Title
Outcome of preoperative weight loss in colorectal surgery.

Journal
American journal of surgery, 210(2)

ISSN
0002-9610

Authors
Moghadamyeghaneh, Zhobin
Hanna, Mark H
Hwang, Grace
et al.

Publication Date
2015-08-01

DOI
10.1016/j.amjsurg.2015.01.019

Peer reviewed

Outcome of preoperative weight loss in colorectal surgery

Zhobin Moghadamyeghaneh, M.D., Mark H. Hanna, M.D.,
Grace Hwang, M.D., Joseph C. Carmichael, M.D., Steven D. Mills, M.D.,
Alessio Pigazzi, M.D., Michael J. Stamos, M.D.*

Department of Surgery, University of California, Irvine School of Medicine, Orange, CA, USA

Abstract

BACKGROUND: There are limited data regarding the outcomes of patients with preoperative weight loss.We sought to identify complications associated with preoperative weight loss in colorectal surgery.

METHODS: The National Surgical Quality Improvement Program database was used to examine the clinical data of patients undergoing colorectal resection from 2005 to 2012 who had unintentional preoperative weight loss (more than 10% in 6 months of surgery). Multivariate analysis was performed to quantify the association of weight loss with postoperative complications.

RESULTS: We sampled a total of 79,696 patients who were admitted nonemergently for colorectal resection. The rate of preoperative unintentional weight loss was 3%. There were associations between preoperative weight loss with preoperative hypoalbuminemia (serum albumin level , 3.5 g/dL) (adjusted odds ratio [AOR] 2.58, P , .01). Postoperative mortality (AOR 1.74, P , .01) and complications of myocardial infarction (AOR 1.97, P 5.03) and ventilator dependency (AOR 1.54, P 5.03) had strong associations with weight loss.

CONCLUSIONS: A history of unintentional weight loss can be used to predict mortality and morbidity rates and as a marker for nutritional assessment in colorectal surgery. Cardiopulmonary complications have significant association with preoperative weight loss.

Weight loss, with a prevalence of 30% to 50% in patients undergoing gastrointestinal operation, is a poor prognostic indicator associated with increased morbidity and mortality. [1–3] Furthermore, weight loss has been reported to decrease patient's response to surgery, radiation therapy, and/or chemotherapy.[4] It is important to recognize these patients before operation. Additionally, the prevalence of severe malnutrition among colorectal cancer patients has been noted to increase from 2.6% preoperatively to 19.9% after an operation.[5] In other words, malnutrition is significantly aggravated by surgery and compromises recovery, resulting in reduced quality of life for

the affected patient.[5] However, early screening and treatment of nutrition problems in patients suffering from weight loss and malnutrition have been shown to improve outcomes.[6] Furthermore, recent studies have suggested that all surgical patients should undergo nutritional screening on admission to highlight malnourished or at-risk patients to try and decrease their perioperative morbidity and mortality.[7] Gastrointestinal cancer patients are considered to have a high risk for weight loss and malnutrition.5 Nutritional deficits may take up to a year to recover after an operation.[8] Nutritional problems, and subsequent weight loss, in gastrointestinal cancer patients can result from the local effects of the tumor, such as obstruction, or from alterations in metabolism of carbohydrates and proteins.9 In colorectal cancer surgery, preoperative weight loss has been introduced as a risk factor of advanced stage cancer which increases morbidity and mortality of patients as well.[10] However, there are limited data investigating the association between nonmalignant conditions and preoperative weight loss. Also, a study evaluating the associations between preoperative laboratory biochemical parameters and weight loss is lacking.

A number of previous studies have introduced risk factors for mortality and morbidity of patients who underwent colorectal surgery. Preoperative weight loss has been identified as an important factor associated with surgical outcomes. However, there are limited data analyzing associations between preoperative unintentional weight loss and specific postoperative complications. Using a large national database to analyze 19 postoperative complications, we aim to report on the incidence, outcomes, and association between unintentional weight loss and each postoperative complication in patients who underwent colorectal procedures.

