The American Journal of Surgery 220 (2020) 1290–1295

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Association between interhospital transfer and morbid obesity in emergency general surgery procedures

Madeline M. Georgino, Keith Murphy, B. Lauren Paton, Lynn Schiffern, Samuel W. Ross, Caroline E. Reinke*

Department of Surgery, Carolinas Medical Center, 1025 Morehead Medical Plaza Suite 300, Charlotte, NC, 28204, USA

ARTICLE INFO

Article history:
Received 14 February 2020
Received in revised form
11 May 2020
Accepted 25 June 2020

Keywords:
Obesity
Super obese
Non-elective general surgery
Emergency general surgery
Outcomes
Transfer

ABSTRACT

Background: Obese patients may have unique surgical needs. The goal of this study is to determine if there is an association between obesity and transfer in patients undergoing EGS.
Methods: EGS patients were identified in the NSQIP 2011–2016 database. Outcome variables included interhospital transfer, days to surgery, SSI, postoperative LOS, discharge destination, and 30-day readmission. Descriptive statistics and multivariable regression were utilized.
Results: 419,373 EGS patients were identified, and transfer status varied by obesity class. After controlling for other factors, obese patients had increased odds of interhospital transfer (OR = 1.07–1.53), SSI (OR = 1.22–1.69), and decreased odds of discharge to home (OR = 0.42–0.71, all $p < 0.01$) but not of 30-day readmission or delay from admission to surgical intervention.
Conclusions: Obese patients undergoing EGS procedures have an increased likelihood of transfer from an acute care hospital. As obese EGS patients are increasingly prevalent, determining best triage practices for this unique patient population warrants additional investigation.
© 2020 Elsevier Inc. All rights reserved.

Introduction

Obesity is a worldwide health epidemic. The World Health Organization (WHO) estimates that the prevalence of obesity doubled between 1980 and 2008 with approximately 12% of the world's population classified as obese.[1] Obesity is a complex, multisystem, prothrombotic and proinflammatory disorder that puts patients at risk for developing hypertension, heart disease, diabetes and certain cancers.[11] Obesity and its associated comorbidities influence post-operative morbidity and mortality as well as increase healthcare cost.[1–11] Patient with obesity require higher hospital resource utilization including: specialty equipment and structural changes, post-operative intensive care unit admissions, prolonged length of stay, and reoperation.[7] For the largest volume surgical procedures obese patients have significantly higher annual national hospital expenditures.[4] Preoperative weight loss is an opportunity to decrease postoperative complications for patients planning an elective surgical procedure. However, for non-elective procedures, patient optimization in the outpatient setting is not an option and obesity may impact patient management. The relationship between obesity and interhospital transfer in non-elective procedures has not been previously studied.

Therefore, to better study the effect of obesity on non-elective surgical patients, our study aimed to investigate the relationship between obesity and interhospital transfer, as well as time to surgery and postoperative outcomes in a broad range of general surgery patients. We hypothesized that obese patients would be more likely to undergo interhospital transfer independent of their comorbidities - possibly due to resource and equipment limitations - and would have an increased time to operative interventions. Additionally, we hypothesized that in the emergency general surgery population, obese patients would have increased rates of wound infection, increased post-operative length of stay, be less likely to discharge to home and more likely to have a 30-day readmission.

* Corresponding author.
E-mail addresses: Madeline.Georgino@atriumhealth.org (M.M. Georgino), Keith.Murphy@atriumhealth.org (K. Murphy), Lauren.Paton@atriumhealth.org (B.L. Paton), Lynn.Schiffern@atriumhealth.org (L. Schiffern), Samuel.Ross@atriumhealth.org (S.W. Ross), Caroline.E.Reinke@atriumhealth.org (C.E. Reinke).

https://doi.org/10.1016/j.amjsurg.2020.06.039
0002-9610/© 2020 Elsevier Inc. All rights reserved.

