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Original Article

Effects of obesity and hysterectomy approach on the surgical management of uterine malignancy

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Abstract: The impact of obesity on surgical outcomes in endometrial cancer patients has been well studied; however, the economic burden attributable to obesity in these patients has not yet been reported. In this study, we sought to compare direct hospital costs for obese and non-obese women undergoing surgical treatment of uterine malignancy (UM). The University HealthSystem Consortium database was queried to identify women with a diagnosis of UM, with and without obesity, who underwent open, laparoscopic, or robotic hysterectomy during the study period (2009-2013). Mean direct hospital costs were compared by hysterectomy approach between obese and non-obese cohorts. 25,263 patients were included; 8,407 (33%) were coded as obese. Of hysterectomies performed on obese women, 55% were open, 9% were laparoscopic, and 36% were robotic. Of hysterectomies performed on non-obese women, 52% were open, 15% were laparoscopic, and 33% were robotic. Frequencies of hysterectomy methods were significantly different ($P < .0001$) between the obese and non-obese cohorts. Mean direct hospital costs were significantly greater for obese compared with non-obese women regardless of hysterectomy approach: open 17% higher ($12,021 v $10,249; $P < .0001$), robotic 15% higher ($10,180 v $8,868; $p < .0001$), and laparoscopic 17% higher ($8,532 v $7,290; $P < .0001$). In both obese and non-obese cohorts, minimally invasive approaches cost less than open surgery ($P < .05$). Our results demonstrate that obesity is associated with higher costs of surgical treatment of UM. With the advent of novel payment models, including bundled payments, cost control is of major concern. Weight management and minimally invasive surgery warrant consideration as components of strategies for cost-effective management of UM. Additionally, the high rate of open surgeries performed in our study deserves further investigation. Previous data have consistently demonstrated decreased perioperative morbidity using minimally invasive approaches compared with open procedures. We conclude that minimally invasive approaches are uniformly less costly than open surgery and that this finding further supports their use when feasible.

Keywords: Cost, hysterectomy, obesity, uterine cancer

Introduction

Obesity in the United States is a serious public health epidemic affecting over one-third of the population [1]. While prevalence rates of moderate obesity (BMI 30-35) appear to be stabilizing, clinically severe or morbid obesity (BMI > 40) prevalence continues to escalate rapidly [2]. In addition to the clinical impact of being linked with numerous other medical comorbidities including hypertension, diabetes, dyslipidemia, cardiovascular disease, and several cancer types, obesity is also associated with increased healthcare costs. Several studies have demonstrated that obesity confers a significant economic burden on the healthcare system due to associated obesity-related medical comorbidities [3-6]. Finkelstein and co-workers demonstrated that annual per capita medical spending across all payers for obese patients is approximately 42 percent higher than for patients of normal weight [4]. Others have estimated that over 20 percent of U.S. health expenditures can be attributed to obesity-related illnesses [5] and that annual medical costs increase by approximately four percent per unit of BMI between BMI values of 25 to 45 [6]. Though costs directly attributable to obesity are difficult to compare across studies, one systematic review suggests the direct medical cost of overweight and obesity combined amounts to approximately 5 to 10 percent of U.S. healthcare spending [7].

While these studies have demonstrated increased expenditures mainly related to outpatient management and pharmaceutical costs, recent data also suggest that surgical care of obese patients is more costly than that of non-obese patients. For the most common non-bariatric surgical procedures performed in the United States, the additional cost for annual national hospital expenditures associated with obesity is estimated to be $160 million [8]. Included in this estimate is one of the most common surgical procedures performed in women: hysterectomy. Cost comparisons for obese and non-obese women, however, have not been performed specifically in gynecologic cancer patients.

