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Factors associated with outcomes and inpatient 90-day cost of care in endometrial cancer patients undergoing hysterectomy - implications for bundled care payments

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HIGHLIGHTS

- Obesity is associated with higher complication rates after hysterectomy for endometrial cancer.
- Obese patients had higher rates of medical but not surgical complications compared to non-obese patients.
- Obesity is associated with higher cost of hysterectomy for endometrial cancer.
- Route of surgery and the number of co-morbidities is significantly associated with cost of hysterectomy.
- Bundle payment models should take into account all of these factors for accurate risk-adjustment.

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ABSTRACT

Objective. To investigate the association of obesity and other comorbidities as well as route of surgery with postoperative outcomes, as well as 30- and 90-day inpatient cost of care after hysterectomy for endometrial cancer.

Methods. From the 2013 National Readmission Database release, patients who underwent hysterectomy for endometrial cancer were included. Obesity was classified as non-obese (body mass index [BMI] < 35 kg/m^2); class I/II obesity (BMI ≥ 35 but <40 kg/m^2 and without obesity related medical condition qualifying it as morbid obesity), class III obesity (BMI ≥ 40 kg/m^2 OR BMI ≥ 35 kg/m^2 with an obesity-related medical condition). Incremental cost at 30 and 90 days was calculated using cost-to-charge ratio.

Results. A total of 27,658 patients were identified. Compared to non-obese patients those with class III obesity had higher rate of any medical (non-surgical) complication (22.3% vs 17.2%, $p = 0.004$), and higher rate of 30-day readmission (6% vs 4.4%, $p = 0.003$), but similar rates of surgical complications. There were no significant differences in perioperative outcomes between non-obese patients and those with class I/II obesity. Non-obese patients had higher rates of traditional laparoscopy (8.4% vs 13.6%, $p < 0.001$) and lower conversion rates from a minimally invasive to abdominal (5.5% vs. 8.2%, $p < 0.001$) than those with class III obesity. Based on multivariate regression model compared to non-obese patients, class I/II obesity (OR 1.05, 95% CI 1.02–1.09) and class III obesity (OR 1.1, 95% CI 1.1–1.18) were associated with higher cost of care. Other factors increasing cost of care included: comorbidity score per unit increase (OR 1.08, 95% 1.07–1.08), insurance status and route of surgery.

Conclusions. Class III obesity was associated with higher medical (but not surgical) complication rates as well as increased overall inpatient care cost when compared to the non-obese population. Number of comorbidities significantly impacted the cost and outcomes after hysterectomy. As more healthcare initiatives focus on bundled payments, our results suggest that payment packages should adjust for obesity rates and medical comorbidities stratified by region and hospital type in order to fairly compensate for increased costs of care.

1. Introduction

Obesity is associated with higher healthcare costs and increased surgical complexity [1,2]. As of 2014, more than one-third of adults in the United States were obese and the general medical cost for patients with obesity was estimated to be $1429 higher per year than for non-

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obese patients [3]. For surgical patients with obesity, there is an increased hospital cost at the time of surgery (as compared to patients without obesity), reduced utilization of minimally invasive surgical techniques, increased length of stay, increased number of diagnostic/therapeutic procedures in the postoperative period, and increased requirement for intensive care for mechanical ventilation [1,2,4]. While the cost of index hospitalization has been the major metric considered for cost of care analyses, recent changes in the healthcare industry have prompted interest in the utilization of a 90-day cost of care.

Recently, the Centers for Medicare and Medicaid Services (CMS) launched the Bundled Payments for Care Improvement (BPCI) Initiative as a mandatory requirement for select surgical procedures [5]. Participating hospitals will receive total episode payments for surgical procedures (for the hospitalization and Medicare-covered services during the 90 days after discharge). Such implementation of bundled payments is currently not in place for hysterectomy or for patients with endometrial cancer. However, the push for alternative payment models is likely to bring such payment reforms to the care of patients with endometrial cancer [6].

We therefore investigated the association of obesity, in addition to other factors, with the variation in cost of hysterectomy in endometrial cancer patients. We also investigated the association of obesity with postoperative outcomes (surgical and medical) after hysterectomy for endometrial cancer. We hypothesized that obesity is independently associated with a higher rate of complications, as well as with increased inpatient cost of care, not only during the index hospitalization, but also within the 90-day time frame after surgery—possibly due to a higher readmission rate in this patient population.

