%)	15,332 (19.2%)	
South	90,573 (46.7%)	77,798 (52.1%)	57,889 (43.7%)	39,871 (36.7%)	38,771 (48.5%)	
West	38,177 (19.7%)	25,898 (17.4%)	25,475 (19.2%)	22,544 (20.8%)	9812 (12.3%)	
Area of residence						
Metropolitan	173,066 (89.3%)	147,537 (98.9%)	128,725 (97.1%)	104,175 (95.9%)	77,518 (97.0%)	
Non-metropolitan	20,838 (10.8%)	1675 (1.1%)	3836 (2.9%)	4430 (4.1%)	2429 (3.0%)	

Variable	Quintile				P value
	Lowest, n	Second, n	Third, n	Fourth, n	
Hospital size					< .0001
Small	20,546 (10.6%)	8177 (5.5%)	5549 (4.2%)	3089 (2.8%)	7424 (9.3%)
Medium	47,967 (24.7%)	29,765 (20.0%)	25,065 (18.9%)	27,051 (24.9%)	21,747 (27.2%)
Large	125,391 (64.7%)	111,270 (74.6%)	101,947 (76.9%)	78,465 (72.3%)	50,776 (63.5%)
Hospital teaching status					< .0001
Nonteaching	125,576 (64.8%)	54,888 (36.8%)	36,283 (27.4%)	36,345 (33.5%)	40,022 (50.1%)
Teaching	68,328 (35.2%)	94,324 (63.2%)	96,278 (72.6%)	72,260 (66.5%)	39,925 (49.9%)
Indication for surgery					
Leiomyoma	114,155 (58.9%)	86,754 (58.1%)	74,831 (56.5%)	63,938 (58.9%)	48,543 (60.7%)
Endometriosis	68,932 (35.6%)	44,494 (29.8%)	38,829 (29.3%)	32,896 (30.3%)	26,845 (33.6%)
Abnormal bleeding	86,890 (44.8%)	54,530 (36.6%)	48,131 (36.3%)	41,596 (38.3%)	32,569 (40.7%)
Benign neoplasm	55,215 (28.5%)	38,253 (25.6%)	33,505 (25.3%)	28,755 (26.5%)	23,218 (29.0%)
Pelvic organ prolapse	13,099 (6.8%)	7992 (5.4%)	7259 (5.5%)	5524 (5.1%)	4269 (5.3%)
Uterine cancer	10,035 (5.2%)	14,140 (9.5%)	14,002 (10.6%)	9405 (8.7%)	5486 (6.9%)
Ovarian cancer	4061 (2.1%)	7455 (5.0%)	6857 (5.2%)	4501 (4.1%)	2280 (2.9%)
Concomitant procedures					
Salpingo-oophorectomy	139,411 (71.9%)	109,345 (73.3%)	98,660 (74.4%)	78,059 (71.9%)	55,885 (71.9%)
Anterior colporrhaphy	2609 (1.4%)	1517 (1.0%)	1772 (1.3%)	1071 (1.0%)	825 (1.0%)
Posterior colporrhaphy	3536 (1.8%)	2359 (1.6%)	2433 (1.8%)	1613 (1.5%)	1188 (1.5%)
Antincontinence procedure	13,338 (6.9%)	7595 (5.1%)	6902 (5.2%)	5670 (5.2%)	4307 (5.4%)
Small-bowel resection	545 (0.3%)	842 (0.6%)	788 (0.6%)	551 (0.5%)	315 (0.4%)
Colon resection	884 (0.5%)	1325 (0.9%)	1294 (1.0%)	839 (0.8%)	468 (0.6%)
Lymphadenectomy	8002 (4.1%)	14,798 (9.9%)	14,298 (10.8%)	9747 (9.0%)	5032 (6.3%)
Hysterectomy type					< .0001
Total	179,711 (92.7%)	137,767 (92.3%)	119,400 (90.1%)	97,700 (90.0%)	73,329 (91.7%)
Subtotal	14,193 (7.3%)	11,445 (7.7%)	13,161 (9.9%)	10,905 (10.0%)	6618 (8.3%)

