Published in final edited form as:
Am Surg. 2011 July ; 77(7): 832–838.

Outcomes of Revascularized Acute Mesenteric Ischemia in the American College of Surgeons National Surgical Quality Improvement Program Database

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Abstract

This report examines outcomes of revascularization for acute arterial mesenteric ischemia (AAMI) using the American College of Surgeons National Surgical Quality Improvement Program database. Patients with International Classification of Diseases, 9th Revision and Current Procedural Terminology codes indicating AAMI with concomitant mesenteric revascularization were identified. Demographic, risk factor, procedural, morbidity, and mortality data were examined. Associations with morbidity and mortality were analyzed by logistic regression. One hundred forty-two cases of AAMI were identified. Seventy-one cases were thrombotic and 71 were embolic according to revascularization codes. Mean age was 66 years, 84 per cent of patients were white, and 54 per cent were female. Unadjusted major morbidity and mortality rates were 69 and 30 per cent, respectively. Patients with thrombotic AAMI were more likely to have a lower body mass index, greater than 10 per cent weight loss in the past 6 months, and a history of smoking. Patients with embolic AAMI were more likely to present emergently with sepsis. Unadjusted morbidity and mortality rates were 78 and 38 per cent for embolic and 61 and 23 per cent for thrombotic AAMI, respectively. Multi-variable predictors of morbidity included bowel resection at the time of revascularization, transfer admission, and involvement of a surgical resident. Multivariable predictors of mortality included impaired functional status, increased age, and postoperative sepsis. Cause of AAMI was not a significant predictor of morbidity or mortality. In a large sample of AAMI cases, AAMI remained a highly lethal and morbid condition.

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Presented at the Annual Scientific Meeting and Postgraduate Course Program, Southeastern Surgical Congress, Chattanooga, TN, February 12–15, 2011.

Predictors of morbidity and mortality included indicators of advanced presentation, treatment delay, and patient-related factors specific to AAMI, including debility and advanced age. Efforts directed at prevention and increasing the speed of diagnosis and definitive treatment appear to be necessary to improve outcomes.

Acute arterial mesenteric ischemia (AAMI) is an uncommon but life-threatening surgical emergency. Despite widespread advances in surgery and surgical critical care, the mortality associated with AAMI remains high.[1–3] The major causes of acute arterial occlusive AAMI include acute thrombosis of chronic mesenteric atherosclerotic disease and acute embolization of previously disease-free mesenteric arteries.[2–6] Independent of etiology, the acute cessation of perfusion to the bowel leads to irreversible tissue necrosis if untreated. Early diagnosis with prompt, aggressive intervention is essential to avoid intestinal infarction and patient death. Unfortunately, nonspecific clinical presentations can lead to delays in diagnosis, making it difficult to achieve early revascularization in many cases. The propensity for delay in diagnosis is compounded by the rarity of AAMI, which often leads to the omission of AAMI consideration in the differential diagnosis for high-risk patients with acute abdominal pain. This relative rarity of AAMI cases has also precluded systematic multi-center and prospective investigations of AAMI leaving important gaps in our collective knowledge relating to this condition. In this study, we examined contemporary surgical practice and outcome patterns in patients undergoing revascularization for AAMI using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) public use database to further characterize the problem of AAMI in North American surgical practice.

Methods

Data Source

The private sector ACS-NSQIP is a validated, prospective database derived from a systematic sampling of cases at 211 participating hospitals throughout North America. Available data include patient demographics, medical risk factors, and detailed information regarding procedural specifics and postoperative morbidity and mortality. All data are collected at participating sites by a trained research nurse. Definitions for those variables collected in the NSQIP database have been described in previous reports.[7–9]

Study Sample

Patients with International Classification of Diseases, 9th Revision (ICD-9) and Current Procedural Terminology (CPT) codes indicating AAMI with concomitant mesenteric revascularization between January 2005 and December 2008 were identified in the ACS-NSQIP database. Cases were defined as revascularized AAMI based on the presence of CPT codes indicating mesenteric arterial revascularization by bypass (CPT codes 35531, 35631, 35632, 35633), endarterectomy (CPT code 35341), or embolectomy (CPT code 34151) and the presence of an ICD-9 code for mesenteric ischemia (ICD-9 codes 557.0, 569.83, 557.9, 567.21, 567.9, 789.00 to 789.99, or 787.3). This yielded 142 total cases of AAMI with concomitant mesenteric revascularization for our investigation.

