National perioperative outcomes of pulmonary lobectomy for cancer in the obese patient: A propensity score matched analysis

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Objectives: Obesity in the United States is a growing epidemic that results in challenging patients with complicated comorbidities. We sought to compare hospital outcomes of obese patients with those of nonobese patients undergoing pulmonary lobectomy for cancer.

Methods: We performed a retrospective cohort analysis of obese (body mass index ≥ 30 kg/m²) and nonobese (body mass index < 30 kg/m²) patients undergoing pulmonary lobectomy for lung cancer. By using the Nationwide Inpatient Sample database from 2002 to 2007, we determined independent risk factors for perioperative death, discharge to an institutional care facility, and prolonged hospital length of stay (>14 days). Cohorts were matched on the basis of propensity scores incorporating preoperative patient variables.

Results: We identified 1238 obese patients (3.7%) and 31,983 nonobese patients (96.3%) undergoing lobectomy for cancer. In regard to patient demographics, obese patients were younger (mean age, 64.8 vs 66.7, $P < .001$) and predominantly female (59.5% vs 50.0%, $P < .001$) compared with nonobese patients. After matching based on propensity scores, except for a greater incidence of pulmonary insufficiency ($P = .03$) and pneumonia ($P = .01$) in the obese group, there were no differences in postoperative complications. By controlling for patient demographics, obese patients had higher odds to be discharged to an institutional care facility (odds ratio, 1.21; $P = .02$) but not for prolonged hospital length of stay or perioperative death.

Conclusions: Obese patients have an increased risk for postoperative pulmonary complications but not other morbidity, mortality, or prolonged hospital length of stay after lobectomy for cancer. Obesity should not be considered a surgical risk factor for pulmonary resection. (J Thorac Cardiovasc Surg 2013;145:1312-8)

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Obesity in the United States has increased from an incidence of 15% in 1980 to more than 35% in 2010, with more than 65% of US residents currently overweight or obese.^{1,2} Obesity may pose risks to surgery that are not present in the nonobese population. Medical conditions associated with obesity, such as hypoventilation syndromes, cardiac arrhythmias, wound healing complications, and proinflammatory states, cause clinicians to be hesitant to proceed with surgery as a means of complex cancer treatment.^{3,4} Previous studies report an

increase in postoperative morbidity in the obese patient after nonbariatric surgery, although not perioperative or 30-day mortality.^{5,6}

The impact of obesity on general thoracic surgery outcomes is unclear. Single institution studies suggest that obesity may not be a risk factor for pulmonary lobectomy and esophagectomy for postoperative complications and mortality.^{7,8} We queried the Healthcare Cost and Utilization Project Nationwide Inpatient Sample (HCUP-NIS) database and used a propensity score (PS) matched analysis to compare perioperative mortality and morbidity rates between nonobese and obese patients undergoing pulmonary lobectomy for lung cancer. In addition, we compared the incidence of discharge to an institutional care facility (ICF) and rate of prolonged length of stay (PLOS).

MATERIALS AND METHODS

Database

This is a retrospective cohort analysis of hospital discharge data for the years 2002 to 2007, from the HCUP-NIS. The HCUP-NIS is the largest all-payer inpatient care database in the United States. HCUP-NIS is an approximate 20% stratification of US hospitals representing 44 states, 1050 hospitals, and approximately 8 million hospital stays.⁹ This project was approved by the institutional review board of the University of California, Davis Medical Center.

Patient Selection and Search Criteria

Patients were identified by procedure codes, and preoperative and postoperative morbidity were identified by disease codes. All procedure and

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Abbreviations and Acronyms

BMI	= body mass index
CHF	= congestive heart failure
CI	= confidence interval
HCUP-NIS	= Healthcare Cost and Utilization Project Nationwide Inpatient Sample
ICD-9-CM	= International Classification of Diseases, 9th edition, Clinical Modification
ICF	= institutional care facility
OR	= odds ratio
PLOS	= prolonged length of stay
PS	= propensity score

disease codes were based on the International Classification of Diseases, 9th edition, Clinical Modification (ICD-9-CM) Volume 3. The overall study population included patients who received pulmonary lobectomy (ICD-9-CM codes 32.40, 32.41, and 32.49) for the primary diagnosis of lung cancer (ICD-9-CM codes 162.0-162.9, 197.0-197.3). From this population, patients were divided into 2 cohorts on the basis of body mass index (BMI): nonobese (BMI < 30 kg/m²) and obese (BMI ≥ 30 kg/m²).

