Emergency surgery for acute diverticulitis: Which operation? A National Surgical Quality Improvement Program study

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BACKGROUND: The optimal surgical management of acute diverticulitis is still a controversial and unresolved issue. While the Hartmann's procedure (') is the most commonly performed operation, primary anastomosis (PA), with or without proximal diversion, has also been used with increasing frequency.

METHODS: This is a National Surgical Quality Improvement Program database study including all patients requiring emergency surgery for acute diverticulitis. Three operative approaches were analyzed: HP, colectomy with PA, and colectomy with PA with proximal diversion (PAPD). Mortality and postoperative outcomes were compared between the three groups using a logistical regression model.

RESULTS: There were 1,314 patients who required emergent operation for acute diverticulitis, 75.4% underwent HP, 21.7% underwent PA, and 2.9% underwent PAPD. Thirty-day mortality was 7.3%, 4.6%, and 1.6% for HP, PA, and PAPD respectively (p = 0.163), while surgical site infections occurred in 19.7%, 17.9%, and 13.2%, respectively (p = 0.59). After multivariable analysis adjusting for age, alcohol consumption, comorbidities, steroid use, preoperative laboratory values, hemorrhage at admission and laparoscopic surgery, the adjusted odds ratio for 30-day mortality comparing PA with HP was 0.77 (95% confidence interval [CI], 0.38–1.56; p = 0.465), 0.47 (95% CI, 0.06–3.74; p = 0.479) comparing PAPD with HP, and 1.62 (95% CI, 0.19–13.78; p = 0.658) comparing PA with PAPD. In addition, the three groups did not have significantly different adjusted odds ratio for the development of surgical infectious complications, acute kidney injury, cardiovascular incidents, or venous thromboembolism after surgery.

CONCLUSION: Resection and PA in patients undergoing an emergency operation for acute diverticulitis is a safe alternative to the HP, with no significant difference in mortality or postoperative surgical site infections. (*J Trauma Acute Care Surg*. 2013;74: 1385–1391. Copyright © 2013 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Therapeutic study, level IV.

KEY WORDS: Acute diverticulitis; Hartmann's procedure; primary anastomosis; primary anastomosis; proximal diversion.

Acute diverticulitis is a common acute surgical problem in the Western world. An estimated 30% of the population older than 60 years is affected with diverticular disease, and as many as 25% of these people will go on to develop acute diverticulitis.[1–3] In the United States, the age-adjusted admission rate for acute diverticulitis has increased by 26% from 120,500 hospital admissions in 1998 to 151,900 admissions in 2005. The largest increase in hospital admission has been in patients younger than 45 years.[4,5]

Patients with contained perforation (Hinchey Stages I and II) can often be managed with intravenously administered antibiotics with or without percutaneous drainage of the abscess, depending on abscess size. Those with free perforation resulting in either purulent or fecal peritonitis (Hinchey Stages III and IV) require surgery.[1,6,7] The original three-stage operative approach to diverticulitis with perforation (initial diversion, resection of diseased colon, and subsequent anastomosis) is no longer recommended and by the 1980s; the Hartmann's procedure (HP) became the operation of choice in the management of complicated diverticulitis requiring an emergency operation.[6,7] However, in the late 1990s, the concept of resection and primary anastomosis (PA) with or without proximal diversion (PAPD) was introduced and has since become a common procedure.[6–8]

The purpose of this study was to compare postoperative outcomes with the three common techniques (HP, PA, and PAPD) used in the emergency management of acute diverticulitis using the American College of Surgeons' (ACS) National Surgical Quality Improvement Program (NSQIP) database.

PATIENTS AND METHODS

This is a study using the ACS NSQIP database. Established in 2004, the NSQIP database collects data from a growing number of hospitals in the United States, with more than 300 participating in 2011. The NSQIP database is capable of documenting outcomes up to 30 days in 95% of the cases entered into the database. The ACS provides training and ongoing education and conducts audits to ensure data reliability.

