

Clinical Science

# Obesity, outcomes and quality of care: body mass index increases the risk of wound-related complications in colon cancer surgery

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Obesity;  
Body mass index;  
Postoperative complications;  
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## Abstract

**BACKGROUND:** Obese patients may face higher complication rates during surgical treatment of colon cancer. The aim of this study was to measure this effect at a high-volume tertiary care center.

**METHODS:** All patients with colon cancer treated surgically at a single center from 2004 through 2011 were reviewed. Multivariate regression assessed relationships of complications and stay outcomes with body mass index (BMI) controlling for age, gender, comorbidity score, surgical approach, and history of smoking.

**RESULTS:** In 1,048 included patients, BMI was a predictor of several complications in both laparoscopic and open procedures. For every increase of BMI by one World Health Organization category, the odds ratios were 1.61 ( $P < .001$ ) for wound infection and 1.54 ( $P < .001$ ) for slow healing. Additionally, right colectomies had an odds ratio of 3.23 ( $P = .017$ ) for wound dehiscence. No further associations with BMI were found.

**CONCLUSIONS:** BMI was incrementally associated with wound-related complications, illustrating how the proliferation of obesity relates to a growing risk for surgical complications. As the surgical community strives to improve the quality of care, patient-controllable factors will play an increasingly important role in cost containment and quality improvement.

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Obesity is still on the rise in the Western world and continues to be a growing challenge for the surgical community. In the United States, the proportion of obese adults has steadily increased over the past 50 years. In 1962, 13.4% of adults were classified as obese,<sup>1</sup> and now, 35.7% of adults in the United States are obese according to the latest data from the Centers for Disease Control and Prevention.<sup>2</sup> Meanwhile, hospitals and surgeons are striving to improve their outcomes and reduce their complication rates. The Surgical Care Improvement Project (SCIP) measures and guidelines, meant to improve the

quality of care,<sup>3</sup> as well as the National Surgical Quality Improvement Program (NSQIP) surveying are now commonplace.<sup>4,5</sup>

Hospitals and surgeons are judged on their performance. However, obesity, which is a patient-controllable risk factor, is beyond the control of the medical community but plays an important role in surgical outcomes. Obesity is suspected to increase resection difficulty<sup>6</sup> and to be predictive of a complicated postoperative course,<sup>7,8</sup> although this premise has also been disputed.<sup>9–11</sup>

Colon cancer is affected by obesity as an etiologic risk factor,<sup>12–14</sup> but it may also be a potential complicating factor during surgical treatment. The higher prevalence of obesity combined with the abdominal location and the relatively advanced median age of affected patients<sup>15</sup> may be a triad that exacerbates the risk for obesity-related complications during operative management of colon cancer.

More than 100,000 new cases of colon cancer are diagnosed each year in the United States,<sup>15</sup> and surgical resection is indicated for the vast majority of these. Meanwhile, obesity rates are reaching new heights, yet current literature fails to provide unequivocal, reliable evidence on links between obesity and colon cancer surgery complications. Even scarcer is evidence concerning these potential links at centers that have been compliant with SCIP guidelines and are NSQIP implementers.

Body mass index (BMI) is a widely used numeric expression of body habitus using patient weight in relationship to the square of height. It is closely related to percentage body fat and total body fat<sup>16</sup> and is the measure used to define a threshold value for obesity. In this study, therefore, we measured the effect of BMI on operative outcomes and the risk for postoperative complications at a center that has been among the early adopters of NSQIP in the private sector.<sup>17</sup>

## Methods

### Patients

All patients surgically treated for colonic adenocarcinoma at Massachusetts General Hospital from 2004 through 2011 were included. Data on all cases were gathered from medical records and hospital data repositories as defined by an institutional review board–approved protocol. Patients without known BMIs were the only ones to be excluded from further analysis.

Perioperative BMI was determined using several sources, including the operative anesthesia record, preadmission history and physical examination, preoperative anesthesia examination, and physical examination by the operating surgeon. In case of discrepancies, patient history and outside records were also reviewed to identify the most accurate measurement.

Links were assessed between BMI and outcomes, including duration of surgery, conversion rate, duration of

stay, and postoperative complications. Most complications were actively reported because of our center's enrollment in the American College of Surgeons NSQIP throughout the time span of this research. Some complications were further specified in our database for the sake of this research according to their clinical magnitude: Wound infection was any culture-ascertained infection or infectious redness or discharge located at the operative wound severe enough to necessitate targeted attention, including antibiotic treatment. Slow healing included any operative wound that was the independent cause of a longer stay or led to targeted and unplanned clinical attention, not limited to infectious origins. Bowel motility delay was any return of bowel function that took substantially longer than initially expected and necessitated an unplanned intervention, such as the (re)placement of a nasogastric tube or initiation of parenteral nutrition. Fascial dehiscence, bowel obstructions, anastomotic leaks, bowel perforations, and colitis were all empirically established, usually ascertained through imaging or appropriate lab work.

BMI was categorized according to the classification defined by the World Health Organization in 2000<sup>18</sup>: these groups were underweight ( $<18.5$  kg/m<sup>2</sup>), normal (18.5 to 24.9 kg/m<sup>2</sup>), preobese (25 to 29.9 kg/m<sup>2</sup>), and obese grades I (30 to 34.99 kg/m<sup>2</sup>), II (35 to 39.99 kg/m<sup>2</sup>), and III ( $>40$  kg/m<sup>2</sup>). After direct association measures, BMI was also controlled for possible confounders, including baseline characteristics that could influence its link with outcomes. These were age, race, gender, comorbidity scores, and smoking status. Baseline characteristics found to significantly influence BMI were considered in multivariate models. For complications found to be significantly associated with BMI, a further detailed breakdown was made on the basis of resection region (right colectomy, left colectomy, or sigmoid or low anterior), admission type (urgent vs elective), and surgical approach (open vs laparoscopic).

### Statistical analysis

Statistical significance was defined as a *P* value  $\leq .05$ . Statistical analysis was performed using SPSS version 20.0 (IBM, Armonk, NY). Bivariate Pearson's correlations were measured between BMI and baseline characteristics. Univariate analysis was used to assess the statistical significance of differences between groups using chi-square tests for nominal variables and analysis of variance for continuous numbers. In multivariate analysis, binary logistic regression was used for dichotomous outcomes, while linear regression was used for continuous outcomes. The most appropriate multivariate model in terms of included covariates was selected on the basis of model fit ( $R^2$ ).

## Results

Of the 1,071 patients operated on for colon cancer in the defined time interval, 1,048 had reliable information to

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