At an estimated 52,630 new cases diagnosed in 2014 in the United States (http://seer.cancer.gov/csr/1975_2011), endometrial cancer is the most common gynecologic malignancy and is also strongly associated with obesity, one of the most significant risk factors for the disease. This risk has been shown to increase linearly with increasing BMI [9]. Additionally, the vast majority of cases are treated by surgical management which includes total hysterectomy. Several challenges are associated with surgical treatment of obese endometrial cancer patients. In some studies, morbidly obese women are less likely to undergo complete surgical staging compared with their non-obese counterparts [10, 11]. They have also been shown in retrospective studies to have greater blood loss [10-13], longer operative times [11, 12], and increased wound infection rates [10, 11] compared with non-obese women. Though the impact of obesity on surgical outcomes in endometrial cancer patients has been well studied, the economic burden attributable to obesity in these patients has not yet been reported. An understanding of the reasons for and degree to which obesity affects healthcare costs in this setting may help further support interventions to reduce this modifiable risk factor. The objective of this study was to describe and compare direct hospital costs for obese and non-obese women undergoing surgical management of uterine malignancy.

Materials and methods

This is a retrospective cohort study using the University Health System Consortium (UHC) database (Chicago, IL) to compare mean direct hospital costs for women with and without obesity who underwent open, laparoscopic, or robotic hysterectomy during the study period. The UHC database contains data from 120 academic medical centers and 299 affiliate hospitals, thus representing over 90% of U.S. nonprofit academic medical centers. This database was queried to identify all women with a diagnosis of uterine malignancy (*International Classification of Diseases, Ninth Revision [ICD-9]* 182.x and 179) in all available fiscal years (2009-2013) undergoing hysterectomy. These patients were then divided into two cohorts: those coded with the comorbidity obesity and those without this coded comorbidity. Amongst both obese and non-obese cohorts, patients were stratified by hysterectomy type: open (*ICD-9* 68.3, 68.39, 68.4, 68.49, 68.6, 68.69, 68.79, 68.9), laparoscopic (*ICD-9* 68.31, 68.41, 68.51, 68.61, 68.71), or robotic (*ICD-9* 17.4, 17.41, 17.42, 17.43, 17.44, 17.45, 17.49 and including *ICD-9* 68.x). Data collection and analysis using the UHC database was approved by the University of California, San Diego Institutional Review Board.

Frequencies of each hysterectomy type were calculated and compared between obese and non-obese cohorts using Chi-square tests. Mean direct hospital costs for each of these strata were obtained and 95% confidence intervals for the means were calculated. Within the obese and within the non-obese cohorts, mean direct costs stratified by type of hysterectomy performed were compared using ANOVA tests. For each hysterectomy type, mean direct costs between obese and non-obese patients were compared using Student's t-tests. Stratification of the sample, first into obese and non-obese cohorts then stratification by hysterectomy approach, was done in order to compare mean direct costs. Mean hospital costs in each group, i.e. obese, non-obese and laparoscopic, robotic, and open approaches, were compared to the overall average cost per case for the entire study group to determine relative potential changes in cost.

Results

25,263 patients with a diagnosis of uterine malignancy underwent hysterectomy during the study period. 8,407 (33%) of these patients were coded in the UHC database as obese. Of the hysterectomies performed on obese

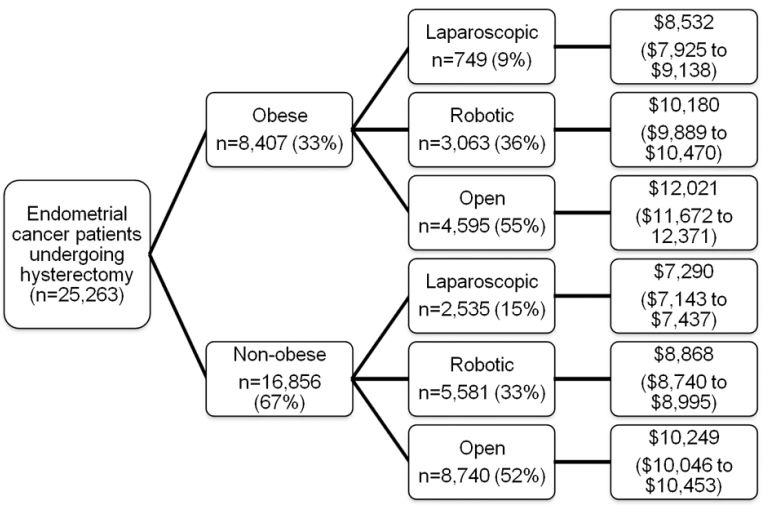

Figure 1. Frequencies of hysterectomy approaches and mean direct hospital costs in obese and non-obese patients. Hysterectomy approaches and mean direct hospital costs in obese and non-obese patients. The distribution (%) of obese and non-obese patients in the total sample (n = 25,263) and the distribution (%) of hysterectomy approaches amongst obese (n = 8,407) and non-obese (n = 16,856) cohorts are shown. Direct hospital costs are shown as means with 95% confidence intervals.