International Classification of Diseases—9th Rev. codes were used to identify all patients with diverticulitis (562.11, diverticulitis of colon without hemorrhage; 562.13, diverticulitis of colon with hemorrhage). Only cases coded as emergent were included, and elective cases were excluded. The study population was further divided into three groups based on surgical management using current procedural terminology (CPT) codes: colectomy partial with end colostomy and closure of distal segment (HP), colectomy with PA and colectomy with PA and proximal diversion (PAPD) (Table 1). CPT code 44141 (colectomy partial with skin level cecostomy or colostomy) was excluded because the Hartmann-type procedure has its own CPT code, and an anastomosis is not included in the definition of the CPT code; therefore, it does not necessarily define HP, PA, or PAPD.

TABLE 1. CPT Codes

HP	44143: Colectomy partial with end colostomy and closure of distal segment (Hartmann-type procedure)
	44206: Laparoscopy surgical; colectomy partial with end colostomy and closure of distal segment (Hartmann-type procedure)
PA	44140: Colectomy, partial with anastomosis
	44145: Colectomy with coloproctostomy (low pelvic anastomosis)
	44204: Laparoscopy surgical; colectomy, partial with anastomosis
	44207: Laparoscopy surgical; colectomy partial with anastomosis with coloproctostomy
PAPD	44146: Colectomy partial with coloproctostomy (low pelvic anastomosis) with colostomy
	44208: Laparoscopy surgical; colectomy partial with anastomosis with coloproctostomy; with colostomy

The preoperative characteristics of the three groups were compared using the following variables: age, sex, a history of smoking, alcohol consumption, a history of comorbidities (cardiovascular incidents [CVIs], hypertension, cerebrovascular accidents [CVAs], steroid use, chemotherapy, and radiotherapy of malignancy), level of practitioner performing the operation (attending or resident), septic status at admission (systemic inflammatory response syndrome or septic shock), preoperative laboratory values (white blood cell [WBC] count, hematocrit, and abnormal creatinine level [>1.5 mg/dL]), presence of hemorrhage at admission, and the surgical technique (laparoscopy vs. open surgery). Body mass index (BMI) was used to classify patients as overweight (BMI, 25–29.9 kg/m^2) and obese (BMI ≥ 30 kg/m^2).

The outcomes measured included the development of complications including surgical site infections (SSIs), systemic infectious complications (SICs), CVIs, and acute kidney injury (AKI), hospital length of stay (LOS), and mortality.

The preoperative characteristics of the three study groups were compared using Pearson's χ^2 or Fisher's exact test as appropriate for categorical variables, and Student's *t* test or Mann-Whitney U-test for continuous variables. Mortality, SSIs, SICs, postoperative AKI, and postoperative CVIs were reported using Pearson's χ^2.

To compare the safety and efficacy of the three different surgical techniques (HP, PA, and PAPD), a multivariate analysis for each outcome was performed adjusting for covariables that differed between the three groups both statistically and clinically.

TABLE 2. Epidemiology and Clinical Characteristics of Patients Undergoing Emergency Surgery