Patients and Methods

This study was performed using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database from January 1, 2005 to December 31, 2012. ACS NSQIP is a nationally validated, risk-adjusted, outcomes-based program to measure and improve the quality of surgical care in the United States.[11] ACS NSQIP provides preoperative to 30-day postoperative surgical outcomes based on clinical data. We considered patients who had undergone nonemergent colorectal resections for the diagnosis of benign or malignant colorectal tumor, diverticular diseases, Crohn’s disease, and ulcerative colitis (UC) using the appropriate procedural and diagnosis codes as specified by the International Classification of Diseases, 9th revision, clinical modifications. Patients who had colorectal procedures were defined based on the following Current Procedural Terminology codes: 44,140 to 44,160, 44,204 to 44,212, 45,110, 45,113, and 45,395. Inclusion and exclusion criteria of the study were reported in Fig. 1.

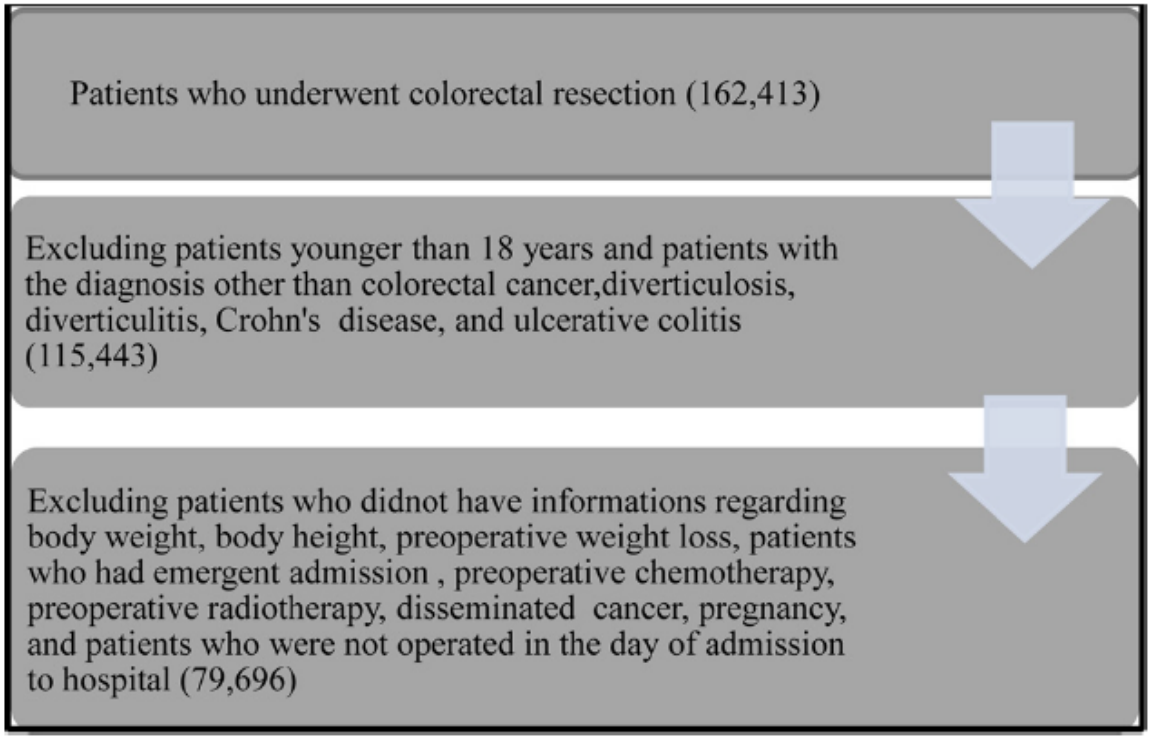

Figure 1 Inclusion and exclusion criteria in case selection for the study.

Patients' diagnoses were defined based on the following International Classification of Diseases, 9th revision codes: malignant neoplasm of colon and rectum (153.0 to 153.9, 154.0, 154.1, 230.3, and 230.4), benign neoplasm of colon and rectum (211.3, 211.4), diverticulosis or diverticulitis (562.10 to 562.13), Crohn's disease (555.0 to 555.9), and UC (556.0 to 556.9). Preoperative weight loss was defined as unintentional weight loss more than 10% of baseline body weight in the last 6 months before the date of surgery. Patients who had intentionally lost weight were not included.