Demographics and Medical Risk Factors

All demographic and medical risk factor data were extracted directly from the ACS-NSQIP database. Race was considered as white or nonwhite (including Hispanic, Asian, Native American, and black race categories). Age was considered as a continuous variable with ages exceeding 90 years coded as being 90 years of age by the ACS-NSQIP to prevent the potential for individual patient identification (this affected three observations in the sample). Estimated glomerular filtration rate was used to assess renal function and calculated using the abbreviated Modification of Diet in Renal Disease formula.[10] Body mass index (BMI) was calculated using height and weight data. Decreased functional status was defined as partial or total dependence before surgery. AAMI cases were defined as secondary to thrombosis based on operative codes for bypass or endarterectomy or embolic based on the CPT codes defined previously.

End Points

Two major outcomes were analyzed for the purposes of this investigation: morbidity and mortality. Postoperative complications (morbidity) were analyzed individually and in aggregate categories including wound (superficial or deep surgical site infections), pulmonary (pneumonia, reintubation, or failure to wean from ventilator within 48 hours), renal (postoperative renal function decline or need for dialysis), venous thromboembolic (deep vein thrombosis or pulmonary embolus), cardiovascular (myocardial infarction, cardiac arrest, or stroke), operative (return to the operating room, postoperative bleeding, or graft failure), and septic (sepsis and septic shock). Postoperative mortality was defined as death within 30 days or during the same acute care hospital stay regardless of time. As a secondary outcome, length of stay (LOS) was defined as the time from the endovascular aneurysm surgery to hospital discharge or death.

Statistical Analysis

Preoperative characteristics, medical risk factors, and procedural data were described using mean ± SD, count (%), or median (Quartile 1, Quartile 3). Patient descriptives were compared across etiologies using chi-square or Fisher exact test for categorical variables and independent samples *t* test for continuous variables.

Morbidity and mortality associations with preoperative characteristics, medical risk factors, and procedural information were examined using simple and multivariable logistic regressions. Stepwise variable selection techniques were used for multivariable models using $P < 0.10$ to enter the model and $P < 0.05$ to stay. To preserve sample size, variables with greater than 5 per cent missing data were excluded from the candidate covariate lists. All analyses were performed using SAS software, Version 9.2 (SAS Institute, Cary, NC).

Results

Study Sample Characteristics

Demographic and risk factor data are summarized in Table 1. A total of 142 revascularized AAMI cases were identified. Mean age for the study sample was 66 years, and 84 per cent of patients were white. Seventy-seven (54%) were female and 65 (46%) were male. Thirtythree patients (23%) underwent revascularization surgery after an interhospital transfer and 50 patients (35%) had a decreased functional status preoperatively as defined by partial or total dependence. Twenty-nine cases (20%) had a greater than 10 per cent weight loss in the past 6 months. Seventy-four cases were septic preoperatively (52%).

An equal number of cases were designated as embolic (71) or thrombotic (71). Patients with embolic AAMI were more likely to present with sepsis and to have an emergency operation for their AAMI. Patients with thrombotic AAMI were more likely to be white, smokers, to have undergone prior coronary angioplasty or a stent procedure, have 10 per cent or greater weight loss in the preceding 6 months, and had a lower BMI.