	Overall (n = 1,314)	HP (n = 991)	PA (n = 285)	PAPD (n = 38)	*p*
Demographics					
Age	62.5 ± 15.2	62.9 ± 15.2	60.7 ± 15.1	64.3 ± 15.4	0.086
Sex (male)	49.4 (649)	49.6 (492)	48.1 (137)	52.6 (20)	0.825
BMI	26.9 ± 1.0	26.8 ± 1.0	27.5 ± 8.8	26.1 ± 8.1	0.502
Overweight	30.7 (403)	30.4 (301)	30.2 (86)	42.1 (16)	0.300
Obese	34.7 (456)	35.0 (347)	34.7 (99)	26.3 (10)	0.543
Social history					
Tobacco	24.3 (319)	24.6 (244)	23.9 (68)	18.4 (7)	0.670
Alcohol	5.9 (77)	5.8 (57)	5.3 (15)	13.2 (5)	0.144
Comorbidities					
Diabetes mellitus	11.9 (156)	12.6 (125)	10.5 (30)	2.6 (1)	0.128
HxCVI	14.5 (191)	15.6 (155)	11.9 (34)	5.3 (2)	0.076
Hypertension	53.0 (697)	54.6 (541)	49.5 (141)	39.5 (15)	0.074
CVA	9.9 (130)	9.6 (95)	11.9 (34)	2.6 (1)	0.159
Renal failure	4.3 (57)	4.8 (48)	2.5 (7)	5.3 (2)	0.210
Steroid use	13.6 (179)	15.7 (156)	7.0 (20)	7.9 (3)	<0.001
Chemotherapy for malignancy	2.7 (35)	3.1 (31)	1.1 (3)	2.6 (1)	0.159
Radiotherapy for malignancy	1.7 (22)	2.0 (20)	0.7 (2)	0.0 (0)	0.224
Septic status at admission					
SIRS	44.7 (588)	46.2 (458)	38.6 (110)	52.6 (20)	0.045
Septic shock	4.9 (65)	5.4 (54)	2.8 (8)	7.9 (3)	0.135
Operative wound classification					
Contaminated	11.4 (150)	9.8 (97)	16.5 (47)	15.8 (6)	0.005
Infected	73.7 (969)	78.6 (779)	56.8 (162)	73.7 (28)	<0.001
Preoperative laboratory values					
WBC	13.7 ± 6.3	14.0 ± 6.4	12.8 ± 6.1	12.4 ± 6.3	0.006
Hematocrit	38.3 ± 6.2	38.3 ± 6.2	38.3 ± 6.2	38.7 ± 6.6	0.925
Abnormal creatinine (>1.5 mg/dL)	16.1 (211)	18.1 (179)	10.2 (29)	7.9 (3)	0.002
Hemorrhage at admission	4.9 (64)	3.9 (39)	7.7 (22)	7.9 (3)	0.022
Laparoscopic operation	6.3 (83)	4.3 (43)	13.3 (38)	5.3 (2)	<0.001
Resident operating	33.1 (435)	32.2 (319)	36.1 (103)	34.2 (13)	0.453

HxCVI, history of cardiovascular incident; SIRS, systemic inflammatory response syndrome.

Owing to the multiple comparisons, statistical significance was set at $p < 0.01$. The type of operative management (HP, PA, and PAPD) was entered into the logistic regression model as an ordinal variable. Adjusted odds ratios (AORs) with 95% confidence intervals and adjusted p values were derived from the logistic regressions.

To examine the impact of BMI on development of SSIs, BMI was categorized into four groups as follows: underweight (BMI ≤ 18.5 kg/m^2), normal weight (BMI, 18.6–24.9 kg/m^2), overweight (BMI, 25–29.9 kg/m^2), and obese (BMI ≥ 30 kg/m^2). The incidence of SSIs for each BMI group was assessed.

RESULTS

During the study period (2005–2008), 1,334,886 surgical patients were entered in the ACS NSQIP database. Of these, 1,314 required an emergent operation for acute diverticulitis. A total of 991 patients (75.4%) were managed with the HP, 285 (21.7%) had a colectomy with PA, and 38 (2.9%) had colectomy with PA and proximal diverting colostomy or ileostomy. There were no changing trends in how acute diverticulitis was operatively managed during the 4-year study period. The rates of HP and PA were the same throughout each year.

Baseline characteristics of each group are shown in Table 2. There were no significant differences between the three groups in age, BMI, social history, preoperative septic status, preoperative WBC count, hematocrit, abnormal creatinine level, and most comorbidities. Those who underwent HP (15.7%) were more likely to have a history of steroid use at admission compared with PA (7%) and PAPD (7.9%) ($p < 0.001$). Patients who underwent HP (78.6%) and PAPD (73.7%) were more likely to have an infected wound at operation compared with PA (56.8%) ($p < 0.001$). The PA group (13.3%) was more likely to have a laparoscopic procedure compared with HP (4.3%) and PAPD (5.3%) ($p < 0.001$). No patients in the database underwent laparoscopic lavage and drainage only as the primary surgical management of their diverticulitis.