Patient and Hospital Demographics and Perioperative Outcomes

Patient demographics studied included age, sex, race, primary mode of payment, and preoperative comorbidities. Preoperative comorbidities measured were diabetes mellitus, hypertension, coronary artery disease, congestive heart failure (CHF), peripheral vascular disease, chronic obstructive pulmonary disease, gastroesophageal esophageal reflux disease, and chronic kidney disease. The hospital demographic measured was hospital type (ie, rural, urban nonteaching and urban teaching). Perioperative outcomes measured included occurrence of PLOS as defined by hospital stay more than 14 days, discharge disposition (routine to home, ICF, or death at the time of discharge), and postoperative morbidity. Postoperative morbidity included cardiac complications, respiratory complications, nervous system complications, renal complications, gastrointestinal complications, vascular complications, surgical wound complications, and other. A list of ICD-9-CM codes for all measured pre- and postoperative comorbidities is found in [Appendix 1](#). For the majority of the preoperative comorbidity ICD-9-CM codes analyzed, their listing for a patient discharge is most likely preprocedure; thus, it is impossible to know definitively on the basis of the deidentified design of the NIS database.

Statistical Analysis

Differences in the distribution of patient disposition/outcome (routine [to home], discharged to ICF, or died), patient demographics (including age, sex, race, primary expected payer, and hospital type), and pre- and postoperative comorbidities were evaluated using the *t* test for continuous variables and chi-square test for proportions. The primary analyses examine the association between obesity status and likelihood of discharge to an ICF, mortality, and PLOS. For this purpose, the PS method was used to obtain matched sets of nonobese patients to each obese patient on the basis of PS matching. For this study, the PS is the probability of being obese as a function of preoperative patient variables, and the estimated PS was obtained using logistic regression.^{10,11} The PS-matched sets were then used in logistic regression models to evaluate the likelihood (odds) of discharge to ICF (relative to routine). Likewise, logistic regression was used to evaluate the odds of dying. For PLOS, which potentially depends on patient

disposition/outcome (routine, discharged to ICF, or died), logistic regression models were considered for data stratified by patient disposition. All analyses were performed using SAS 9.2 (SAS Institute Inc, Cary, NC). All *P* values reported are for 2-sided tests.

RESULTS

Patient Demographics

The study cohorts consisted of 1238 obese patients (3.7%) and 31,983 nonobese patients (96.3%) ([Table 1](#)). From 2002 to 2007, there was a 32.7% increase in the number of obese patients undergoing lobectomy for lung cancer, with obese patients accounting for 2.8% of total lobectomies in 2002 to 4.6% in 2007. Obese and nonobese patients both demonstrated a similar mean age (64.8 vs 66.7 years) and predominantly white race (85.0% vs 86.5%). A higher percentage of obese patients were female than nonobese patients (59.5% vs 50.0%, *P* < .001). The majority of all patients had Medicare/Medicaid as the primary expected payer, with nonobese patients exhibiting a higher predilection toward Medicare/Medicaid compared with obese patients (62.9% vs 58.8%, *P* = .006). A higher number of nonobese patients had their surgery performed at urban teaching hospitals (55.2% vs 50.3%, *P* = .002). Obese patients had more preoperative comorbidities ([Table 1](#)). Obese patients had higher rates of diabetes mellitus, hypertension, coronary artery disease, CHF, and gastroesophageal esophageal reflux disease (all *P* ≤ .003).

Perioperative Outcomes

On the basis of the cohort of PS-matched sets, there were more obese patients (31.0%) than nonobese patients (26.7%) discharged to an ICF and higher perioperative mortality in the nonobese group compared with the obese cohort (2% vs 1.2%; [Table 2](#)). PLOS was more common among nonobese patients (8.6%) relative to obese patients (6.4%; *P* = .01). There was no difference in postoperative morbidity among obese and nonobese patients except for pulmonary insufficiency and pneumonia, which were more prevalent in the obese cohort (9.5% vs 7.7%, *P* = .03 and 19.7% vs 16.7%, *P* = .01, respectively; [Table 2](#)).