Methods

Study population

We identified patients undergoing non-elective general surgery procedures using the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP). The NSQIP is a nationally validated, risk-adjusted, outcomes-based program utilized to measure and improve the quality of surgical care nationwide.[3,11,12] NSQIP provides participating hospitals with various tools, reports, analyses and other resources to assist healthcare providers in making informed decisions about quality care. This is in an effort to improve quality of surgical care and simultaneously reduce complications and cost.[12] We analyzed data from the NSQIP Participant Use Data File (PUF) from 2011 to 2016, identifying patients with a surgical specialty of "general surgery" undergoing non-elective procedures. These patients are referred to as "emergency general surgery patients" throughout this manuscript. Subsequently, patients were classified by body mass index (BMI), as non-obese (18–29 kg/m^2), obese (30–39 kg/m^2), morbidly obese (40–49 kg/m^2) and super obese ($\geq$50 kg/m^2).[13]

Definition of variables

The primary outcome of interest was interhospital transfer. Patients were classified as transferred if their origin was "transferred from an acute care hospital inpatient" compared to those admitted from home. Secondary outcome variables included: days to operation, surgical site infection (SSI [organ space, deep, and superficial]), wound disruption, composite wound outcome (any SSI and/or wound disruption), postoperative length of stay, discharge definition (home vs other) and rate of 30-day readmissions.

Independent variables included patient characteristics: BMI, age, sex, race, NSQIP-specific comorbidities, wound classification, and procedure classification. CPT codes were identified and classified using the Agency for Healthcare Research and Quality (AHRQ) "Clinical Classifications Software for Services and Procedures".[14] All variables obtained as part of this study are listed in the Data Variables and Definitions section of the NSQIP PUF.

Statistical analysis

Descriptive statistics were used to characterize the study population. Student's t-test and Anova were used for normally distributed continuous variables and the Chi square tests for categorical variables to compare obese and non-obese populations. Multivariable logistic regression was used to examine the relationship between obesity and preoperative care (interhospital transfer) and postoperative outcomes (SSI, discharge destination and readmission) after controlling for patient characteristics and AHRQ procedure type. Linear regression models were used to examine the relationships between obesity and time to operation as well as time from operation to discharge after controlling for patient characteristics and procedure type.

Results

We identified a total of 419,373 patients who underwent non-elective general surgery. The non-obese patients made up 63% of the population, with 7% of patients being morbidly obese, and 2% being super obese. Patient characteristics by obesity class are reported in Table 1. Obese patients (in all three subclasses), had higher rates of diabetes, hypertension, and dyspnea ($p < 0.01$ for all). Normal weight patients had increased rates of smoking, steroids, disseminated cancer and weight loss ($p < 0.01$ for all).

Highest frequency AHRQ categories[15] included: Appendectomy (95,062); Colorectal resection (78,422); Cholecystectomy and common duct exploration (75,090); Other hernia repair (26,161); Small bowel resection (21,282); Other OR lower GI therapeutic procedures (19,105); and Debridement of Wound, Infection or Burn (13,243). Highest frequency CPT codes[16] included: 44970 laparoscopic procedures on the appendix (19.8%); 47562 and 47563 laparoscopic procedures on the biliary tract (15.7%); 44120, 44140, 44143 excision procedures on the intestines (except rectum, 11.4%).

Patient outcomes by obesity status are reported in Table 2. A total of 19,290 (5%) patients were transferred from another hospital, and the highest rate of transfer was in the super obese patients ($p < 0.01$). Rates of superficial and deep SSI, wound dehiscence and overall wound complications varied by obesity class ($p < 0.01$ for all). Additionally, super obese patients had the highest average length of stay and were the least likely to be discharged home from the hospital.

In multivariate analysis super-obese patients had greater than 50% increased odds of transfer versus normal weight patients (Table 3). Obese patients did not have a significant delay from day of admission to surgical intervention. In fact, the obese and morbidly obese had decreased time to operation, although not clinically meaningful (Table 3). These results were not substantially altered after controlling for transfer status.