Unadjusted outcomes between the three procedures are shown in Table 3. There were no significant differences in 30-day mortality or the development of SSIs. SICs were less common in the PA group compared with HP (14.0% vs. 20.7%) and PAPD (14.0% vs. 23.7%), but these differences did not reach statistical significance (Table 3). Similarly, AKI, CVI, and deep venous thrombosis/thrombophlebitis after surgery did not differ significantly among the three groups (Table 3). Pulmonary embolism was more likely to occur after HP (14%) compared with PA (4%), but not significantly so. No pulmonary embolisms occurred in the PAPD group. The hospital LOS was significantly longer in the PAPD group (14 days) and HP group (13.1 days) compared with the PA group (11.8 days) ($p = 0.008$) (Table 3).

There were 65 cases admitted with septic shock, 54 of which underwent HP, 8 underwent PA, and 3 underwent PAPD. The mortalities in HP and PA group were 33.3% and 12.5%, respectively ($p = 0.489$). The SSIs were 22.2% and 25.0% ($p = 0.639$) and the SICs 37.0% and 25.0%, respectively ($p = 0.800$).

When development of SSIs was stratified according to different BMI groups, patients with normal weight had the lowest incidence. Patients classified as overweight or obese were significantly more likely to develop SSIs. Underweight patients were more likely to develop SSI, but this difference did not reach significance (Fig. 1).

After a multivariate analysis (adjusting for age, diabetes, alcohol consumption, history of comorbidities [CVI, CVA, hypertension requiring medication], steroid use, infected wound, preoperative laboratory values [WBC and creatinine], presence of hemorrhage at admission and laparoscopic surgery), no

TABLE 3. Unadjusted Outcomes According to the Type of Emergency Operation

	Overall (n = 1,314)	HP (n = 991)	PA (285)	PAPD (n = 38)	p
30-d mortality	6.5 (86)	7.3 (72)	4.6 (13)	2.6 (1)	0.163
SSIs	16.1 (251)	19.7 (195)	17.9 (51)	13.2 (5)	0.509
Superficial wound infection	9.5 (125)	10.1 (100)	8.1 (23)	5.3 (2)	0.392
Deep incisional infection	3.0 (39)	2.8 (28)	3.9 (11)	0.0 (0)	0.364
Abscess	5.0 (66)	5.2 (52)	4.6 (13)	2.6 (1)	0.709
Wound dehiscence	4.0 (53)	4.0 (40)	3.5 (10)	7.9 (3)	0.435
SICs	19.3 (254)	20.7 (205)	14.0 (40)	23.7 (9)	0.034
Pneumonia	7.2 (94)	7.9 (78)	4.2 (12)	10.5 (4)	0.077
UTI	2.8 (37)	2.8 (28)	2.8 (8)	2.6 (1)	0.997
Sepsis	7.8 (102)	7.9 (78)	8.1 (23)	2.6 (1)	0.484
Septic shock	8.7 (114)	9.2 (91)	6.3 (18)	13.2 (5)	0.193
AKI	3.1 (41)	3.1 (31)	3.5 (10)	0.0 (0)	0.505
CVI	5.6 (73)	5.7 (56)	4.9 (14)	7.9 (3)	0.727
Pulmonary embolism	1.4 (18)	1.4 (14)	1.4 (4)	0.0 (0)	0.762
DVT/Thrombophlebitis	2.6 (34)	2.6 (26)	2.1 (6)	5.3 (2)	0.510
Hospital LOS	12.9 ± 9.0	13.1 ± 9.0	11.8 ± 8.0	14.0 ± 10.0	0.008

DVT, deep venous thrombosis; SIC, surgical infectious complication; UTI, urinary tract infection.