Odds of Discharge to an Institutional Care Facility, Perioperative Mortality, and Prolonged Length of Stay

On the basis of PS-matched sets, we examined the likelihood (odds) of patients being discharged to an ICF relative to routine discharge to home among obese and nonobese patients, adjusted for patient demographics (including age, sex, race, primary expected payer, and hospital type) and pre- and postoperative morbidities ([Table 3](#)). Obese patients were more likely to be discharged to an ICF odds ratio [OR], 1.21 (95% confidence interval [CI], 1.03-1.43; *P* = .02). Increasing age, female sex, and black race were associated with increased odds of discharge to an ICF. The odds of

TABLE 1. Patient demographics

Variable	Obese (n = 1238)		Nonobese (n = 31,983)		P value
	Count	%	Count	%	
Age, mean (SD)	64.8 (9.9)		66.7 (10.5)		<.001
Sex					
Male	501	40.5	15,965	50.0	<.001
Female	737	59.5	15,987	50.0	
Race					
White	801	85.0	20,604	86.5	.128
Black	76	8.1	1528	6.4	
Other	65	6.9	1698	7.1	
Type of hospital					
Rural	60	4.8	1847	5.8	.002
Urban nonteaching	555	44.8	12,478	39.0	
Urban teaching	623	50.3	17,658	55.2	
Primary expected payer					
Medicare/Medicaid	727	58.8	20,101	62.9	.006
Private/HMO	467	37.8	10,714	33.5	
Self	23	1.9	463	1.4	
Other	20	1.6	677	2.1	
Preoperative morbidity	Obese (n = 1238)		Nonobese (n = 31,983)		P value
	Count	%	Count	%	
Diabetes mellitus	31	2.5	233	0.7	<.001
Hypertension	809	65.3	14,305	44.7	<.001
Coronary artery disease	243	19.6	5084	15.9	.001
CHF	76	6.1	1388	4.3	.003
PVD unspecified	34	2.7	1161	3.6	.101
COPD	488	39.4	12,261	38.3	.442
GERD	223	18.0	4080	12.8	<.001
Chronic kidney disease	16	1.3	311	1.0	.236

SD, Standard deviation; HMO, Health Maintenance Organization; CHF, congestive heart failure; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; GERD, gastroesophageal reflux disease.

discharge to an ICF for patients with private/Health Maintenance Organization and self-pay primary expected payer type were lower compared with Medicare/Medicaid. Except for pneumonia and gastrointestinal complications, all other postoperative morbidities were significantly associated with increased odds of discharge to an ICF.

Likewise, on the basis of PS-matched data, we assessed the likelihood of perioperative death among obese and nonobese patients, adjusted for patient demographics and pre- and postoperative morbidities (Table 4). Obesity status was not associated with perioperative death (OR, 0.63; 95% CI, 0.33-1.18; $P = .15$). Other factors predictive of reduced likelihood of perioperative mortality include decreasing age and urban hospital (both teaching and nonteaching) relative to rural hospital (all $P \leq .03$). Preoperative CHF was associated with increased odds of death (OR, 1.96; 95% CI, 1.06-3.61;

TABLE 2. Perioperative/postoperative events (for propensity score matched sets data)

Variable	Obese (n = 1238)		Nonobese (n = 6179)		P value
	Count	%	Count	%	
Disposition					
Routine	839	67.8	4396	71.2	.003
ICF	383	31.0	1650	26.7	
Died	15	1.2	124	2.0	
Prolonged LOS*	79	6.4	529	8.6	.011
Postoperative morbidity					
Acute MI	1	0.1	13	0.2	.338
Atrial fibrillation/flutter	189	15.3	906	14.7	.585
Other cardiac complications	56	4.5	285	4.6	.891
Pulmonary embolus	4	0.3	17	0.3	.772
Pulmonary insufficiency	118	9.5	476	7.7	.031
Pneumonia	244	19.7	1034	16.7	.011
Other respiratory complications	79	6.4	331	5.4	.150
Stroke	1	0.1	17	0.3	.205
Other nervous system complications	1	0.1	4	0.1	.843
ARF	26	2.1	125	2.0	.861
UTI	37	3.0	133	2.2	.073
Other renal complications	11	0.9	61	1.0	.747
GI complications	24	1.9	112	1.8	.763
Venous DVT lower extremity	1	0.1	10	0.2	.499
Other vascular complications	1	0.1	6	0.1	.864
Infectious complications	5	0.4	29	0.5	.756