Preoperative factors that were analyzed include patient characteristics (age, sex, and race), and comorbidity conditions include history of ischemic heart disease (history of myocardial infarction, cardiac angina, and congestive heart failure), history of peripheral vascular disease (history of rest pain, revascularization, or amputation for peripheral vascular disease), history of cerebrovascular disease (history of stroke, cerebrovascular accident, and transient ischemic attacks), renal failure need to dialysis, diabetes mellitus with oral agents or insulin, history of severe chronic obstructive pulmonary disease, partial or total dependency in activities performed in the course of a normal day in a person's life (bathing, feeding, dressing, toileting, and mobility) before surgery as a measure of functional health status, presence of ascites on physical examination or imaging within 30 days before the operation, chronic steroid use, history of bleeding disorders, esophageal varices, and hypertension requiring medication. Other factors analyzed included body mass index (BMI), hypoalbuminemia (serum albumin level < 3.5 days/ dL), anemia (hematocrit < 30), wound classification (clean, clean/contaminated, contaminated, dirty/infected), postsurgical complications, pathologic conditions, type of surgical intervention (total colectomy, partial colectomy, and proctectomy), and surgical approach (open vs laparoscopy). The overall rate of

preoperative weight loss and the rate of postoperative complications by procedure type and patients' pathology were examined. Risk-adjusted analysis was performed to identify independent predictors of postoperative complications following colorectal surgery.

Table 1 Demographics of patients who have undergone colon and rectal surgery

Patients' characteristics	Patients without weight loss (sample size: 77,309)	Patients with weight loss (sample size: 2,387)	Odds ratio and 95% confidence interval	*P* value
Age (year)				
Mean	61 ± 15	61 ± 17	–	–
Median	62	62	–	–
Sex				
Male	39,484 (49.6%)	1,201 (50.4%)	1.03 (.95–1.11)	.45
Race				
White	64,069 (87.3%)	1,891 (86.5%)	.93 (.82–1.05)	.27
Black or African American	6,399 (8.7%)	211 (9.7%)	1.12 (.97–1.29)	.11
Asian	1,996 (2.7%)	54 (2.5%)	.90 (.68–1.18)	.46
Other	920 (1.2%)	29 (1.3%)	1.06 (.73–1.54)	.75
Comorbidity				
Hypertension	39,144 (49.1%)	1,030 (43.2%)	.78 (.71–.84)	<.01
Smoke	13,314 (16.7%)	620 (26%)	1.78 (1.62–1.96)	<.01
Diabetes mellitus	11,103 (13.9%)	311 (13%)	.92 (.81–1.04)	.19
Chronic steroid use	4,863 (6.1%)	310 (13%)	2.38 (2.10–2.69)	<.01
Severe COPD	3,398 (4.3%)	163 (6.8%)	1.67 (1.42–1.97)	<.01
CVD*	2,707 (3.5%)	111 (4.7%)	1.34 (1.10–1.63)	<.01
Bleeding disorder	1,786 (2.2%)	64 (2.7%)	1.20 (.93–1.55)	.14
Partial or complete dependency	1,144 (1.4%)	66 (2.8%)	2.01 (1.56–2.58)	<.01
IHD†	602 (.8%)	29 (1.2%)	1.56 (1.07–2.28)	.01
PVD‡	555 (.7%)	28 (1.2%)	1.64 (1.12–2.40)	.01
Congestive heart failure	254 (.3%)	13 (.5%)	1.75 (1.001–3.06)	.04
Renal failure need to dialysis	258 (.3%)	7 (.3%)	.90 (.42–1.91)	.79
Ascites	163 (.2%)	15 (.6%)	3.29 (1.93–5.61)	<.01
Esophageal varices	50 (.1%)	4 (.2%)	2.61 (.94–7.25)	.05
BMI				
BMI < 18.5	1,713 (2.1%)	261 (10.9%)	6.41 (5.58–7.36)	<.01
18.5 ≤ BMI < 24.9	22,751 (28.5%)	1,164 (48.8%)	2.45 (2.26–2.66)	<.01
25 ≤ BMI < 29.9	27,889 (35%)	580 (24.3%)	.58 (.53–.64)	<.01
30 ≤ BMI < 39.9	23,170 (29.1%)	346 (14.5%)	.40 (.36–.45)	<.01
40 ≤ BMI	4,173 (5.2%)	36 (1.5%)	.27 (.19–.37)	<.01
Pathology				
Colorectal cancer	36,890 (46.3%)	1,338 (56.1%)	1.49 (1.38–1.62)	<.01
Diverticulitis	19,395 (24.3%)	369 (15.5%)	.56 (.50–.62)	<.01
Benign colorectal tumor	13,448 (16.9%)	140 (5.9%)	.30 (.25–.35)	<.01
Crohn's disease	4,430 (5.6%)	302 (12.7%)	2.56 (2.26–2.90)	<.01
Ulcerative colitis	3,457 (4.3%)	200 (8.4%)	2.07 (1.79–2.41)	<.01
Diverticulosis	2,076 (2.6%)	38 (1.6%)	.59 (.43–.82)	<.01
Approach				
Open surgery	35,296 (44.3%)	1,437 (60.2%)	1.94 (1.78–2.10)	<.01
Operation length				
Mean (minutes)	172 ± 88	182 ± 101	–	–
Median	154	160	–	–
Procedure				
Partial colectomy	71,139 (89.3%)	1,962 (82.2%)	.54 (.48–.60)	<.01
Total colectomy	4,173 (5.2%)	216 (9%)	1.84 (1.59–2.12)	<.01
Proctectomy	3,381 (4.2%)	153 (6.4%)	1.57 (1.32–1.85)	<.01
Other factors				
Hypoalbuminemia§	9,158 (18.4%)	752 (42.7%)	3.51 (3.19–3.87)	
Anemia	9,477 (12.5%)	652 (28.2%)	2.88 (2.62–3.16)	