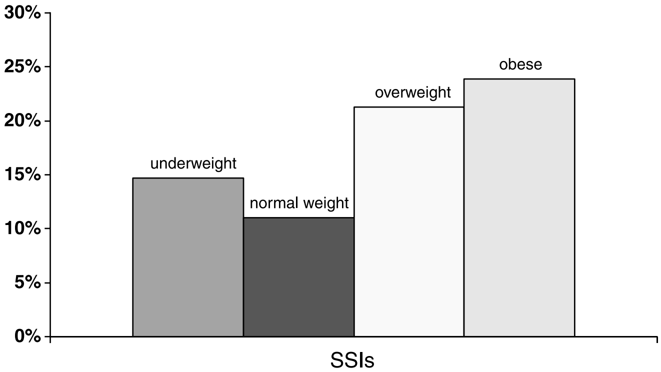

Figure 1. Impact of BMI on the development of SSIs. Underweight to normal weight, $p = 0.271$; normal weight to overweight: $p < 0.001$; overweight to obese, $p = 0.371$, Impact of BMI on development of SSIs (AOR [95% CI], 1.34 [1.15–1.56]; adjusted $p < 0.001$).

significant difference was found in the AOR for 30-day mortality between the three surgical techniques used to manage patients presenting with acute diverticulitis. In addition, the three groups did not have significantly different AOR for the development of SSIs, surgical infectious complications, AKI, CVIs, or venous thromboembolism after surgery (Table 4).

DISCUSSION

The optimal surgical management of acute diverticulitis is still a controversial and unresolved issue. While the HP has become the standard of care in the emergency operative management of acute diverticulitis, the morbidity and mortality of the HP can be as high as 24.2% and 18.8%, respectively.[8] In addition, 10% of patients will have stoma complications after HP and in up to 27% of patients, the stoma will be permanent.[8,9] The postoperative complications after Hartmann's reversal can range from 4.9% to 25%, with an anastomotic leak rate of 4.3%.[8,9] In addition, Vermeulen et al.[10] found that long-term quality of life was worse after the HP compared with PA, with the presence of a permanent stoma being the primary factor that related to poor quality of life in patients surveyed. Because of the potential stoma-related complications, poor quality of life, risk of permanent colostomy, and the complications associated with reversal, avoidance of the HP in the management of acute diverticulitis is a desirable a goal.

Last updated in 2006, the American Society of Colon and Rectal Surgeons practice parameters for sigmoid diverticulitis recommend urgent sigmoid colectomy for patients with diffuse peritonitis, but "the precise role and relative safety of PA … remains unsettled."[1] A systematic literature review of 569 patients from 50 studies found that PA for diverticular peritonitis may be safe compared with HP.[8] In a multicenter study of 200 consecutive patients presenting with perforated diverticulitis from the Netherlands, 70% of patients underwent an HP, while 30% were managed by PA. There was no significant difference in mortality comparing HP with PA but a twofold increase in complications after HP compared with PA.[11] In our study of the ACS NSQIP database, 1,314 patients underwent emergency surgery for acute diverticulitis, the majority of which underwent the Hartmann's procedure (75.4%), with nearly 300 patients receiving a resection and PA (21.7%). When HP was compared with PA in a multivariate analysis correcting for multiple factors, there was no significant difference in mortality, SSI, surgical infectious complications, venous thromboembolism, CVI, and AKI (Table 4). There was a trend toward a higher mortality in the HP group (7.3% vs. 4.6%), but this did not reach significance (Table 3). In this analysis of the ACS NSQIP database, resection and PA in patients undergoing an emergency operation for acute diverticulitis showed no difference in mortality or postoperative complications compared with the HP.