Results of the multivariate analysis for types of SSI by obesity status are reported in Table 4. Obese, morbidly obese, and super obese had higher odds of superficial, deep, incisional surgical site infection, and the odds of SSI increased progressively in each obesity category. After controlling for other factors organ space SSI became non-significant in the super obese patients. Super obese patients had 70% higher odds than normal weight patients of having the composite SSI outcome (Table 4).

Morbidly obese and super obese patients had higher postoperative length of stay versus non-obese patients, with the super obese staying more than 1 day longer (Table 5). Morbidly obese patients and super obese patients have decreased odds of being discharged to home, 31% and 60% respectively (Table 5). Obese patients had a slightly decreased odds of 30-day readmission, while this was not statistically significant for the morbidly obese and super obese (Table 5).

Discussion

Our study found that obese patients had increased odds of interhospital transfer, increased rates of postoperative wound occurrences, and increased odds of being discharged to somewhere other than home care across a wide variety of emergency general surgery procedures. Obese patients, for the largest volume surgical procedures, had significantly higher annual national hospital expenditures compared to non-obese patients - totaling nearly $160 million.[4] Emergency general surgery admissions account for approximately three million hospitalizations in the United States annually, and continues to rise.[17,18] In general, patients undergoing emergency general surgery constitute a different population than those undergoing elective surgery, as the need for intervention negates the opportunity for preoperative selection and optimization.[6] Emergency operations in the general population (orthopedic, gastrointestinal, hernia) are associated with a higher risk of morbidity, mortality, length of stay and resource utilization.[19] Obesity is associated with increased risk of several comorbidities such as diabetes mellitus, ischemic stroke, hypertension, heart disease, cancers and cardiovascular diseases; These comorbidities also predispose patients to post-operative morbidity and mortality.[1–10] With the concurrent rise of obesity and emergency surgeries

Table 1
EGS population characteristics.

	Normal Weight/Overweight N = 262,243	Obese N = 118,117	Morbidly Obese N = 29,053	Super Obese N = 9,960	p-value
Female	51%	55%	67%	69%	<0.01
White	71%	72%	71%	69%	<0.01
Black	11%	14%	17%	20%	
Other	18%	14%	12%	11%	
Age, mean (SD)	56 (20)	55 (17)	51 (16)	50 (14)	<0.01
Diabetes	12%	22%	30%	35%	<0.01
Hypertension	38%	48%	53%	59%	<0.01
COPD	6%	6%	7%	9%	<0.01
Dyspnea	6%	7%	9%	14%	<0.01
Dependent functional status	7%	5%	6%	9%	<0.01
CHF	2%	2%	3%	4%	<0.01
Renal failure	1%	2%	2%	3%	<0.01
Dialysis	2%	3%	3%	3%	<0.01
Ascites	2%	2%	1%	0.9%	<0.01
Smoking	22%	19%	19%	19%	<0.01
Steroids	6%	5%	4%	4%	<0.01
Disseminated cancer	5%	3%	2%	1%	<0.01
Weight loss	5%	2%	0.9%	0.8%	<0.01
Bleeding disorder	8%	9%	9%	10%	<0.01

COPD = Chronic obstructive pulmonary disease; CHF = congestive heart failure.

understanding the patterns of care in this patient population will be valuable to develop interventions to improve patient outcomes.

In the neurosurgical, orthopedic, and elective general surgery patient population, obesity is an independent risk factor for 30-day readmission.[20–26] The cause of readmission differed by procedure specialty grouping; however, reasons for re-admission did not differ between the obese and non-obese patient population within the various surgical subpopulations.[26] In general, obese patients are more likely to be discharged to a facility versus home at time of discharge, which is consistent with findings from our study.[24] In our study, morbid and super obesity was associated with increased rates of 30-day readmission and discharge to a facility after inpatient hospital admission.