ICF, Institutional care facility; LOS, length of stay; MI, myocardial infarction; ARF, acute renal failure; UTI, urinary tract infection; GI, gastrointestinal; DVT, deep venous thrombosis. *PLOS if more than 14 days.

$P = .03$) and preoperative coronary artery disease (OR, 1.98; 95% CI, 1.22-3.24; $P < .01$). Only the postoperative morbidities pulmonary insufficiency and renal complications were significantly associated with increased odds of death.

Likewise, we examined the likelihood of PLOS between obese and nonobese groups among patients with routine disposition. The models were adjusted for important relevant confounders as described previously. The results are summarized in Table 5. In the cohort of patients with routine disposition, the odds of PLOS were not different between the groups of obese and nonobese patients (OR, 0.79; 95% CI, 0.50-1.22; $P = .28$; Table 5). As expected, all postoperative morbidities were associated with increased odds of PLOS (all $P < .05$), except for other cardiac complications ($P = .43$) and gastrointestinal complications ($P = .50$). Among preoperative comorbidities, chronic

TABLE 3. Predictors of discharge to an institutional care facility (for propensity score matched sets data)

Variable	OR	95% CI	P value
Obese	1.214	1.033-1.426	.018
Age	1.048	1.039-1.057	<.001
Sex	1.515	1.328-1.729	<.001
Race, black	1.281	1.019-1.61	.034
Race, other	0.815	0.630-1.055	.121
Hospital type, urban nonteaching	0.973	0.730-1.297	.853
Hospital type, urban teaching	0.850	0.640-1.128	.260
Primary expected payer, private/HMO, Medicare/Medicaid	0.707	0.600-0.833	<.001
Primary expected payer, self	0.451	0.251-0.811	.008
Primary expected payer, other	0.668	0.402-1.110	.120
Preoperative morbidity			
Hypertension	0.969	0.845-1.112	.656
Coronary artery disease	1.134	0.967-1.329	.122
CHF	1.698	1.267-2.275	<.001
PVD unspecified	1.051	0.694-1.59	.815
COPD	1.221	1.075-1.387	.002
GERD	1.051	0.895-1.233	.547
Other (diabetes, CKD)	1.573	1.136-2.178	.006
Postoperative morbidity			
Atrial fibrillation/flutter	1.292	1.074-1.554	.007
Other cardiac complications*	1.351	1.000-1.825	.050
Pulmonary insufficiency	1.804	1.421-2.289	<.001
Pneumonia	1.151	0.958-1.383	.132
Other respiratory complications†	1.451	1.088-1.934	.011
Renal complications (other, UTI, ARF)	1.885	1.421-2.501	<.001
GI complications	1.453	0.930-2.268	.101
Other complications‡	2.191	1.180-4.069	.013

OR, Odds ratio; CI, confidence interval; HMO, Health Maintenance Organization; CHF, congestive heart failure; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; GERD, gastroesophageal reflux disease; CKD, chronic kidney disease; UTI, urinary tract infection; ARF, acute renal failure; GI, gastrointestinal. *Includes 56 acute myocardial infarctions. †Includes 123 pulmonary emboli. ‡Includes stroke, nervous system other, vascular complication other, deep venous thrombosis lower extremity, and infectious complication.

obstructive pulmonary disease was associated with increased likelihood of PLOS ($P < .05$).