TABLE 4. Adjusted Outcomes of the Three Operative Approaches in Acute Diverticulitis

	PA vs. HP		PAPD vs. HP		PA vs. PAPD	
	AOR (95% CI)	Adjusted *p*	AOR (95% CI)	Adjusted *p*	AOR (95% CI)	Adjusted *p*
30-d mortality	0.77 (0.38–1.56)	0.465	0.47 (0.06–3.74)	0.479	1.62 (0.19–13.78)	0.658
SSIs	0.94 (0.66–1.34)	0.727	0.67 (0.25–1.74)	0.406	1.41 (0.52–3.83)	0.499
Superficial wound infection	0.82 (0.50–1.33)	0.414	0.50 (0.12–2.13)	0.348	1.63 (0.37–7.28)	0.522
Deep incisional infection	1.43 (0.67–3.06)	0.355	<0.01 (<0.001–15.23)	0.998	<0.01 (<0.001–5.9E7)	0.998
Abscess	0.98 (0.52–1.88)	0.961	0.58 (0.08–4.34)	0.591	1.71 (0.21–13.70)	0.613
Wound dehiscence	0.81 (0.37–1.74)	0.580	2.15 (0.61–7.55)	0.232	0.37 (0.09–1.51)	0.168
SICs	0.72 (0.49–1.06)	0.098	1.38 (0.63–3.01)	0.424	0.52 (0.22–1.21)	0.130
Pneumonia	0.56 (0.29–1.09)	0.086	1.74 (0.58–5.17)	0.320	0.32 (0.10–1.10)	0.070
UTI	0.95 (0.40–2.24)	0.898	0.77 (0.10–6.17)	0.809	1.22 (0.14–10.61)	0.856
Sepsis	1.14 (0.68–1.91)	0.615	0.34 (0.05–2.53)	0.292	3.36 (0.44–25.98)	0.245
Septic shock	0.87 (0.50–1.51)	0.615	1.70 (0.62–4.65)	0.299	0.51 (0.17–1.52)	0.227
AKI	1.69 (0.75–3.78)	0.204	<0.01 (<0.001–15.23)	0.998	<0.01 (<0.001–3.1E7)	0.998
CVI	0.91 (0.46–1.81)	0.788	2.07 (0.58–7.42)	0.264	0.44 (0.11–1.74)	0.242
Pulmonary embolism	0.90 (0.27–2.93)	0.856	<0.01 (<0.001–12.89)	0.998	0.01 (<0.001–1.9E7)	0.998
DVT/Thrombophlebitis	1.01 (0.39–2.64)	0.980	3.20 (0.69–14.96)	0.139	0.32 (0.06–1.72)	0.182

Adjusting for factors with a $p < 0.01$ (steroid use, contaminated or infected operative wound, WBC, creatinine > 1.5 mg/dL, and laparoscopic surgery), age, alcohol consumption, history of comorbidities (diabetes, CVI, CVA, hypertension requiring medication), and presence of hemorrhage at admission.

DVT, deep venous thrombosis; SIC, surgical infectious complication; UTI, urinary tract infection.

The role of proximal diversion after resection and PA for acute diverticulitis is not clear. The associated complications after diverting ileostomy or colostomy are less frequent when compared with an end colostomy. The rates of wound infection and anastomotic leak are less, and diverting ostomies are more likely to be reversed.[8,9] In the present study, there were only 38 patients who underwent PAPD with mortality rate of 2.6% versus 7.3% compared with HP. In the PAPD group, there was a trend toward fewer SSIs (13.2% vs. 19.7%), more SICs (23.7% vs. 20.7%), and more CVIs (7.9% vs. 5.7%) when compared with the HP (Table 3), but these differences did not reach significance. When comparing the adjusted outcomes of PAPD with HP, there was no difference in mortality or other postoperative complications (Table 4). When comparing PA with PAPD, there was a trend toward higher mortality (AOR, 1.62), SSIs (AOR, 1.41), and postoperative sepsis (AOR, 3.36), but these differences were not significant (Table 4). While there seems to be a trend toward improved mortality and no significant difference in postoperative outcomes in the PAPD group compared with the HP group, given the small number of patients in this study, it is difficult to draw definitive conclusions. A recent analysis of 2,018 patients in the ACS NSQIP database comparing PAPD (340) with HP (1,678) in the management of diverticulitis found no difference in mortality or morbidity between the two approaches. The authors did find a twofold increase in mortality after PAPD compared with HP when only dirty/infected cases were considered. It is difficult to interpret their results for several reasons. First, patients with the diagnosis of diverticulosis were included in their analysis. Second, their definition of PAPD used the CPT code 44140 (colectomy, partial with anastomosis), not CPT codes 44146 (colectomy, partial with coloproctostomy with colostomy) or 44208 (laparoscopy surgical, colectomy partial with anastomosis with coloproctostomy, with colostomy) (Table 1) further confounding their results.[12] Recently, Oberkofler et al.[13] performed the only randomized clinical trial comparing PA with diverting ileostomy to the HP. Sixty-two patients with purulent or fecal peritonitis (Hinchey Stages III and IV) in four centers were randomized to PAPD or HP. The overall outcomes for the initial resection and subsequent stoma takedowns were not significantly different, but there was trend toward a higher mortality (13% vs. 9%) but lower overall morbidity (67% vs. 75%) in the HP group. Those with a PAPD had a significantly higher stoma reversal rate compared with HP (90% vs. 57%, $p = 0.005$).