We hypothesized that obese patients would be more likely to be transferred between acute care hospitals independent of their comorbidities due to perceived higher risk for this population. Our findings supported that obesity is independently associated with increased odds of transfer, especially in the morbidly and super obese. Based on the current body of literature little is known about outcomes and resource utilization of interhospital transfers for obese patients with EGS diagnoses.[27] Surgical patients have a higher rate of comorbidities, utilize additional resources at transferring and receiving hospitals, have higher acuity and have worse outcomes involving post-operative complications and mortality. Therefore, there is an anticipated benefit when transferring patients between hospitals.[27–29] Potential reasons for emergency general surgery patients undergoing interhospital transfer include rural surgeon shortage and increasing specialization in surgical fields which may incentivize patient transfers to prevent malpractice concerns.[27–29] Additionally, as health care providers

Table 2
EGS outcomes by obesity class.

	Normal Weight/Overweight N = 261,949	Obese N = 117,999	Morbidly Obese N = 29,016	Super Obese N = 9,952	p-value
Transferred[a]	5.5%	5.6%	6.2%	8.0%	<0.01
Days to operation (median)	1	1	1	1	<0.01
Days to operation (mean)	2.29	2.08	2.08	2.23	<0.01
Wound complications					
Superficial SSI	3.0%	3.4%	3.8%	5.3%	<0.01
Deep SSI	1.1%	1.4%	2.0%	2.4%	<0.01
Organ space SSI	4.1%	3.8%	3.5%	3.3%	<0.01
Fascial dehiscence	0.9%	1.0%	1.1%	1.2%	<0.01
Any of the above	8.3%	8.8%	9.7%	11.2%	<0.01
Days to discharge (median [IQR])	4 (7)	3 (6)	3 (6)	4 (6)	<0.01
Days to discharge (mean [SD])	6.3 (8)	5.7 (8)	6.0 (8)	7.2 (10)	<0.01
Discharge destination[b]					<0.01
Home	82%	85%	83%	77%	
Skilled Care	10%	8%	9%	12%	
Rehab	3%	3%	3%	4%	
Death	4%	3%	3%	4%	
30-day Readmission	8%	8%	8%	9%	<0.01

*medians compared using KWallis test, median by ANOVA.
[a] Transferred from other acute care hospital.
[b] Home = home or "facility which was home".

Table 3
Multivariate analysis.

Interhospital Transfer[a]			
	OR	CI	P-value
Non-obese	Ref	Ref	Ref
Obese	1.07	0.04–1.11	<0.01
Morbid obesity	1.20	1.14–1.27	<0.01
Super obesity	1.53	1.41–1.66	<0.01
Admission to day of operation (per day)[b]			
	Coefficient	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	−0.10	(-0.14) - (−0.07)	<0.01
Morbid obesity	−0.15	(-0.21) - (−0.09)	<0.01
Super obesity	−0.07	(-0.18) – (0.03)	0.19

[a] Controlling for age, sex, race, comorbidities, wound class, AHRQ procedure category.
[b] Controlling for age, sex, race, comorbidities, wound class, AHRQ procedure category, and transfer status.

are increasingly able to prolong life in patients with a myriad of significant comorbidities, emergency general surgery patients may represent a more complex patient subpopulation which smaller hospitals may be less comfortable treating.[27] Health care provider implicit bias towards obese patients may also contribute to higher rate of interhospital transfer, as there is a general perception of increased work effort to care for these patients.[30] Weight bias refers to physician perception that obesity is associated with laziness, noncompliance and a general lack of personal responsibility which may influence surgeon reluctance to perform surgery on these patients and prompt interhospital transfer.[30] Obese patients require unique resources which may not be readily available in most smaller or rural hospitals prompting transfer. This includes but not limited to: increased weight limit/larger diameter CT/MRI machines, bariatric specialty equipment, and structural changes to patient care facilities to accommodate increasingly larger patients.[30] Increasing resources for this unique subclass of patient at hospitals currently without these resources may provide the opportunity to improve patient outcomes – by deterring transfers - and improve total cost and health care utilization. Additional research is warranted to understand specific hospital factors associated with transfer, investigating both structural and clinical resources. However, the current body of literature - including the findings of this study - demonstrate a correlation between obesity and post-operative morbidity that is important to understand.