DISCUSSION

Obesity intuitively would seem to be an independent risk factor for major surgery. Hypoventilation syndromes, cardiac arrhythmias, wound-healing complications, and proinflammatory states are common in the obese patient populations,^{3,4} but other metabolic abnormalities also are prevalent, such as deficiencies in protein synthesis efficiency and elevated muscle catabolism in response to trauma.¹¹ In the trauma population, obese patients exhibit a higher risk of mortality and morbidity compared with nonobese patients.^{12,13} Although most nonbariatric general surgical studies examining the impact of obesity on perioperative outcome demonstrate an increased risk for morbidity, including atrial fibrillation, surgical site infection, and embolism, there are few data to support an increase in mortality.^{5,6}

TABLE 4. Predictors of mortality (for propensity score matched sets data)

Variable	OR	95% CI	P value
Obese	0.627	0.333-1.180	.148
Age	1.034	1.004-1.066	.028
Sex	1.041	0.660-1.640	.864
Race, black	1.394	0.656-2.963	.388
Race, other	1.574	0.734-3.372	.244
Hospital type, urban nonteaching	0.408	0.183-0.910	.028
Hospital type, urban teaching	0.296	0.131-0.670	.004
Primary expected payer, private/HMO, Medicare/Medicaid	0.811	0.426-1.546	.525
Primary expected payer, self	1.443	0.349-5.960	.612
Primary expected payer, other	1.516	0.338-6.800	.587
Preoperative morbidity			
Hypertension	0.784	0.495-1.241	.299
Coronary artery disease	1.984	1.215-3.240	.006
CHF	1.958	1.063-3.607	.031
PVD unspecified	1.913	0.634-5.770	.250
COPD	0.953	0.609-1.492	.834
GERD	0.813	0.404-1.637	.562
Other (diabetes, CKD)	0.902	0.335-2.433	.839
Postoperative morbidity			
Atrial fibrillation/flutter	1.002	0.580-1.732	.993
Other cardiac complications*	1.843	0.865-3.929	.113
Pulmonary insufficiency	13.087	7.993-21.427	<.001
Pneumonia	1.032	0.608-1.753	.906
Other respiratory complications†	1.632	0.830-3.209	.156
Renal complications (other, UTI, ARF)	3.688	2.110-6.445	<.001
GI complications	0.344	0.072-1.64	.181
Other complications‡	2.838	0.959-8.404	.060

OR, Odds ratio; CI, confidence interval; HMO, Health Maintenance Organization; CHF, congestive heart failure; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; GERD, gastroesophageal reflux disease; CKD, chronic kidney disease; UTI, urinary tract infection; ARF, acute renal failure; GI, gastrointestinal. *Includes 56 acute myocardial infarctions. †Includes 123 pulmonary emboli. ‡Includes stroke, nervous system other, vascular complication other, deep venous thrombosis lower extremity, and infectious complication.

The cardiothoracic surgical literature demonstrates mixed results. Although there are few data to support obesity as an independent risk factor for perioperative mortality, Zacharias and colleagues¹⁴ demonstrated an increased risk of atrial fibrillation in obese patients undergoing coronary artery bypass grafting. Kuduvali et al¹⁵ found an increased risk of perioperative arrhythmia, sternal wound infections, and longer hospital stay in obese patients undergoing coronary artery bypass grafting. In regard to general thoracic surgery, Scipione et al⁸ retrospectively reviewed more than 2000 patients undergoing transhiatal esophagectomy, of whom 133 were profoundly obese (BMI ≥ 35 kg/m²), and found no difference in mortality, morbidity (except recurrent laryngeal nerve injury, which was higher in the obese group), hospital length of stay, or intensive care unit stay. For pulmonary resection, Smith et al⁷ found no difference in perioperative mortality or morbidity in 127

TABLE 5. Predictors of prolonged length of stay (for propensity score matched sets data)