Only 83 of the patients in this cohort underwent laparoscopic surgery; 43 underwent laparoscopic HP, 38 laparoscopic resection and PA, and 2 had a laparoscopic resection with PAPD (Table 2). No patients in the ACS NSQIP database were identified that underwent laparoscopic peritoneal lavage as the sole surgical management of acute diverticulitis. During the 4-year study period, there was no increasing trend toward the use of the laparoscopic approach in the surgical management of complicated diverticulitis.

The optimal surgical management of critically ill patients admitted in septic shock is not clear. There were only 65 such patients in this study, and no meaningful outcome analysis could be performed. The major beneficial role of damage control in trauma is well established. However, there are no studies addressing this issue in this selected group of unstable patients.

The impact of BMI on SSI after surgery for acute diverticulitis was also evaluated (Fig. 1). In this analysis of the ACS NSQIP database, patients who were overweight or obese were significantly more likely to develop a postoperative SSI. In patients undergoing major intra-abdominal cancer surgery, Mullen et al.[14] found that BMI of greater than 30.1 kg/m^2 was an independent risk factor for overall morbidity primarily from wound infections. The increased risk of SSI in obesity is thought to be secondary to technical difficulty during the operation, altered wound physiology, and impaired wound healing.[15] Underweight patients in this study tended to have more SSIs as well. Mullen et al. did not find that being underweight (BMI < 18.5 kg/m^2) was associated with additional morbidity but, when adjusted for other factors, did increase the risk of death after surgery by more than fivefold.[14] In a prospective analysis of various elective surgical patients, Waisbren et al.[15] found a nonlinear relationship between BMI and SSI. Obese patients as defined by BMI (30.1–45 kg/m^2) did not have an increased risk of SSI when compared with patients with a normal BMI, but when percent body fat was used to define obesity, there was a fivefold increased risk of SSI after elective surgery. More study is needed to determine the precise impact of BMI in postoperative outcomes and SSIs in patients with complicated diverticulitis.

In conclusion, our analysis of the ACS NSQIP database shows that the Hartman's procedure is the most common operation used in NSQIP participating hospitals in the United States for the emergent operative management of acute diverticulitis. There was no difference in postoperative outcomes comparing three different operative strategies (HP, PA, and PAPD). Resection and PA can be performed safely in acute diverticulitis with no difference in postoperative morbidity or 30-day mortality when compared with the Hartmann's procedure. Given the risk of permanent colostomy, known stoma related complications, and the additional morbidity and mortality associated with subsequent Hartmann's reversal, resection and PA with or without proximal diversion should be considered over the HP in the emergent surgical management of acute diverticulitis.

AUTHORSHIP

E.K., M.T., D.S., and D.D. performed the literature search. D.D. and A.S. provided the study design. E.K., D.S., and D.S. performed the data collection. E.K., D.S., D.D., and P.T. performed the data analysis. D.D., K.I., P.T., and A.S. performed the data interpretation. E.K., D.S., D.D., A.S., K.I. wrote the article. A.S., P.T., and K.I. provided the critical revision.

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