women, 4,595 (55%) were open, 749 (9%) were laparoscopic, and 3,063 (36%) were robotic. Of the hysterectomies performed on non-obese women, 8,740 (52%) were open, 2,535 (15%) were laparoscopic, and 5,581 (33%) were robotic. Frequencies of hysterectomy techniques between the obese and non-obese cohorts were significantly different (P < .0001 **Figure 1**).

Within both obese and non-obese cohorts, mean direct hospital costs were significantly different between those undergoing open versus laparoscopic versus robotic hysterectomy (P < .0001). Mean direct hospital costs were significantly greater for obese compared with non-obese patients regardless of the hysterectomy approach (**Figure 1**). These mean costs were 17% greater for obese compared with non-obese women for those undergoing open hysterectomy ($12,021 (95% CI = $11,672 to $12,371) vs $10,249 (95% CI = $10,046 to $10,453), P < .0001) as well as for those undergoing laparoscopic hysterectomy ($8,532 (95% CI = $7,925 to $9,138) vs $7,290 (95% CI = $7,143 to $7,437), P < .0001). For women undergoing robotic hysterectomy, these mean costs were 15% greater for obese compared with non-obese women ($10,180 (95% CI = $9,889 to $10,470) vs $8,868 (95% CI = $8,740 to $8,995), P < .0001). In both obese and non-obese cohorts, minimally invasive approaches were less costly than open procedures (P < .05).

The overall average cost per case for the entire study group was $9,929. When stratified into obese and non-obese cohorts, average costs weighted by observed frequencies of hysterectomy techniques were $11,044 for the obese group and $9,373 for the non-obese group, resulting in an added cost of $1,115 (11%) per case in the obese group and potential savings of $556 (6%) per case in the non-obese group. When stratified by hysterectomy technique, average costs for all patients (including all obese and non-obese subjects) were $7,703 for cases performed laparoscopically, $9,305 for those performed robotically, and $10,839 for cases performed open. Compared to the average cost in all patients, we found a cost reduction of $2,226 (22%) per laparoscopic case, a cost reduction of $624 (6%) per case performed robotically, and an increased cost of $910 (9%) per open case.

Discussion

In this study, we found that hospital costs for women with uterine malignancy undergoing hysterectomy were higher for obese women as compared with non-obese women. This finding persisted regardless of the hysterectomy approach used. In addition, we found that amongst both obese and non-obese patients, minimally invasive approaches were less costly than open approaches. From the perspective of cost control strategies in the setting of U.S. healthcare reform, these findings lend additional information to consider when calculating bundled payment costs. Given the cost differential between obese and non-obese patients, the proportion of the population that is obese for a given hospital or region may significantly impact estimated hospitalization costs for the episode during which hysterectomy is per-

formed for uterine cancer. In particular, in a population which is comprised of mostly obese patients, neglecting this factor and using an applied cost estimate as calculated for a less obese population may result in significant losses for that particular hospital group.

We performed calculations stratified by obesity classification and by hysterectomy approach in order to estimate potential cost savings and losses resulting from changes in these parameters. These calculations demonstrated the approximate degree to which obesity reduction and minimally invasive surgery may offer significant cost savings; however, several other factors exist which may affect overall cost and these variables could not be accounted for in our estimates. We also did not examine other components that are used to calculate bundled payments such as cost of post-acute care including readmissions and rehabilitation or skilled nursing facility services; however it is plausible that obesity may be associated with increased utilization and costs in this context as well and should be examined in future studies. At minimum, our calculations support the application of sensitivity analyses based on obesity prevalence and hysterectomy approach in future models estimating cost of uterine cancer treatment.