Variable	OR	95% CI	P value
Obese	0.787	0.509-1.218	.283
Age	0.974	0.957-0.992	.004
Sex	0.891	0.649-1.222	.473
Race, black	1.393	0.848-2.290	.191
Race, other	0.593	0.300-1.170	.132
Hospital type, urban nonteaching	0.973	0.483-1.962	.940
Hospital type, urban teaching	0.799	0.399-1.601	.527
Primary expected payer, private/HMO, Medicare/Medicaid	0.586	0.407-0.844	.004
Primary expected payer, self	0.415	0.123-1.405	.158
Primary expected payer, other	0.518	0.155-1.732	.286
Preoperative morbidity			
Hypertension	0.670	0.487-0.921	.014
Coronary artery disease	0.731	0.471-1.133	.161
Heart failure	1.037	0.475-2.264	.927
PVD unspecified	0.970	0.332-2.837	.956
COPD	1.374	1.003-1.881	.048
GERD	0.613	0.376-1.001	.050
Other (diabetes, CKD)	1.413	0.625-3.193	.407
Postoperative morbidity			
Atrial fibrillation/flutter	1.591	1.014-2.497	.044
Other cardiac complications*	1.320	0.663-2.626	.429
Pulmonary insufficiency	3.701	2.375-5.766	<.001
Pneumonia	1.815	1.235-2.666	.002
Other respiratory complications†	1.823	1.043-3.187	.035
Renal complications (other, UTI, ARF)	1.978	1.055-3.710	.034
GI complications	1.401	0.526-3.726	.500
Other complications‡	10.007	3.779-26.499	<.001

OR, Odds ratio; CI, confidence interval; HMO, Health Maintenance Organization; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; GERD, gastroesophageal reflux disease; CKD, chronic kidney disease; UTI, urinary tract infection; ARF, acute renal failure; GI, gastrointestinal. *Includes 56 acute myocardial infarctions. †Includes 123 pulmonary emboli. ‡Includes stroke, nervous system other, vascular complication other, deep venous thrombosis lower extremity, and infectious complication.

obese patients compared with 372 nonobese patients. By reviewing 154 patients undergoing pneumonectomy, Petrella et al¹⁶ found that obese patients (defined as BMI ≥ 25 kg/m², n = 93) have a 5-fold increase in respiratory complications.¹⁵

Our data, a national retrospective review of perioperative outcomes of 1238 obese and 31,983 nonobese patients undergoing lobectomy for cancer, found similar results to those of previous smaller single institution studies. We found that despite having fewer preoperative comorbidities and a higher predilection toward having their surgery performed at academic teaching hospitals, nonobese patients demonstrated higher perioperative mortality than obese patients and a higher incidence of PLOS. We found no difference in perioperative morbidity, including wound infections and deep venous thrombosis, but obese patients exhibited a higher incidence of respiratory complications compared with

matched nonobese patients. Contrary to the adult cardiac surgery literature,^{14,15} obese patients did not have an increase in incidence of atrial fibrillation/flutter compared with nonobese patients. In our study, obese patients demonstrated a higher propensity to be discharged to an ICF compared with nonobese patients. Obesity was in fact an independent risk factor for discharge to an ICF. This may explain the decreased incidence of PLOS in the obese population.

There are limitations to our analysis. The results of this study would suggest an obesity protection paradox; however, the obese patients may have been a highly selected group. HCUP-NIS does not provide cancer stage information or pulmonary function results, such as diffusion capacity for the lungs for carbon monoxide or forced expiratory volume in 1 second. There may have been stage inequities between groups, and the obese patients may have been selected for optimal lung function above recommended guidelines. Also, during the study period, there was no ICD-9-CM code for video-assisted thoracoscopic lobectomy used by the database; therefore it would be impossible to determine whether the obese cohort had a higher incidence of video-assisted thoracoscopic lobectomy, which has been shown to result in diminished perioperative complications.^{17,18} Obesity is defined as BMI 30 kg/m² or greater; however, other reports suggest that BMI may not be the most accurate measurement of obesity-related perioperative risk. Computed tomography quantitative measurement of visceral adiposity may identify at-risk populations independently of BMI.^{19,20}

CONCLUSIONS

Despite having more preoperative comorbidities and a higher predilection to undergoing surgery at nonteaching hospitals compared with nonobese patients, outside of pulmonary complications, obese patients do not have an increased risk for postoperative morbidity, mortality, or PLOS after lobectomy for cancer. Obese patients undergoing lobectomy for cancer do have an independent increased odds of being discharged to an ICF rather than to home. Obesity should not be considered a prohibitive surgical risk factor for pulmonary resection. Therefore, obese patients should undergo surgical standard of care therapy for appropriately stage-specific lung cancer. However, given the independent increased risk of postoperative pulmonary insufficiency and pneumonia in obese patients, attention should be given to aggressive prophylactic respiratory therapy in the perioperative period.