Procedural Specifics

Procedural specifics are summarized in Table 2. There was a mean interval of 1.8 (±2.9) days from hospital admission to operation (embolic 1.1 ± 1.7 days, thrombotic 2.5 ± 3.6 days). Ninety-seven (68%) AAMI cases underwent emergent operations. Ninety-six AAMI cases (68%) were performed by vascular surgeons and 46 (32%) were performed by general surgeons. Overall, the mean operative time for the study sample was 204 minutes. A surgical resident was involved in 112 (79%) AAMI cases. The mean blood transfusion amount was 1.2 (±1.8) units. A bowel resection was performed as part of 48 (34%) AAMI cases.

Procedural specifics varied according to AAMI etiology (Table 2). Cases of AAMI from an embolic source had a shorter operative time and were more likely to involve a concomitant bowel resection. In cases of thrombotic AAMI, 16 (22.5%) underwent endarterectomy and 55 (77.5%) required a bypass. Seventeen bypass procedures (31%) used a vein and 38 (69%) were performed with a prosthetic conduit. No extra-anatomic bypasses were identified in the sample (bypasses with an iliac artery origin for a retrograde bypass to the mesenteric vessels defined by CPT codes 35632 and 35633).

Associations with Morbidity, Mortality, and Length of Stay

Overall, defined morbidity occurred in 69 per cent of the total AAMI cases. In the subsets, 78 per cent of the embolic cases experienced major morbidity *versus* 61 per cent of the thrombotic cases. Mean LOS was 16.0 ± 16.4 days, and median LOS was 10.5 days (6.0, 22.0). Thirty-day mortality was 30 per cent (38% for cases of embolic AAMI and 23% for thrombotic AAMI).

Univariable associations with morbidity and mortality are summarized in Table 3. Significant univariable associations with morbidity and mortality were observed for emergency surgery, decreased functional status, preoperative sepsis, AAMI etiology (embolic *vs* thrombotic), hospital transfer status, and bowel resection at the time of revascularization. In addition, univariate associations with mortality were also seen with surgeon specialty (general *vs* vascular surgeon), increased patient age, prior cardiac surgery, history of stroke, postoperative acute renal failure, postoperative hemorrhage, postoperative septic shock, and weight loss greater than 10 per cent weight loss in the past 6 months.

Multivariable analyses of morbidity and mortality are summarized in Tables 4 and 5. Significant multivariable associations with morbidity were observed for concomitant bowel resection (OR, 17.7; 95% CI, 3.9 to 79.9; $P < 0.001$), interhospital transfer (OR, 5.6; 95% CI, 1.4 to 21.5; $P = 0.013$), and resident involvement (OR, 2.7; 95% CI, 1.0 to 7.4; $P = 0.045$). Multivariable predictors of mortality included impaired functional status (OR, 4.0; 95% CI, 1.8 to 9.0; $P < 0.001$), increased age (OR 1.2 for 5-year increase; 95% CI, 1.1 to 1.5; $P = 0.007$), and postoperative septic shock (OR, 3.1; 95% CI, 1.2 to 7.8; $P = 0.017$).

Discussion

In this multicenter sample of prospectively collected data regarding revascularized cases of AAMI in North America, AAMI remained a highly morbid and lethal condition. Predictors of morbidity and mortality included factors associated with advanced presentation and delays in definitive treatment as well as factors specific to the populations at risk.

AAMI has long been known to represent a serious threat to the lives of affected patients. A number of well-characterized single-center series have addressed this topic. Endean et al.[5] examined 58 patients with vaso-occlusive AAMI and found a nearly equal number of cases secondary to thrombosis and embolus with a 60 per cent overall mortality for cases of arterial occlusion. Park et al.[6] examined the experience at the Mayo Clinic with 58 patients and found a 43 per cent prevalence of pre-AAMI symptoms consistent with chronic visceral ischemia and a 32 per cent overall mortality with the need for bowel resection and increased patient age independently predictive of mortality. Our group examined 76 patients with AAMI at Wake Forest[4] and demonstrated a high prevalence of advanced clinical presentation with 81 per cent of patients manifesting a gangrenous bowel. Delays in treatment were common as were premorbid conditions increasing patient risk for AAMI, including symptoms of chronic mesenteric ischemia (34%) and unanticoagulated atrial fibrillation (12%). Overall mortality was 62 per cent and lifelong dependence on parenteral nutrition among survivors was common. Other reports[1, 3, 11–13] have supported the findings from these large experiences, specifically the high mortality rates of 30 to 70 per cent and the association of mortality with increased age, delays in presentation, and advanced clinical presentation. However, all of these reports have represented retrospective reviews at single institutions and are subject to inherent biases of local referral and practice patterns.