Although obesity has been demonstrated to be protective against mortality, obesity is a significant risk factor for surgical site infection, longer operation time, prolonged length of stay (LOS), and unplanned hospital readmissions.[1–3,5,7–10] We observed an increased rate of all types of surgical site infection and prolonged LOS. Yet when controlling for patient characteristics and procedure type, there was a decreased rate of 30-day readmission. Non-surgical costs associated with obesity are well documented, however, surgical, and in particular emergency surgical costs are not.[4] Severely obese patients have been shown to require greater resources, including repeat surgery and prolonged ICU stay.[6]

Table 4
Multivariate analysis, EGS Wound Complications by Obesity Class.

Superficial Incision Surgical Site Infection			
	OR	CI	P-value
Non-obese	Ref	Ref	Ref
Obese	1.32	1.27–1.38	<0.01
Morbid obesity	1.58	1.48–1.70	<0.01
Super obesity	2.22	2.01–2.44	<0.01
Deep Incisional (Fascial) Surgical Site Infection			
	OR	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	1.38	1.29–1.47	<0.01
Morbid obesity	1.79	1.63–1.98	<0.01
Super obesity	1.82	1.57–2.10	<0.01
Organ Space Surgical Site Infection			
	OR	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	1.04	1.00–1.08	0.03
Morbid obesity	1.08	1.01–1.16	0.03
Super obesity	1.08	0.96–1.21	0.22
Wound Dehiscence			
	OR	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	1.36	1.26–1.46	<0.01
Morbid obesity	1.81	1.60–2.05	<0.01
Super obesity	2.01	1.66–2.45	<0.01
Total Synthesized Surgical Site Infection			
	OR	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	1.22	1.19–1.25	<0.01
Morbid obesity	1.45	1.38–1.51	<0.01
Super obesity	1.69	1.57–1.81	<0.01

*All models controlled for age, sex, race, comorbidities, wound class and CPT category.

Table 5
Multivariate analysis: EGS length of stay, discharge home, and readmission.

Postoperative Length of Stay			
	Coefficient (Days)	CI	P-value
Non-obese	Ref	Ref	Ref
Obese	0.00	−0.05 - 0.05	0.87
Morbid obesity	0.37	0.29–0.46	<0.01
Super obesity	1.15	1.00–1.29	<0.01
Discharge to Home (vs. Other)			
	OR	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	0.97	0.95–0.99	0.02
Morbid obesity	0.71	0.68–0.74	<0.01
Super obesity	0.42	0.39–0.44	<0.01
30-day Readmission			
	OR	**CI**	**P-value**
Non-obese	Ref	Ref	Ref
Obese	0.96	0.93–0.98	<0.01
Morbid obesity	0.99	0.94–1.04	0.60
Super obesity	1.05	0.97–1.13	0.23

*Controlling for age, sex, race, comorbidities, wound class, and procedure category.

Additionally, it has been theorized that obesity has a significant impact on workload for general surgeons. A study performed by Hawn and colleagues noted a statistical correlation between BMI and increased operative time.[7] This directly translates to increased workload not only for surgeons but also anesthesia and nursing. In 2002 due to Medicare reimbursement stipulations, reimbursement for colectomy and mastectomy decreased by 50% when compared to 1989 reimbursement rates.[4] During this same timeframe the prevalence of obesity doubled. This suggests that as the obesity epidemic persists, surgeons are getting paid less to do more.[4] Several investigators have supported the development of a CPT modifier and appropriate considerations for RVU assigned to surgical cases for obese patients due to increased workload for surgeons and increased health services use associated with this unique patient population.[4,6,7]