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APPENDIX 1. International Classification of Diseases, 9th edition, Clinical Modification codes

Preoperative Morbidity

- 25001 Diabetes mellitus
- 25002 Diabetes mellitus
- 25003 Diabetes mellitus
- 4010 Hypertension
- 4011 Hypertension
- 4019 Hypertension
- 41400 Coronary artery disease
- 41401 Coronary artery disease
- 4280 Heart failure
- 4289 Heart failure
- 4439 Peripheral vascular disease, unspecified
- 496 COPD (COPD/emphysema)
- 4928 Emphysema (COPD/emphysema)
- 53081 Esophageal reflux
- 5851 Chronic kidney disease
- 5852 Chronic kidney disease

(Continued)

APPENDIX 1. Continued

- 5853 Chronic kidney disease
- 5854 Chronic kidney disease
- 5855 Chronic kidney disease
- 5856 Chronic kidney disease
- 5859 Chronic kidney disease

Postoperative Morbidity

Cardiac complications

- 9971 Cardiac complications
- 4100 Acute MI
- 4101 Acute MI
- 4102 Acute MI
- 4103 Acute MI
- 4104 Acute MI
- 4105 Acute MI
- 4106 Acute MI
- 4107 Acute MI
- 4108 Acute MI
- 4109 Acute MI
- 42731 Atrial fibrillation (Afib/flutter)
- 42732 Atrial flutter (Afib/flutter)

Respiratory Complications

- 9973 Respiratory complications (respiratory complications other)
- 99739 Other respiratory complications (other)
- 41510 PE and infarction (pulmonary embolus)
- 41511 Iatrogenic PE and infarction (pulmonary embolus)
- 51881 Acute respiratory failure (pulmonary insufficiency)
- 51882 Other pulmonary insufficiency (pulmonary insufficiency)
- 51884 Acute on chronic respiratory failure (pulmonary insufficiency)
- 5184 Acute edema of lung, unspecified (pulmonary insufficiency)
- 5185 Pulmonary insufficiency after trauma and surgery (pulmonary insufficiency)
- 485 Pneumonia
- 486 Pneumonia
- 4820 Pneumonia
- 4821 Pneumonia
- 4822 Pneumonia
- 48230 Pneumonia
- 48231 Pneumonia
- 48232 Pneumonia
- 48239 Pneumonia
- 48240 Pneumonia
- 48241 Pneumonia
- 48242 Pneumonia
- 48249 Pneumonia
- 48281 Pneumonia
- 48282 Pneumonia
- 48283 Pneumonia
- 48289 Pneumonia
- 4829 Pneumonia
- 5180 Atelectasis

Nervous System Complications

- 99700 Nervous system complications unspecified (nervous system other)
- 99701 Central nervous system complication (other)
- 99702 Iatrogenic cerebrovascular infarction or hemorrhage (stroke)
- 99709 Other nervous system complications (other)

(Continued)

APPENDIX 1. Continued

Renal Complications

9975 Urinary complications (renal complications other)

5845 ARF

5846 ARF

5847 ARF

5849 ARF

5990 UTI

GI Complications

9974 Digestive system complications (GI complications other)

5601 Paralytic ileus

Vascular Complications

9972 Peripheral vascular complications (vascular complications other)

45340 Venous DVT lower extremity

45341 Venous DVT lower extremity

45342 Venous DVT lower extremity

Other Infectious Complications

99851 Infected postoperative seroma

99859 Other postoperative infection

Wound

99883 Nonhealing surgical wound

Other

9989 Complications affecting other specified body systems, not elsewhere classified

COPD, Chronic obstructive pulmonary disease; *MI*, myocardial infarction; *Afib*, atrial fibrillation; *PE*, pulmonary embolism; *ARF*, acute renal failure; *UTI*, urinary tract infection; *GI*, gastrointestinal; *DVT*, deep vein thrombosis.