BMI = body mass index; COPD 5 chronic obstructive pulmonary disease; CVD 5 cerebrovascular disease; IHD 5 ischemic heart disease; PVD 5 peripheral vascular disease.

*History of stroke, cerebrovascular accident, and transient ischemic attacks.
†History of myocardial infarction, cardiac angina, and congestive heart failure.
‡History of rest pain, revascularization, or amputation for peripheral vascular disease.
§ Serum albumin level lower than 3.5 g/dL.

Statistical analysis

Statistical analysis was performed with SPSS software, Version 22 (SPSS, Inc, Chicago, IL). Logistic regression analysis was used to estimate the association between preoperative weight loss and each outcome, including in-hospital mortality and all of the considered postoperative complications. P values less than .05 were considered statistically significant. For each outcome, the adjusted odds ratio (AOR) with a 95% confidence interval (CI) was calculated and reported to estimate the relative risk associated with weight loss. Adjustments were made for the technique of the surgery (open vs laparoscopic), wound classification, age, sex, race, hypoalbuminemia, anemia, BMI, type of the procedure, patients pathology, and comorbidities of hypertension, diabetes mellitus, chronic obstructive pulmonary disease, ascites, steroid use, bleeding disorders, esophageal varices, functional health status, renal failure need to dialysis, ischemic heart disease, peripheral vascular disease, and cerebrovascular disease. Logistic regression was also used to describe the weights assigned to preoperative variables that best discriminate patients with preoperative weight loss from those without.

Results

We sampled 79,696 patients who underwent colorectal resection from 2005 to 2012. The mean age of patients 61 years with a standard deviation of 15 years; the majority of the patients were Caucasian (87.3%) and female (50.4%). The most common comorbidities included hypertension (49.1%) and diabetes (13.9%). Demographic data of patients are reported in Table 1.

Of the patients who underwent colorectal resection, 2,387 (3%) patients had preoperative weight loss. The median length of stay in the hospital for patients experiencing weight loss was 6 days, while patients who did not undergo weight loss were hospitalized for 5 days. The adjusted mean difference in hospitalization was one day longer ($P = .04$).

The unadjusted mortality rate in patients with or without weight loss was 2.1%and .7%, respectively, while the adjusted risk of mortality in patients with weight loss was higher than patients without (AOR 1.74, 95% CI 1.14 to 2.66, $P < .01$).

Not surprisingly, there are significant associations between preoperative weight loss and preoperative hypoalbuminemia (AOR 2.58, 95% CI 2.27 to 2.94, $P < .01$), and preoperative anemia (AOR 1.49, 95% CI 1.29 to 1.72, $P < .01$).

If serum albumin level below 3.5 g/dL is used as a marker of malnutrition, the sensitivity and specificity of weight loss to identify malnourished patient were 8.21% and 97.52% respectively.

The risk-adjusted analysis for postsurgical complications associated with weight loss is reported in Table 2.