As health care transitions from volume-based to a value-based bundled system, defining quality care for obese patients undergoing emergency general surgery will be necessary. Bundled payment models were implemented in 2016 by Medicare for hip or knee replacement surgery and are being developed for other surgical specialties. There is considerable concern that bundled-payment programs create an incentive to treat healthier patients rather than those that are “sicker” and have more “costly” care.[30] Meller and colleages[31] analyzed patients undergoing total knee arthroplasty (TKA) to capture data on subpopulations (in particular morbid and super-morbidly obese) on which to define bundled payments for episodes of care. The investigators noted excess costs for patients defined as morbid or super-morbid obese versus non-obese patients which have implications in negotiating CMS bundled payments for this subclass of patients.[31] It can be inferred that in the setting of transitioning to value-based bundled care payments, without appropriate adjustment for obesity, hospitals caring for obese emergency general surgery patients may be unfairly penalized. Additional investigation is warranted to determine excess costs of caring for obese emergency general surgery patients to assist in the definition of value-based bundled payments for this unique group of patients.

With over a third of the patients undergoing non-elective general surgery procedures being obese, we believe our findings highlight the need for enhanced recovery protocols in emergency general surgery patients with special attention given to the obese subset. NSQIP is one of the few national datasets which collects BMI in addition to over 200 other variables.[12] This makes NSQIP data uniquely qualified to assess post-operative outcomes for obese patients in an attempt to enhance surgical quality on a national level.[3,10,12,32,33] In elective surgery cases, weight loss programs have been utilized for obese patients to enhance pre-operative patient optimization and prevent post-operative morbidity and mortality.[34] However compliance with these programs is poor, and the chances of returning to a normal weight for someone who is already obese is extremely low.[35,36] Therefore, enhanced recovery protocols in the emergency general surgery obese patient population that emphasize operative and postoperative management of obese patients may also be valuable in the elective surgery population.

Enhanced recovery protocols (ERPs) are a set of standardized perioperative orders and procedures that are applied to all patients undergoing a given surgery in an attempt to improve patient outcomes, and has traditionally focused on elective procedures.[32,33] ERPs aim to improve outcomes such as pain at rest, return of bowel function, wound/surgical site healing, nausea, and early hospital discharge.[32,33] ERPs are often designed for the elective surgical patients, but components of the protocols could be generalized to the emergency general surgery patient.[32,33] Boodaie and colleages[10] developed a “perioperative care map” using precautions and best practices commonly employed for bariatric patients to all general surgery patients. Findings from this enhanced recovery protocol-type intervention noted an adjusted decrease in rates of unplanned returns to the operating room, total length of stay, postoperative length of stay, and unplanned readmission.[10] It can be inferred that with additional research regarding the impact of obesity on preoperative care and post-operative outcomes, a similar ERP can be developed to improve outcomes in the emergency general surgery patient population.

Limitations

Despite the many benefits of the NSQIP database, there are limitations to our study. The NSQIP PUF does not include cost or charge data. However, it can be inferred that the observed increased incidence of surgical site infection, increased inter-hospital transfer, increased length of stay, and discharge to a location other than home, contribute to overall increased cost in the obese patient population. The sample analyzed is a cohort obtained from hospitals that participate in NSQIP, thereby may not be representative of all obese patients whom undergo emergency general surgery nationally. There is a known relationship between poverty and obesity in the United States, however patient-level data on socioeconomic status and insurance status are not included in the NSQIP PUF database and thus were unable to be included in the analysis.[36]

Information regarding the attributes of the hospital that patients initially presented to and were transferred from is not available in the NSQIP database. Utilizing the National Inpatient Sample (NIS) hospital level factors including characteristics such as total number of discharges, bed size (small, medium, large), hospital region, hospital control/ownership and teaching status were noted to be more contributory to transfer status for emergency general surgery patients (operative and non-operative) and were noted to outweigh patient-level factors.[37] However, the NIS does not include patient BMI which prohibits itsd ability to evaluate the association between BMI and transfer.