This report represents the first large, multicenter report concerning AAMI using prospectively collected data that we are aware of. It examined 142 cases of revascularized AAMI in 211 North American hospitals using data from the ACS-NSQIP. These data have affirmed many of the findings from the prior single-center studies and provided additional novel data. Specifically, these data have affirmed the relatively rare occurrence of AAMI. Only 142 revascularized AAMI cases were observed in a sample of over 600,000 sampled major operations. Although the ACS-NSQIP represents a nonrandom, structured sample of major surgeries that is not specifically designed to provide weighted prevalence and incidence information, this relative rarity of AAMI cases, representing less than 0.02 per cent of major surgical cases, is striking. AAMI was also demonstrated to be a disease of the elderly and the infirm with a mean age for patients of 66 years and 35 per cent of patients having some degree of functional dependence. Also in agreement with prior reports, the morbidity and mortality of these cases were high. A total major morbidity rate of 69 per cent and a mortality rate of 30 per cent were observed. The mortality rate may appear to represent an improvement over historical controls, and this may be true; however, it must be remembered that the characteristics of the ACS-NSQIP data set made it practically impossible to identify cases of AAMI not treated by revascularization (i.e., unsalvageable cases with massive bowel necrosis). These cases represented a significant portion of the samples reported in the previously discussed single-center series[4, 5] and demonstrated the worst results.

The larger sample size afforded by the ACS-NSQIP database also allowed for more robust multivariable analyses of adverse outcomes. In this report, major morbidity was associated with the need for a bowel resection at the time of revascularization, the receipt of the patient to the treating institution through interhospital transfer, and the participation of a surgical resident in the operation. We feel that these results indicate the adverse predictive power of delays in definitive care and advanced clinical presentation as the result of such delays. We do not feel that the participation of a surgical resident is a predictor of morbidity, *per se,* as much as such participation is the result of the patient's transfer to a teaching facility. Mortality was predicted, in this report, by impaired functional status, increased patient age, and the occurrence of postoperative septic shock. We feel that these associations with mortality are indicative of the adverse effects of patient-specific factors indicating infirmity (age and functional status) and the occurrence of septic sequelae so common with advanced presentations of AAMI.

This report also detailed a number of other very interesting findings. Despite the fact that etiology of AAMI (thrombosis *vs* embolus) was not an independent predictor of morbidity or mortality, it was very intriguing that embolic AAMI cases were more likely to be associated with an emergent operative status, need for bowel resection, presence of preoperative sepsis, and higher morbidity and mortality. We speculate that the strong associations of embolic AAMI with bowel necrosis led to its relative nonsignificance as an independent predictor in multivariable modeling, but that does not detract from the importance of the findings. As to why this occurs, we hypothesize that patients with embolic AAMI do not possess the collateral mesenteric circulation that is so commonly observed in the evaluation of patients with chronic atherosclerotic mesenteric occlusive disease, which is the primary underlying condition leading to cases of thrombotic AAMI. As such, when the embolus acutely occludes the midgut circulation, the ischemia is immediately profound and rapidly progressive. This acuity of ischemia coupled with the rarity of the condition (which likely leads to its noninclusion in the differential diagnosis for acute abdominal pain in the minds of most early evaluators of these patients) could certainly be a postulated mechanism for the observed results in terms of the advanced presentations of embolic AAMI in this report. Another interesting finding was the high incidence of significant weight loss preceding the AAMI event in the thrombotic group. This finding echoes the previous findings of Edwards et al.[4] and Park et al.[6] and suggests a need for intensified efforts in identifying and treating patients with chronic mesenteric ischemia before thrombosis of their occlusive disease.