Specific postsurgical complications found to have a relationship with weight loss include myocardial infarction (AOR 1.97, 95% CI 1.05 to 3.70, P = .03), pneumonia (AOR 1.56, 95% CI 1.12 to 2.18, P <.01), and ventilator dependency (AOR 1.54, 95% CI 1.04 to 2.28, P = .03). Table 3 and Fig. 2 illustrate the associations between preoperative pathologic conditions and preoperative weight loss. In a multivariate analysis, malignancy (compared with benign pathologies) had strong associations with preoperative weight loss. Also, UC, and Crohn's disease, had strong associations with preoperative weight loss.

Finally, Table 4 reports risk-adjusted analysis of mortality risk related to weight loss according to patients' BMI. Underweight patients (BMI , 18.5) had the highest risk of mortality after operation.

Table 3 Risk-adjusted analysis of pathologies associated with preoperative weight loss in colon and rectal surgery patients

Patient pathology	Patients without weight loss (sample size:77,309)	Patients with weight loss (sample size: 2,387)	Univariate analysis		Multivariate analysis	
			OR (95% CI)	*P* value	AOR (95% CI)	*P* value
Benign pathology	41,757 (54%)	1,049 (43.9%)	Reference	–	Reference	–
Cancer in pathology	35,552 (46%)	1,338 (56.1%)	1.49 (1.38–1.62)	<.01	1.42 (1.24–1.62)	<.01
Rectal cancer	9,487 (12.3%)	376 (15.8%)	Reference	–	Reference	–
Colon cancer	26,065 (33.7%)	962 (40.3%)	.93 (.82–1.05)	.25	.97 (.81–1.17)	.80
Ulcerative colitis	3,257 (4.2%)	200 (8.4%)	2.07 (1.79–2.41)	<.01	1.34 (1.06–1.69)	.01
Crohn's disease	4,128 (5.3%)	302 (12.7%)	2.56 (2.26–2.90)	<.01	1.31 (1.06–1.62)	.01
Left side colon cancer*	7,883 (10.2%)	285 (11.9%)	1.19 (1.05–1.35)	<.01	1.17 (1.03–1.74)	<.01
Colon cancer	26,065 (33.7%)	962 (40.3%)	1.32 (1.22–1.44)	<.01	1.28 (1.12–1.46)	<.01
Rectal cancer†	9,487 (12.3%)	376 (15.8%)	1.33 (1.19–1.49)	<.01	1.19 (1.002–1.42)	.04
Right side colon cancer‡	14,215 (18.4%)	545 (22.8%)	1.31 (1.19–1.44)	<.01	1.04 (.89–1.20)	.61
Diverticulitis of colon	19,026 (24.6%)	369 (15.5%)	.56 (.50–.62)	<.01	.76 (.64–.90)	<.01
Carcinoma in situ	444 (.6%)	10 (.4%)	.72 (.38–1.36)	.32	.73 (.26–2.01)	.54
Benign colorectal tumor	13,308 (17.2%)	140 (5.9%)	.30 (.25–.35)	<.01	.42 (.33–.54)	<.01
Diverticulosis of colon	2,038 (2.6%)	38 (1.6%)	.59 (.43–.82)	<.01	.70 (.43–1.15)	.16

AOR 5 adjusted odds ratio; CI 5 confidence interval; OR 5 odds ratio.
*Includes sigmoid.
†Includes recto-sigmoid junction.
‡Includes transverse colon.