An additional limitation of this study is that patients with emergency general surgery conditions managed non-operatively were not captured. Previous studies have identified that as many as half of these patients with emergency general surgery diagnoses do not undergo operative intervention, which has been shown to be true for transferred patients as well.[28]

Conclusions

This study found that after controlling for patient characteristics, obese patients had increased odds of transfer, wound infection, and discharged to location other than home. However, obese patients had slightly decreased odds of 30-day readmission. As obesity and emergency general surgery continue as significant public health burdens, it is necessary to better understand their impact on outcomes, resources, and hospital quality metrics so we can identify areas for targeted improvement.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

References

1. Defining adult Oerweight and Obesity. http://www.cdc.gov/obesity/adult/defining.html; 2016.
2. Tjeertes EK, Hoeks SE, Beks SB, Valentijn TM, Hoofwijk AG, Stolker RJ. Obesity–a risk factor for postoperative complications in general surgery? *BMC Anesthesiol*. 2015;15:112.
3. Spartalis M, Tzatzaki E, Moris D, Athanasiou A, Spartalis E. Morbidity, mortality, and obesity paradox. *Ann Transl Med*. 2017;5:440.
4. Mullen JT, Moorman DW, Davenport DL. The obesity paradox: body mass index and outcomes in patients undergoing nonbariatric general surgery. *Ann Surg*. 2009;250:166–172.
5. Mason RJ, Moroney JR, Berne TV. The cost of obesity for nonbariatric inpatient operative procedures in the United States: national cost estimates obese versus nonobese patients. *Ann Surg*. 2013;258:541–551. discussion 51-3.
6. Kwon Y, Kim HJ, Park S, Park YG, Cho KH. Body mass index-related mortality in patients with type 2 diabetes and heterogeneity in obesity paradox studies: a dose-response meta-analysis. *PloS One*. 2017;12, e0168247.
7. Kupper S, Karvellas CJ, Khadaroo RG, Widder SL, Acute C, Emergency Surgery G. Increased health services use by severely obese patients undergoing emergency surgery: a retrospective cohort study. *Can J Surg*. 2015;58:41–47.
8. Hawn MT, Bian J, Leeth RR, et al. Impact of obesity on resource utilization for general surgical procedures. *Ann Surg*. 2005;241:821–826. discussion 6-8.
9. Glance LG, Li Y, Osler TM, Mukamel DB, Dick AW. Impact of obesity on mortality and complications in trauma patients. *Ann Surg*. 2014;259:576–581.
10. Encinosa WE, Bernard DM, Chen CC, Steiner CA. Healthcare utilization and outcomes after bariatric surgery. *Med Care*. 2006;44:706–712.
11. Solsky Ian, Edelstein Alex, Brodman Michael, Kaleya Ronald, Rosenblatt Meg, Santana Calie, Feldman David L, Kischak Patricia, Somerville Donna, Mudiraj Santosh, Leitman I Michael, Shamamian Peter. Perioperative care map improves compliance with best practices for the morbidly obese. *Surgery*. 2017;160(6). ISSN: 0039-6060:1682–1688. https://doi.org/10.1016/j.surg.2016.07.035.
12. Khuri SF, Daley J, Henderson W, et al. The Department of Veterans Affairs' NSQIP: the first national, validated, outcome-based, risk-adjusted, and peer-controlled program for the measurement and enhancement of the quality of surgical care. National VA Surgical Quality Improvement Program. *Ann Surg*. 1998;228:491–507.
13. ACS National Surgical Quality Improvement Program (ACS NSQIP). https://www.facs.org/quality-programs/acs-nsqip/about; 2017. Accessed December 11, 2017.
14. Al-Mulhim AS, Al-Hussaini HA, Al-Jalal BA, Al-Moagal RO, Al-Najjar SA. Obesity disease and surgery. *Int J Chronic Dis*. 2014;2014:652341.
15. AfHRa Quality. *HCUP CCS-Services and Procedures. Healthcare Cost and Utilization Project (HCUP)*. March 2018.