These novel findings aside, this analysis represents an examination of a large multicenter database with a number of important limitations. First, the ACS-NSQIP database was not designed specifically to answer questions regarding AAMI and lacks important data points that would allow for the identification of patients treated without revascularization. For example, we examined all patients with ICD-9 codes for acute mesenteric ischemia (as defined in the methods) without the codes for revascularization and the search yielded over 4000 cases. The procedure codes associated with these cases included hernia repairs, colon resections, adhesiolysis, and appendectomies. As such, we did not feel that this likely represented a legitimate sample of AAMI of vascular origin but more likely a collection of strangulated hernias, bowel obstructions, etc. The structure of the database also excludes information on subsequent operative procedures within the same hospitalization making it impossible to accurately track the practice of second-look laparotomy and the need for subsequent bowel resection, a practice that has been demonstrated to affect mortality.[4, 11] This limitation is likely to affect other analyses of ACS-NSQIP data, and it would be ideal if future iterations of the data set would allow for tracking of multiple operations within the same hospital stay. Furthermore, the codes included in the ACS-NSQEP purposefully exclude catheter–based codes making it impossible to identify AAMI cases treated with thrombolysis, stents, angioplasty, etc. Although these practices represent a minority of cases in recent investigations, their use to treat AAMI is increasing.[14] Lastly, the necessity of ICD-9 and CPT codes to identify cases relies on the accuracy of both the physicians and coding personnel at the institution of origin as well as the competence of the abstracting NSQIP research nurses. It is likely that a number of AAMI cases were miscoded and missed in the generation of this study sample.

These limitations aside, this report represents a novel multicenter review of AAMI demonstrating the gravity of AAMI and the implications of delayed diagnosis, advanced clinical presentation, and patient-specific factors in predicting subsequent morbidity and mortality. Efforts directed at prevention and increasing the speed of diagnosis and definitive treatment appear to be necessary to improve on the observed outcomes.

References

1. Mamode N, Pickford I, Leiberman P. Failure to improve outcome in acute mesenteric ischaemia: seven year review. Eur J Surg. 1999; 165:203–8. [PubMed: 10231652]
2. Oldenburg WA, Lau LL, Rodenberg TJ, et al. Acute mesenteric ischemia—a clinical review. Arch Intern Med. 2004; 164:1054–62. [PubMed: 15159262]
3. Schoots IG, Koffeman GI, Legemate DA, et al. Systematic review of survival after acute mesenteric ischaemia according to disease aetiology. Br J Surg. 2004; 91:17–27. [PubMed: 14716789]
4. Edwards MS, Cherr GS, Craven TE, et al. Acute occlusive mesenteric ischemia: surgical management and outcomes. Ann Vasc Surg. 2003; 17:72–9. [PubMed: 12522695]
5. Endean ED, Barnes SL, Kwolek CJ, et al. Surgical management of thrombotic acute intestinal ischemia. Ann Surg. 2001; 233:801–8. [PubMed: 11407335]
6. Park WM, Gloviczki P, Cherry KJ, et al. Contemporary management of acute mesenteric ischemia: factors associated with survival. J Vasc Surg. 2002; 35:445–52. [PubMed: 11877691]
7. Crawford RS, Cambria RP, Abularrage CJ, et al. Preoperative functional status predicts perioperative outcomes after infrainguinal bypass surgery. J Vasc Surg. 2010; 51:351–9. [PubMed: 20141958]
8. Hua HT, Cambria RP, Chuang SK, et al. Early outcomes of endovascular versus open abdominal aortic aneurysm repair in the National Surgical Quality Improvement Program-Private Sector (NSQIP-PS). J Vasc Surg. 2005; 41:382–9. [PubMed: 15838467]
9. LaMuraglia GM, Conrad MF, Chung T, et al. Significant perioperative morbidity accompanies contemporary infrainguinal bypass surgery: an NSQIP report. J Vasc Surg. 2009; 50:299–304. [PubMed: 19631864]