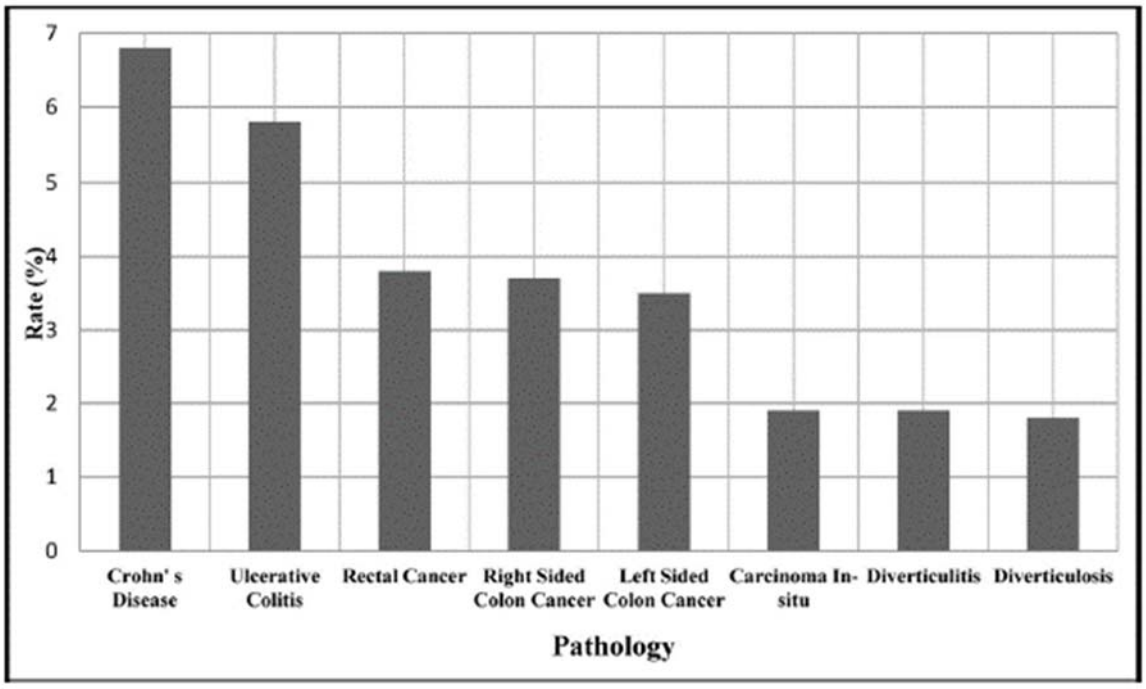

Figure 2 Rate of preoperative weight loss according to patients' pathology.

Table 4 Risk-adjusted analysis of mortality of patients with preoperative weight loss according to patients' BMI

		Mortality risk	
BMI	Weight loss (rate)	Adjusted odds ratio (95% confidence interval)	*P* value
BMI < 18.5	261 (15.2%)	16.66 (1.71–161.80)	.01
18.5 ≤ BMI < 25	1,164 (5.1%)	2.22 (1.29–3.84)	<.01
25 ≤ BMI < 30	580 (2.1%)	1.43 (.55–3.70)	.46
30 ≤ BMI < 40	346 (1.5%)	.72 (.09–5.42)	.75
BMI ≥ 40	36 (.9%)	.99 (.99–1)	.99

BMI 5 body mass index.

Comments

Preoperative unintentional weight loss in patients undergoing colorectal resection is associated with a poor prognosis, significant mortality, and an observed increase in length of hospital stay.

Our data, which represent the largest to date on this topic, reinforce preoperative weight loss as an accurate predictor of mortality, morbidity, and 4 postoperative complications in colorectal surgery patients. Multivariate analysis of the data shows that preoperative unintentional weight loss of more than 10% during 6 months before surgery is associated with increased mortality and morbidity of patients by 74% and 23%, respectively. This is in line with a previous report of preoperative weight loss as a risk factor of mortality and morbidity.[10]

Malnutrition and anemia have strong associations with preoperative weight loss. Patients with preoperative weight loss have more than a 2-fold increased risk of

malnutrition compared with patients without. Our analysis confirms the earlier report of more than 10% weight loss in 6 months as a predictor of protein energy malnutrition by Collins.[12] Furthermore, the rate of anemia, which is a previously reported mortality and morbidity predictor in surgery, is revealed to be higher in patients with preoperative weight loss.[13] Our findings support the previously reported need for routine nutritional risk assessment before surgery, especially for patients suffering from weight loss.[7]

Cardiopulmonary complications are at the top of the list of surgical complications associated with preoperative weight loss. In our multivariate analysis, we found 4 complications which had associations with preoperative weight loss. Postoperative complications of myocardial infarction, pneumonia, ventilator dependency, and unplanned intubation have the significant correlations with weight loss. The high rates of respiratory complications in patients experiencing weight loss can perhaps be explained by the weakness of respiratory muscles in malnourished patients.[14] However, there are limited published data regarding associations between weight loss and myocardial infarction. Further studies are indicated to evaluate associations between preoperative weight loss and postoperative cardiac complications. Postoperative pneumonia is also significantly higher in patients experiencing preoperative weight loss. This is in line with the report of higher rate of septic complications in patients with weight loss by Windsor and Hill.[15] Higher rate of pneumonia in patients with weight loss may be explained by impaired immune response in patients with preoperative weight loss.[16,17]