16. Beta Clinical Classifications Software (CCS) for ICD-10-CM/PCS. Healthcare cost and utilization project (HCUP), 2019 www.hcup-us.ahrq.gov/toolssoftware/ccs10/ccs10.jsp; 2018.
17. AAPC Coder. https://coder.aapc.com/; 2019.
18. Reinke CET M, Paton L, Schiffern L, Rozario N, Matthews BD. Emergency general surgery transfers in the United States: a 10-year analysis. *J Surg Res*. 2017;219:128–135.
19. Ogola GO, Gale SC, Haider A, Shafi S. The financial burden of emergency general surgery: national estimates 2010 to 2060. *J Trauma Acute Care Surg*. 2015;79:444–448.
20. Sippey M, Pender JR, Chapman WH, et al. Delayed repair of obstructing ventral hernias is associated with higher mortality and morbidity. *Am J Surg*. 2015;210:833–837.
21. Ali AM, Loeffler MD, Aylin P, Bottle A. Factors associated with 30-day readmission after primary total hip arthroplasty: analysis of 514455 procedures in the UK national health service. *JAMA Surg*. 2017;152, e173949.
22. Elsamadicy AA, Adogwa O, Vuong VD, et al. Patient body mass index is an independent predictor of 30-day hospital readmission after elective spine surgery. *World Neurosurg*. 2016;96:148–151.
23. Kassin MT, Owen RM, Perez SD, et al. Risk factors for 30-day hospital readmission among general surgery patients. *J Am Coll Surg*. 2012;215:322–330.
24. Silber JH, Rosenbaum PR, Kelz RR, et al. Medical and financial risks associated with surgery in the elderly obese. *Ann Surg*. 2012;256:79–86.
25. Fu MC, Samuel AM, Sculco PK, MacLean CH, Padgett DE, McLawhorn AS. Discharge to inpatient facilities after total hip arthroplasty is associated with increased postdischarge morbidity. *J Arthroplasty*. 2017;32:S144–S149 e1.
26. Prohaska MG, Keeney BJ, Beg HA, et al. Preoperative body mass index and physical function are associated with length of stay and facility discharge after total knee arthroplasty. *Knee*. 2017;24:634–640.
27. Reinke CE, Kelz RR, Zubizarreta JR, et al. Obesity and readmission in elderly surgical patients. *Surgery*. 2012;152:355–362.
28. Reinke CE, Thomason M, Paton L, Schiffern L, Rozario N, Matthews BD. Emergency general surgery transfers in the United States: a 10-year analysis. *J Surg Res*. 2017;219:128–135.
29. Yelverton S, Rozario N, Matthews BD, Reinke CE. Interhospital transfer for emergency general surgery: an independent predictor of mortality. *Am J Surg*. 2018;216:787–792.
30. Hammond KL. Practical issues in the surgical care of the obese patient. *Ochsner J*. 2013;13:224–227.
31. Barnett ML, Wilcock A, McWilliams JM, et al. Two-Year evaluation of mandatory bundled payments for joint replacement. *N Engl J Med*. 2019;380:252–262.
32. Meller MM, Toossi N, Johanson NA, Gonzalez MH, Son MS, Lau EC. Risk and cost of 90-day complications in morbidly and superobese patients after total knee arthroplasty. *J Arthroplasty*. 2016;31:2091–2098.
33. Improving perioperative care worldwide. http://erassociety.org/about/history/; 2017. Accessed December 11, 2017.
34. Carmichael JC, Keller DS, Baldini G, et al. Clinical practice guidelines for enhanced recovery after colon and rectal surgery from the American society of colon and rectal surgeons and society of American gastrointestinal and endoscopic surgeons. *Dis Colon Rectum*. 2017;60:761–784.
35. Kmietowicz Z. Trust defers surgical referrals for patients to lose weight and stop smoking. *BMJ : British Medical Journal (Online)*. Jul 28, 2011;343. https://doi.org/10.1136/bmj.d4792.
36. Lemstra M, et al. Weight loss intervention adherence and factors promoting adherence: a meta-analysis. *Patient Prefer Adherence*. 2016;10:1547–1559.
37. Ingraham A, et al. Factors associated with the interhospital transfer of emergency general surgery patients. *J Surg Res*. 2019;240:191–200.