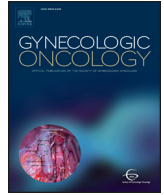




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Impact of body mass index and operative approach on surgical morbidity and costs in women with endometrial carcinoma and hyperplasia

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HIGHLIGHTS

- Morbid obesity led to increased rates of venous thromboembolism and wound infection.
- Laparotomy was associated with higher costs compared to minimally invasive surgery.
- Cost differences between surgical approaches were highest in morbidly obese women.
- Patients who had complications had significantly higher costs than those who did not.

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ABSTRACT

Objective. To assess the impact of body mass index (BMI) and operative approach on surgical morbidity and costs in patients with endometrial carcinoma (EC) and hyperplasia (EH).

Methods. All women with BMI data who underwent surgery for EC or EH from 2008 to 2014 were identified from MarketScan, a healthcare claims database. Differences in 30-day complications and costs were compared between BMI groups and stratified by surgical modality.

Results. Of 1112 patients, 35%, 36%, and 29% had a BMI of ≤ 29 , 30–39, and ≥ 40 kg/m², respectively. Compared to patients with a BMI of 30–39 and ≤ 29 , women with a BMI ≥ 40 had higher rates of venous thromboembolism (3% vs 0.2% vs 0.3%, $p < 0.01$) and wound infection (7% vs 3% vs 3%, $p = 0.02$). This increase was driven by the subset of patients who had laparotomy and was not seen in those undergoing minimally invasive surgery (MIS). Median total costs for women with a BMI ≥ 40 , 30–39, and ≤ 29 were U.S. \$17.3 k, \$16.8 k, and \$16.6 k respectively ($p = 0.53$). Costs were higher for patients who had laparotomy than those who had MIS across all BMI groups, with the cost difference being highest in morbidly obese women (≥ 40 : \$21.6 k vs \$14.9 k, $p < 0.01$; 30–39: \$18.9 k vs \$16.1 k, $p = 0.01$; ≤ 29 : \$19.3 k vs \$15 k, $p < 0.01$). Patients who had complications had higher costs compared to those who did not, with a higher cost difference in the laparotomy group (\$27.7 k vs \$16.4 k, $p < 0.01$) compared to the MIS group (\$19.9 k vs \$15 k, $p < 0.01$).

Conclusions. MIS may increase the value of care by minimizing complications and decreasing costs. This may be most pronounced in morbidly obese women.

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1. Introduction

Endometrial carcinoma is the most common gynecologic malignancy in the United States, with an estimated 60,050 new cases in 2016 [1]. Surgery at diagnosis is the cornerstone of management for women

with suspected early stage disease, and traditionally has consisted of laparotomy to perform a total abdominal hysterectomy and bilateral salpingo-oophorectomy, with or without concurrent lymphadenectomy [2]. Endometrial hyperplasia with atypia is often a precursor to or present concurrently with endometrial carcinoma. For postmenopausal women or premenopausal women who have completed childbearing, it is treated surgically in the same fashion [3]. Minimally invasive surgery (MIS) has steadily been incorporated into the management of endometrial carcinoma and hyperplasia in the last two decades, starting with laparoscopic and then robotic-assisted hysterectomy [4,5]. Compared

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to laparotomy, MIS is associated with improved quality of life parameters and perioperative outcomes, without compromising survival [5–10].

The rates of both obesity and morbid obesity have been steadily increasing in the United States. An estimated 36% of adult women are obese, and 8% are morbidly obese with a body mass index (BMI) ≥ 40 kg/m² [11]. It is established that an unopposed excess of endogenous estrogen from obesity is a significant risk factor for type I endometrial carcinoma and hyperplasia [12]. Obese women not only have increased comorbidity, but also an increased rate of operative complications, all-cause mortality, and worse quality of life outcomes [13,14]. Obesity and morbid obesity in particular are also associated with increased healthcare utilization and higher treatment costs across different disease spectra [15].

In 2014, healthcare costs comprised 17.5% of the gross domestic product (GDP) of the United States. Projections from the Center for Medicare and Medicaid Services estimate that medical costs will reach 20% of GDP by 2024 [16]. As medical costs and the obesity rate continue to climb, it is essential to not only scrutinize the benefit of different treatment approaches but also their costs. Preventing or diminishing perioperative complications in addition to decreasing healthcare costs have become central to efforts in providing value-based care. The American Society of Clinical Oncology (ASCO), through the Value in Cancer Care Task Force, has defined value by emphasizing three critical elements: clinical benefit, complications, and cost [17]. The objective of our study was to evaluate the impact of BMI and operative modality on surgical complications and costs in patients with endometrial carcinoma and hyperplasia in a contemporary period, using a national healthcare claims database.