2. Materials and methods

2.1. Data sources

The National Readmission Database (NRD) from the Healthcare Cost and Utilization Project (HCUP) was utilized for this cross-sectional database analysis. The NRD is drawn from the HCUP State Inpatient Databases (SID) and is similar to the other HCUP database— the National Inpatient Sample (NIS) [7]. A key difference in the NRD compared to the NIS database is the presence of a unique de-identified and verified patient linkage number. This allows for tracking patients across hospitals within a state and for calculating both readmission statistics and the cost of inpatient care over a 90-day time frame. Each discharge includes up to 15 inpatient diagnostic codes and 15 procedural codes. The first diagnostic code represents the primary reason for admission. All procedures and diagnoses are coded using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). The NRD includes approximately 15 million discharges (unweighted) and 35 million discharges (weighted). Further details of the design of this database are available at the HCUP website [7]. For this analysis, we utilized data from the 2013 release of the NRD database.

2.2. Study population

We identified patients ≥18 years of age with a procedure code for hysterectomy (ICD-9-CM codes are presented in Table 1). Cases with a modifier "V6441" were labelled as converted from laparoscopic, vaginal, or robotic to open surgery. As there is no reliable way of determining whether the case was laparoscopic, robotic, or vaginal, conversion data is presented as combined data. Next, we retained cases with diagnostic codes 182.0, 182.1, and 182.8 to identify women undergoing hysterectomy for endometrial cancer. To facilitate the 90-day cost calculations, patients with a surgery date within 90 days from the end of the year were excluded.

2.3. Independent variables

There are several codes used in the claims data to identify patients with obesity. ICD-9-CM code 278.0 (Obesity, unspecified) is the general code for obesity. The Centers for Disease Control and Prevention (CDC) defines patients with body mass index (BMI) >40 kg/m^2 as having "severe" or "extreme" obesity [8]. This group is also referred to as "morbidly obese." Patients with morbid obesity fall into two categories: 1) Those with a BMI ≥40 kg/m^2; we utilized V85.41 (BMI 40.0–44.9, adult), V85.42 (BMI 45.0–49.9, adult), V85.43 (BMI 50.0–59.9, adult), V85.44 (BMI 60.0–69.9, adult), and V85.45 (BMI 70 and over, adult) codes to identify these patients, and 2) Those with BMI ≥35 kg/m^2 and an obesity-related medical condition; these patients are identified in the claims data with the code 278.01 (Morbid Obesity) and 278.03 (Obesity hypoventilation syndrome). For the remainder of the manuscript, these patients are referred to as "Class III Obesity." Patients with obesity code 278.0 (but none of the codes mentioned above for morbid obesity) are labelled as "Class I/II obesity." The remainder of the patients are labelled as "non-obese."

Table 1
Diagnostic and procedure codes used to identify patients and outcomes.

Condition	ICD-9-CM codes
Hysterectomy procedure codes	
Abdominal Hysterectomy	68.3 68.39 68.4 68.49 68.9 68.69
Vaginal Hysterectomy	68.5 68.59 68.79
Laparoscopic Hysterectomy	68.31 68.41 68.51 68.61 68.71
Robotic Hysterectomy (modifier)	17.x
Lymph node sampling or dissection	40.0 40.1 40.11 40.19 40.2 40.24 40.29 40.3 40.5 40.50 40.52 40.53 40.59 40.9
Converted to open (modifier)	V6441
Diagnostic codes	
Endometrial cancer	182.0, 182.1, 182.8
Obesity	278.0
Class III obesity	278.01278.03 V85.4 V85.41 V85.42 V85.43 V85.44 V85.45
Class I/II obesity	Includes patients with obesity but not morbid obesity codes
Non-obese	No obesity code in the chart

ICD-9-CM: International Classification of Diseases, Ninth Revision, Clinical Modification.

The following patient, perioperative, and hospital-level factors were also included as independent variables: patient age in years (categorized as: <40, 40–49, 50–59, 60–69, 70–79, and ≥ 80); Charlson comorbidity score (0, 1, 2, or 3); insurance type (Medicare, Medicaid, private, uninsured, other/missing); income categories as provided by the National Readmission Database ($1–37,999, $38–47,999, $48–63,999, ≥$64,000); hysterectomy type (abdominal, laparoscopic, vaginal, robotic, converted); lymphadenectomy (performed or not performed); hospital ownership (government, private non-profit, private for-profit); hospital size (small, medium, large); and hospital teaching status (rural, urban non-teaching, urban teaching).

2.4. Outcomes

Population-level proportions of patient demographics and comorbidities by obesity categories were calculated using discharge-level weight provided by the HCUP. We subsequently used Stata version 14 (StataCorp, College Station, TX) postestimation command **"testparam"** to determine if the proportional distribution in each category was statistically significant. Stata postestimation commands perform likelihood ratio tests to determine if the proportions in each category are significantly different. We used this approach, as the use of traditional Chi-Squared test in weighted data violates the assumption that the data are being independently and identically drawn from a distribution [9].

We evaluated several perioperative outcomes for a relationship with the obesity categories. The perioperative outcomes included any surgical complication, any medical complication, any infectious