10. Levey AS, Coresh J, Greene T, et al. Using standardized serum creatinine values in the Modification of Diet in Renal Disease Study equation for estimating glomerular filtration rate. Ann Intern Med. 2006; 145:247–54. [PubMed: 16908915]

11. Acosta-Merida MA, Marchena-Gomez J, Hemmersbach-Miller M, et al. Identification of risk factors for perioperative mortality in acute mesenteric ischemia. World J Surg. 2006; 30:1579–85. [PubMed: 16865320]

12. Eltarawy IG, Etman YM, Zenati M, et al. Acute mesenteric ischemia: the importance of early surgical consultation. Am Surg. 2009; 75:212–9. [PubMed: 19350855]

13. Kougias P, Lau D, El Sayed HF, et al. Determinants of mortality and treatment outcome following surgical interventions for acute mesenteric ischemia. J Vasc Surg. 2007; 46:467–74. [PubMed: 17681712]

14. Schermerhorn ML, Giles KA, Hamdan AD, et al. Mesenteric revascularization: management and outcomes in the United States, 1988–2006. J Vasc Surg. 2009; 50:341–8. [PubMed: 19372025]

Table 1

Patient Descriptives

	Acute Arterial Mesenteric Ischemia			
Variable	**All (n = 142)**	**Embolic (n = 71)**	**Thrombotic (n = 71)**	***P***[*]
Age (years)[‡]	66.4 ± 13.5	67.9 ± 15.0	64.8 ± 11.7	0.1715
Race				0.0057[†]
American Indian or Alaska Native	0	0	0	
Asian or Pacific Islander	0	0	0	
Black, not of Hispanic origin	7 (4.9)	6 (8.5)	1 (1.4)	
Hispanic, black	0	0	0	
Hispanic, color unknown	5 (3.5)	5 (7.0)	0	
Hispanic, white	1 (0.7)	0	1 (1.4)	
White, not of Hispanic origin	119 (83.8)	53 (74.7)	66 (93.0)	
Unknown	10 (7.0)	7 (9.9)	3 (4.2)	
Female gender	77 (54.2)	41 (57.8)	36 (50.7)	0.3997
Body mass index	24.6 ± 6.2	25.9 ± 6.0	23.4 ± 6.2	0.0202
Diabetes	24 (16.9)	11 (15.5)	13 (18.3)	0.6543
Current smoker	56 (39.4)	25 (35.2)	31 (43.7)	0.3029
Ever smoker	84 (67.2)	33 (53.2)	51 (81.0)	0.0010
Pack-years smoking (all available)[§]	27.2 ± 32.2	19.2 ± 27.2	35.4 ± 34.9	0.0073
Functional status (before current illness)				0.6346[†]
Independent	130 (93.5)	63 (91.3)	67 (95.7)	
Partially dependent	7 (5.0)	5 (7.3)	2 (2.9)	
Totally dependent	2 (1.4)	1 (1.5)	1 (1.4)	
Functional status (before surgery)				0.3720
Independent	92 (64.8)	42 (59.2)	50 (70.4)	
Partially dependent	24 (16.9)	14 (19.7)	10 (14.1)	
Totally dependent	26 (18.3)	15 (21.1)	11 (15.5)	
History of				
Chronic obstructive pulmonary disease	24 (16.9)	8 (11.3)	16 (22.5)	0.0732
Congestive heart failure	8 (5.6)	5 (7.0)	3 (4.2)	0.7185[†]
Myocardial infarction	4 (2.8)	3 (4.2)	1 (1.4)	0.6196[†]
Angina	6 (4.2)	3 (4.2)	3 (4.2)	1.0000[†]
Prior coronary artery bypass grafting	22 (15.5)	12 (16.9)	10 (14.1)	0.6428
Prior percutaneous transluminal coronary intervention	23 (16.2)	7 (9.9)	16 (22.5)	0.0404
Hypertension	109 (76.8)	56 (78.9)	53 (74.7)	0.5511
Revascularization or amputation	24 (16.9)	11 (15.5)	13 (18.3)	0.6543
Acute renal failure	2 (1.4)	1 (1.4)	1 (1.4)	1.0000[†]
Dialysis dependence[//]	3 (2.1)	3 (4.2)	0	0.2447[†]
Transient ischemic attack	12 (8.5)	9 (12.7)	3 (4.2)	0.0703