2. Methods

2.1. Data source

This was a retrospective population-based cohort study using the Truven Health Analytics MarketScan® database, a commercial healthcare claims database. It contains de-identified claims data on 174 million patients in the United States who are enrolled in commercial health insurance plans sponsored by >100 payers. The database includes monthly enrollment data, inpatient admission records, outpatient services, outpatient prescription drug claims, and costs of services, with robust longitudinal follow-up [18]. The core MarketScan commercial dataset was linked to the Truven Health Analytics Health Risk Assessment supplemental database, which includes BMI data. Institutional Review Board approval was obtained. We used a combination of ICD-9 (International Classification of Diseases, 9th Revision) diagnosis codes, CPT (Common Procedural Terminology) codes, and HCPCS (Healthcare Common Procedure Coding System) codes to identify relevant covariates, treatments, and outcomes.

2.2. Cohort selection

We identified a total of 82,809 patients who had a diagnosis of either endometrial carcinoma (ICD-9 code 182.0) or endometrial hyperplasia with atypia (ICD-9 code 621.33) from January 2008 to December 2014. Patients were included if they had 2 inpatient diagnoses claims for those conditions or at least 2 outpatient diagnosis claims that were >30 days apart. BMI was first available through the Health Risk Assessment supplemental database in 2008. We sequentially excluded 28,888 patients who did not undergo hysterectomy, 48,367 patients who did not have BMI data \pm one year from the surgery date, 22 patients who had a diagnosis of 'history of endometrial carcinoma or hyperplasia', and 148 patients who did not have continuous insurance coverage for 3 months after surgery. The final study population consisted of 1112 patients who had a hysterectomy for endometrial carcinoma or hyperplasia and had BMI data. The cohort was divided into 3 BMI groups:

≤ 29 kg/m² (normal/overweight), 30–39 kg/m² (obese), and ≥ 40 kg/m² (morbidly obese).

2.3. Covariates and outcomes

Patient-level variables collected included age at diagnosis (grouped as <40, 40–49, 50–59, ≥ 60 years), surgery year, region of treatment (northeast, north central, south, west), and insurance type (health maintenance organization, preferred provider organization, other). We used the Klabunde modification of the Charlson comorbidity index to assess patient comorbidity [19]. To prevent over-estimation, a patient's comorbidity diagnosis had to appear on at least two different claims that were >30 days apart. Patients were categorized as having had open abdominal surgery or MIS. Patients who had laparoscopic, robotic-assisted, or vaginal hysterectomy comprised the MIS group. The performance of concurrent pelvic and/or para-aortic lymphadenectomy

Table 1
Patient demographics (N = 1112).

Characteristic	Total n = 1112 n (%)	Body mass index (Kg/m ²)			p
		≤ 29 n = 385 n (%)	30–39 n = 406 n (%)	≥ 40 n = 321 n (%)	
Diagnosis					
Endometrial cancer	965 (87%)	344 (89%)	349 (86%)	272 (85%)	0.16
Endometrial hyperplasia	147 (13%)	41 (11%)	57 (14%)	49 (15%)	
Age at diagnosis (years)					
< 40	238 (21%)	80 (21%)	75 (19%)	83 (26%)	0.005
40–49	566 (51%)	205 (53%)	199 (49%)	162 (51%)	
50–59	246 (22%)	85 (22%)	109 (27%)	52 (16%)	
≥ 60	62 (6%)	15 (4%)	23 (6%)	24 (7%)	
Charlson comorbidity index ^a					
0	862 (82%)	340 (92%)	312 (81%)	210 (70%)	<0.001
1	162 (15%)	24 (7%)	60 (16%)	78 (26%)	
≥ 2	31 (3%)	5 (1%)	13 (3%)	13 (4%)	
Surgery year					
2008	35 (3%)	9 (2%)	15 (4%)	11 (3%)	0.35
2009	124 (11%)	53 (14%)	44 (11%)	27 (8%)	
2010	159 (14%)	57 (15%)	55 (14%)	47 (15%)	
2011	200 (18%)	68 (18%)	69 (17%)	63 (20%)	
2012	240 (22%)	79 (20%)	87 (21%)	74 (23%)	
2013	262 (24%)	97 (25%)	94 (23%)	71 (22%)	
2014	92 (8%)	22 (6%)	42 (10%)	28 (9%)	
Region of treatment					
Northeast	183 (16%)	72 (19%)	70 (17%)	41 (13%)	0.13
North central	354 (32%)	119 (31%)	120 (30%)	115 (36%)	
South	433 (39%)	138 (36%)	170 (42%)	125 (39%)	
West	140 (13%)	55 (14%)	45 (11%)	40 (12%)	
Insurance					
HMO	181 (16%)	66 (17%)	63 (15%)	52 (16%)	0.72
PPO	610 (55%)	200 (52%)	230 (57%)	180 (56%)	
Other	321 (29%)	119 (31%)	113 (28%)	89 (28%)	
Surgery					
Open abdominal	441 (40%)	156 (41%)	156 (38%)	129 (40%)	0.81
Minimally invasive	671 (60%)	229 (59%)	250 (62%)	192 (60%)	
Lymphadenectomy					
Yes	564 (51%)	225 (58%)	200 (49%)	139 (43%)	<0.001
No	548 (49%)	160 (42%)	206 (51%)	182 (57%)	

HMO, health maintenance organization; PPO, preferred provider organization.

^a Data missing for 57 patients.

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