Our study results show that the presence of malignancy is associated with preoperative weight loss. However, there was no significant difference in weight loss rates between colon and rectal cancer. Interestingly, we found that patients suffering from Crohn's disease and UC had the highest rate of preoperative weight loss (6.8% and 5.8%, respectively). This confirms the higher rate of malnutrition and impaired muscle strength in patients with inflammatory bowel disease, which has been previously reported, even in the clinical remission phase.[18] We have found that using a history of weight loss as a screening tool to identify malnourished patients is not reliable. Although we found associations between preoperative weight loss and malnutrition, the sensitivity of using a history of weight loss as a screening test is low. If we use serum albumin level below 3.5 g/dL as a marker of malnutrition as suggested by the literature,[19,20] the sensitivity of weight loss to identify malnourished patients is 8.21%. Complete nutritional risk assessment, not just obtaining history of preoperative weight loss, is suggested for patients undergoing major colorectal procedures.

Our study results show that underweight patients (BMI , 18.5) had the highest risk of mortality after operation. The mortality risk of patients with BMI less than 18.5 who had weight loss is increased more than 16 times compared with underweight patients who did not have preoperative weight loss. The effects of weight loss on surgical outcome decrease with increasing patient BMI and for patients with BMI R 25, weight loss did not have significant effects on mortality. Surprisingly, patients with BMI R 35 who had preoperative weight loss had lower mortality rate compared with patients without weight loss (.9% vs 0%). However, following multivariate analysis of the data, this difference was not statistically significant (Table 4). Our results show that preoperative weight loss in patients with BMI less than 30 has negative effects on surgical outcomes, while weight loss in obese and morbidly obese patients may be beneficial. This is in line with a

previous report indicating preoperative weight loss in obese patients is associated with fewer complications and better outcomes by Benotti et al.[21] Considering limited published data on this topic, further studies are indicated to understand these correlations.

Study limitations

This study is a large retrospective review, therefore subject to typical inherent biases for retrospective studies, such as selection bias. Data in this study were extracted from the discharge data of over 500 hospitals in the United States and there is a wide variety of in-hospital settings and surgeons' expertise, and possible coding errors that can affect the study.[22] Patients in this study did not form a homogeneous group and their primary diagnoses varied broadly. The weight loss variable in the study was defined as a greater than 10% decrease in body weight in the 6-month interval immediately preceding surgery, as manifested by serial weights in the chart, as reported by the patient, or as evidenced by change in clothing size or severe cachexia. We did not have any information regarding baseline weight recorded in the preceding 6 months for our patients nor the exact amount of weight loss. Some patients may have received supplementation or resuscitation for malnutrition which may have altered our results. Although adjustment with type of the procedure and type of the surgery was done for the study and only electively admitted patients were included in the study, we could not adjust our results with the complexity of operation which may affect study results. Patients were not tracked beyond 30 days from the date of surgery and we lack long-term outcomes. Although we adjusted the study results with many comorbid conditions, there may be some comorbid conditions which have associations with weight loss which were not included. Despite these limitations, this study is the first to report on postoperative complications associated with preoperative weight loss in colorectal procedures in this population subset.

Conclusions

Unintentional preoperative weight loss has an incidence rate of 3% in colorectal surgery. Preoperative weight loss is associated with increased morbidity, mortality, and length of hospital stay. There are significant associations between preoperative weight loss and preoperative hypoalbuminemia and anemia. A history of weight loss can be used to predict mortality and morbidity rates and as a marker for nutritional assessment in colorectal surgery. However, the sensitivity of weight loss for finding malnourished patients is low (8.2%) and complete nutritional risk assessment in addition to taking the history of preoperative weight loss is suggested for patients undergoing major colorectal procedures. In multivariate analysis, 4 postoperative complications have associations with preoperative weight loss. Cardiopulmonary complications are at the top of the list of surgical complications associated with preoperative weight loss. Our findings suggest that a more complete nutritional assessment of the colorectal surgery patient in the perioperative setting is warranted as perioperative malnutrition had significant effects on patients' morbidity and mortality. Our analysis also suggests that patients with a diagnosis of inflammatory bowel disease are the subset of colorectal surgery patients at the highest risk for preoperative weight loss.