Variable	Acute Arterial Mesenteric Ischemia All (n = 142)	Embolic (n = 71)	Thrombotic (n = 71)	P*
Stroke without disability	9 (6.3)	6 (8.5)	3 (4.2)	0.4934†
Stroke with disability	8 (5.6)	7 (9.9)	1 (1.4)	0.0626†
Bleeding disorder	47 (33.1)	29 (40.9)	18 (25.4)	0.0498
10% or more weight loss in past 6 months	29 (20.4)	4 (5.6)	25 (35.2)	<0.0001
Preoperative sepsis (sepsis inflammatory response syndrome, sepsis, or septic shock)	74 (52.1)	51 (71.8)	23 (32.4)	<0.0001
Operation within preceding 30 days¶	19 (15.2)	10 (15.2)	9 (15.3)	0.9873
Transfer status				0.8770†
Acute care hospital	30 (21.1)	14 (19.7)	16 (22.5)	
Admitted directly from home	109 (76.8)	55 (77.5)	54 (76.1)	
Chronic care facility	3 (2.1)	2 (2.8)	1 (1.4)	
Veterans Affairs acute care hospital	0	0	0	
Veterans Affairs chronic care facility	0	0	0	
Other	0	0	0	
Estimated glomerular filtration rate#	68.2 ± 29.8	59.6 ± 30.9	76.6 ± 26.4	0.0012
Serum albumin **	3.2 ± 0.8	3.3 ± 0.8	3.1 ± 0.8	0.4120
Chronic steroid use	14 (9.9)	8 (11.3)	6 (8.5)	0.5734

* *P* values test association between occlusion type (embolic/thrombotic) and patient characteristic (chi-square or Fisher exact test for categorical, and *t* test for continuous).

† Fisher exact test used in place of chi square as a result of low expected cell counts.

‡ 90+ set to 90.

§ Greater than 20% missing data.

// Dialysis indicated or creatinine greater than 6.0.

¶ Greater than 15% missing data for thrombotic.

\# Set to 0 for preoperative dialysis.