Possible factors contributing to increased costs include longer operative times and higher resource utilization, as has been noted for obese compared with non-obese patients undergoing total abdominal hysterectomy [8]. Less likely explanations include major postoperative complications and increase in length of hospital stays as these outcomes have been shown in previous studies to be equivalent for obese and non-obese uterine cancer patients treated by minimally invasive hysterectomy [11, 13]. As observed costs were determined specifically for the hospitalization during which hysterectomy was performed, these costs are not reflective of delayed postoperative complications or postoperative adjuvant treatments. Additional studies may help elucidate causes of increased costs and determine if any can be addressed in this population.

Obesity is known to be a modifiable risk factor for uterine cancer. In the context of an already diagnosed cancer, however, it is unlikely that any significant decrease in BMI could be achieved prior to surgical treatment. Regardless, our findings provide a somewhat different perspective regarding the significant impact of obesity and the importance of weight management among endometrial cancer patients. The benefits of weight reduction in this group are multi-fold including cardiovascular risk reduction-a modification that may improve survival in this population [14]-and as such, lifestyle interventions that have demonstrated efficacy in weight reduction [15] should be promoted both pre- and post-operatively.

One somewhat unexpected finding in our study was the distribution of surgical approach-specifically, greater than half of both obese and non-obese cohorts underwent open hysterectomies. Choice of surgical approach is largely based on physician judgment and preferences, surgical skill, equipment availability, and in some cases might be modified depending on individualized factors such as extremes of BMI. However, when feasible, minimally invasive surgery is the current standard of care for endometrial cancer treatment based on improved short-term perioperative outcomes with laparoscopy compared with laparotomy [16] as well as comparable rates of recurrence and survival [17]. Retrospective data on robotic hysterectomy for uterine cancer treatment suggests similarly low recurrence rates and high disease-specific survival rates with this approach [18]. Increasing numbers of morbidly obese women combined with limited minimally invasive training with these complicated cases may be one factor leading surgeons to favor open approaches for staging purposes. However, recent data demonstrate that obese women tend to have lower risk, lower stage uterine cancer; this observation supports omission of lymphadenectomy if laparotomy is deemed necessary for this purpose given that the perioperative risk of open surgery outweighs its benefits [19]. Our findings that the majority of hysterectomies in this study were performed using the open approach, as well as the significantly greater cost of open procedures, argue for efforts such as increased minimally invasive training, if needed, to shift this distribution toward fewer open surgeries.

Limitations exist to using registry data as in this investigation. As described above, a specific breakdown of the components of direct hospital costs accounting for the observed increase

associated with obese patients could not be determined. Variability may exist in administrative coding amongst institutions contributing to the UHC database. Given that the UHC modifier for obesity was used in lieu of discrete BMI values, some degree of imprecision in classification of obesity may exist. In particular, we observed that 33% of the study population was coded with the UHC modifier for obesity-this seems low for a uterine cancer population, and it is possible that some obese patients were not accurately coded as such. Their inclusion in the non-obese cohort, however, would reduce any observed cost differences; therefore, these results represent a conservative estimate. In addition, retrospective analyses such as this study are hypothesis-generating and causality of associations cannot be determined. Despite its limitations, the UHC database allows the benefit of a large study sample size as well as inclusion of a nationally representative group of academic medical centers thus increasing the generalizability of our findings.

As obesity prevalence in the U.S. continues to rise, an understanding of the potential impact of this increase on cost and delivery of medical care is important. In the context of uterine malignancy, a disease for which surgery is an essential component of treatment, growth in obesity prevalence has prompted several studies investigating optimal hysterectomy approach and surgical outcomes in obese women. Though cost of various hysterectomy approaches has previously been compared among women with uterine cancer [20-23], to our knowledge this is the first investigation in this setting demonstrating a relationship between obesity and increased costs, regardless of the hysterectomy approach. The underlying causes for this differential in cost warrant investigation to determine which, if any, components of this increased cost can potentially be modified to reduce healthcare spending.

Disclosure of conflict of interest

None.

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