References

1. Bruera E. ABC of palliative care. Anorexia, cachexia, and nutrition. BMJ 1997;315:1219–22.
2. McMahon K, Decker G, Ottery FD. Integrating proactive nutritional assessment in clinical practices to prevent complications and cost. Semin Oncol 1998;25(2 Suppl 6):20–7.
3. Vigano´ A, Bruera E, Jhangri GS, et al. Clinical survival predictors in patients with advanced cancer. Arch Intern Med 2000;160:861–8.
4. Dewys WD, Begg C, Lavin PT, et al. Prognostic effect of weight loss prior to chemotherapy in cancer patients. Eastern Cooperative Oncology Group. Am J Med 1980;69:491–7.
5. ShimH, Cheong JH,LeeKY, et al. Perioperative nutritional status changes in gastrointestinal cancer patients. Yonsei Med J 2013;54:1370–6.
6. Kruizenga HM, Van Tulder MW, Seidell JC, et al. Effectiveness and cost-effectiveness of early screening and treatment of malnourished patients. Am J Clin Nutr 2005;82:1082–9.
7. Moyes LH, McKee RF. A review of surgical nutrition. Scott Med J 2008;53:38–43. quiz 43, 63.
8. Ryu SW, Kim IH. Comparison of different nutritional assessments in detecting malnutrition among gastric cancer patients. World J Gastroenterol 2010;16:3310–7.
9. Langstein HN, Norton JA. Mechanisms of cancer cachexia. Hematol Oncol Clin North Am 1991;5:103–23.
10. Kirchhoff P, Clavien PA, Hahnloser D. Complications in colorectal surgery: risk factors and preventive strategies. Patient Saf Surg 2010;4:5.
11. National Surgical Quality Improvement Program [Home Page on the Internet]. Chicago, IL: American College of Surgeons; 2005. Available at: www.acsnsqip.org. Accessed May 11, 2015.
12. Collins N. Assessment and treatment of involuntary weight loss and protein-calorie malnutrition. Adv Skin Wound Care 2000;13-(1 Suppl):4–10.
13. Dunne JR, Malone D, Tracy JK, et al. Perioperative anemia: an independent risk factor for infection, mortality, and resource utilization in surgery. J Surg Res 2002;102:237–44.
14. Lunardi AC, Miranda CS, Silva KM, et al. Weakness of expiratory muscles and pulmonary complications in malnourished patients undergoing upper abdominal surgery. Respirology 2012;17:108–13.
15. Windsor JA, Hill GL. Weight loss with physiologic impairment. A basic indicator of surgical risk. Ann Surg 1988;207:290–6.
16. Cunningham-Rundles S, McNeeley DF, Moon A. Mechanisms of nutrient modulation of the immune response. J Allergy Clin Immunol 2005;115:1119–28. quiz 1129.
17. Langius JA, Bakker S, Rietveld DH, et al. Critical weight loss is a major prognostic indicator for disease-specific survival in patients with head and neck cancer receiving radiotherapy. Br J Cancer 2013;109:1093–9.

18. Valentini L, Schaper L, Buning C, et al. Malnutrition and impaired muscle strength in patients with Crohn's disease and ulcerative colitis in remission. Nutrition 2008;24:694–702.
19. Fuhrman MP, Charney P, Mueller CM. Hepatic proteins and nutrition assessment. J Am Diet Assoc 2004;104:1258–64.
20. Moghadamyeghaneh Z, Carmichael JC, Mills SD, et al. Effects of ascites on outcomes of colorectal surgery in congestive heart failure patients. Am J Surg; 2014. inpress.
21. Benotti PN, Still CD, Wood GC, et al. Preoperative weight loss before bariatric surgery. Arch Surg 2009;144:1150–5.
22. Lorence DP, Ibrahim IA. Benchmarking variation in coding accuracy across the United States. J Health Care Finance 2003;29:29–42.

The authors declare no conflicts of interest.
Presented as an Oral Presentation at the American College of Surgeons, National Surgical Quality Improvement Program National Meeting, July 28, 2014.
* Corresponding author. Tel.: 11-714-456-6262; fax: 11-714-456-6377.
E-mail address: mstamos@uci.edu