** Greater than 15% missing data for embolic, greater than 20% for thrombotic.

Table 2

Procedural Specifics

	Acute Arterial Mesenteric Ischemia		
Variable	All (n = 142)	Embolic (n = 71)	Thrombotic (n = 71)
Emergency operation	97 (68.3)	63 (88.7)	34 (47.9)
American Society of Anesthesiologists class			
1 = no disturb	0	0	0
2 = mild disturb	8 (5.6)	2 (2.8)	6 (8.5)
3 = severe disturb	54 (38.0)	21 (29.6)	33 (46.5)
4 = life-threatening	71 (50.0)	40 (56.3)	31 (43.7)
5 = moribund	9 (6.3)	8 (11.3)	1 (1.4)
Surgeon specialty			
Vascular surgeon	96 (67.6)	42 (59.2)	54 (76.1)
General surgeon	46 (32.4)	29 (40.9)	17 (23.9)
Resident involved	112 (78.9)	62 (87.3)	50 (70.4)
Postgraduate year class of resident assistance*			
1	5 (4.6)	1 (1.7)	4 (8.3)
2	5 (4.6)	4 (6.7)	1 (2.1)
3	13 (12.0)	8 (13.3)	5 (10.4)
4	25 (23.2)	15 (25.0)	10 (20.8)
5	29 (26.9)	17 (28.3)	12 (25.0)
6	16 (14.8)	10 (16.7)	6 (12.5)
7	14 (13.0)	5 (8.3)	9 (18.8)
8	0	0	0
9	1 (0.9)	0	1 (2.1)
10	0	0	0
Anesthesia type			
General	141 (99.3)	70 (98.6)	71 (100.0)
Regional	0	0	0
Local	0	0	0
Other	1 (0.7)	1 (1.4)	0
Units transfused (red cells)	1.2 ± 1.8	0.8 ± 1.3	1.6 ± 2.2
Operative time (minutes)	203.7 ± 92.5	149.5 ± 60.7	257.9 ± 87.2
Revascularization type			
Embolectomy	71 (50.0)	71 (100.0)	0
Extra-anatomic bypass	0	0	0
Endarterectomy	16 (11.3)	0	16 (22.5)
Bypass (all)	55 (38.7)	0	55 (77.5)
With vein	17 (12.0)	0	17 (23.9)
With prosthetic	38 (26.8)	0	38 (53.5)
Days from hospital admission to operation	1.8 ± 2.9	1.1 ± 1.7	2.5 ± 3.6
Bowel resection	48 (33.8)	33 (46.5)	15 (21.1)

	Acute Arterial Mesenteric Ischemia		
Variable	**All (n = 142)**	**Embolic (n = 71)**	**Thrombotic (n = 71)**
Total work relative value units	52.5 ± 23.2	49.8 ± 21.5	55.1 ± 24.6

*Where resident involved.

Table 3

Univariate Predictors of Morbidity and Mortality

	Morbidity			Mortality		
Variable	**Odds Ratio**	**95% Confidence Interval**	***P***	**Odds Ratio**	**95% Confidence Interval**	***P***
Emergency surgery	3.8	1.8–8.1	<0.001	4.0	1.5–10.4	0.004
Nonindependent functional status	2.8	1.2–6.4	0.016	4.8	2.2–10.3	<0.001
Increased age*				1.3	1.1–1.4	0.004
Preoperative sepsis/sepsis inflammatory response syndrome	2.9	1.4–6.1	0.005	3.4	1.5–7.3	0.002
Concomitant bowel resection	18.6	4.3–81.0	<0.001	2.2	1.1–4.6	0.037
Embolic etiology	2.2	1.1–4.7	0.031	2.1	1.0–4.4	0.046
Hospital transfer	6.0	1.7–21.0	0.005	2.9	1.3–6.4	0.011
General *vs* vascular surgeon	2.0	0.9–4.5	0.10	2.4	1.2–5.2	0.019
Greater than 10% weight loss				0.3	0.1-0.9	0.038
Acute renal failure				3.9	1.0–14.4	0.045
Postoperative hemorrhage				3.7	1.1–12.3	0.036
Postoperative septic shock				3.3	1.5–7.6	0.005

*Greater than 5 years.

Table 4

Multivariable Predictors of Morbidity

	Morbidity		
Variable	**Odds Ratio**	**95% Confidence Interval**	***P***
Bowel resection with revascularization	17.7	3.9–79.9	<0.001
Hospital transfer	5.6	1.4–21.5	0.013
Resident involvement	2.7	1.0–7.4	0.0446

Table 5

Multivariable Predictors of Mortality

	Morbidity		
Variable	**Odds Ratio**	**95% Confidence Interval**	***P***
Impaired functional status	4.0	1.8–9.0	0.001
Increased age	1.2	1.1–1.5	0.007
Postoperative septic shock	3.1	1.2–7.8	0.017