Table 2
Individual complications, stratified by risk-adjusted mortality hospital quintile

Variable	Quintile					P value
	Lowest, n	Second, n	Third, n	Fourth, n	Highest, n	
Any complication	12,591 (6.5%)	14,697 (9.9%)	12,579 (9.5%)	10,337 (9.5%)	6279 (7.9%)	
Medical complications	10,599 (5.5%)	12,344 (8.3%)	10,595 (8.0%)	8880 (8.2%)	5308 (6.6%)	
Myocardial infarction	130 (0.1%)	181 (0.1%)	173 (0.1%)	158 (0.2%)	99 (0.1%)	<.0001
Cardiopulmonary arrest	62 (0.03%)	86 (0.1%)	111 (0.1%)	97 (0.1%)	97 (0.1%)	<.0001
Renal failure	544 (0.3%)	753 (0.5%)	709 (0.5%)	646 (0.6%)	428 (0.5%)	<.0001
Respiratory failure	4819 (2.5%)	6546 (4.4%)	5300 (4.0%)	4538 (4.2%)	2591 (3.2%)	<.0001
Venous thromboembolism	185 (1.0%)	2255 (1.5%)	1899 (1.4%)	1520 (1.4%)	911 (1.1%)	<.0001
Hemorrhage	3489 (1.8%)	3044 (2.0%)	2805 (2.1%)	2392 (2.2%)	1502 (1.9%)	<.0001
Cerebrovascular accident	72 (0.04%)	104 (0.1%)	101 (0.1%)	82 (0.1%)	53 (0.1%)	<.0001
Shock	627 (0.3%)	801 (0.5%)	769 (0.6%)	589 (0.5%)	390 (0.5%)	<.0001
Gastrointestinal bleed	139 (0.1%)	130 (0.1%)	142 (0.1%)	116 (0.1%)	82 (0.1%)	.003
Infectious complications	2980 (1.5%)	3765 (2.5%)	3109 (2.4%)	2430 (2.2%)	1674 (2.1%)	
Wound complication	563 (0.3%)	748 (0.5%)	616 (0.5%)	500 (0.5%)	322 (0.4%)	<.0001
Abscess	1338 (0.7%)	1650 (1.1%)	1366 (1.0%)	1022 (0.9%)	689 (0.9%)	<.0001
Pneumonia	1014 (0.5%)	1288 (0.9%)	1014 (0.8%)	820 (0.8%)	602 (0.8%)	<.0001
Bacteremia/sepsis	322 (0.2%)	550 (0.4%)	497 (0.4%)	428 (0.4%)	319 (0.4%)	<.0001

Table 3
Risk-adjusted mortality ranges, complications, and failure to rescue, stratified by risk-adjusted mortality hospital quintile

Variable	Quintile ^a				
	Lowest	Second	Third	Fourth	Highest
Any complication					
Risk-adjusted mortality rate	0	0.02—0.15	0.15—0.23	0.23—0.35	0.35—1.12
Complication rate	6.5 (6.4—6.6)	9.9 (9.7—10.0)	9.5 (9.3—9.7)	9.5 (9.3—9.7)	7.9 (7.7—8.0)
Failure to rescue rate	0	1.1 (1.0—1.3)	2.1 (1.9—2.4)	2.7 (2.4—3.0)	4.4 (3.9—4.9)
Medical complication					
Complication rate	5.5 (5.4—5.6)	8.3 (8.1—8.4)	8.0 (7.9—8.1)	8.2 (8.0—8.3)	6.6 (6.5—6.8)
Failure to rescue rate	0	1.2 (1.0—1.4)	2.3 (2.0—2.6)	3.1 (2.7—3.5)	5.1 (4.5—5.7)
Infectious complication					
Complication rate	1.5 (1.5—1.6)	2.5 (2.4—2.6)	2.4 (2.3—2.4)	2.2 (2.1—2.3)	2.1 (2.0—2.2)
Failure to rescue rate	0	2.5 (2.0—3.0)	4.7 (4.0—5.5)	5.2 (4.4—6.2)	8.1 (6.9—9.5)

^a Data are given as percent (range).