Open abdominal aortic repair in the current era has more complications for occlusive disease than for aneurysm repair

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ABSTRACT

Background: Endovascular intervention has become the first-line treatment of patients with abdominal aortic aneurysms (AAAs) or aortoiliac occlusive disease (AIOD). However, open abdominal aortic repair remains a valuable treatment option for patients who are younger, those with unfavorable anatomy, and patients for whom endovascular intervention has failed. The cohort of patients undergoing open repair has become highly selected; nevertheless, updated outcomes or patient selection recommendations have been unavailable. In the present study, we explored and compared the characteristics and postoperative outcomes of patients who had undergone open abdominal aortic repair from 2009 to 2018.

Methods: Patients who had undergone open AAA (n = 9481) or AIOD (n = 9257) repair were collected from the National Surgical Quality Improvement Program database. The primary outcome was the 30-day mortality. The secondary outcomes included 30-day return to the operating room, total operative time, total hospital stay, and postoperative complications. Unmatched and matched differences between the two groups and changes over time were analyzed. Univariate and multivariate regression analyses were conducted to assess the risk factors predicting for 30-day mortality.

Results: After propensity matching (n = 4980), those in the AIOD group had had a higher 30-day mortality rate (5.1% vs 4.1%; $P = .021$), a higher incidence of wound complications (7.4% vs 5.1%; $P < .0001$) and an increased 30-day return to the operating room (14.2% vs 9.1%; $P < .0001$). More open AIOD cases ($P = .02$) and fewer open AAA cases ($P = .04$) had been treated in the second half of the decade than in the first. The factors associated with an increased odds of 30-day mortality included advanced age, American Society of Anesthesiologists score ≥III, functional dependence, blood transfusion <72 hours before surgery, weight loss in previous 6 months, and a history of chronic obstructive pulmonary disease.

Conclusions: From 2009 to 2018, the number of open AAA repairs decreased and the proportion of open abdominal AIOD cases increased. Open AIOD surgery was associated with higher 30-day mortality, increased return to the operating room, and increased wound complications vs open AAA repair. Multiple risk factors increased the odds for perioperative mortality. Thus, open abdominal aortic repair should be selectively applied to patients with fewer risk factors. (J Vasc Surg 2023;77:432-9.)

Keywords: Abdominal aortic aneurysm; Aortoiliac occlusive disease; NSQIP; Open abdominal

Endovascular intervention has changed the landscape for abdominal aortic surgery in the past three decades. It has become the first-line treatment for patients with abdominal aortic aneurysms (AAAs) and aortoiliac occlusive disease (AIOD) because of its demonstrated lower perioperative morbidity and mortality compared with open repair.[1-4] Nonetheless, open abdominal aortic repair remains a valuable treatment option for both AAAs and AIOD, especially for patients with unfavorable anatomy or for whom endovascular treatment has failed.[5-9] Therefore, the cohort of patients undergoing open abdominal aortic repair has become highly selected as the indications for endovascular technology have expanded. However, it is unknown whether the narrow patient selection has resulted in different surgical outcomes for open abdominal aortic repair. In the present study, we explored and compared the characteristics of, and postoperative outcomes for, patients who had undergone open repair of AAAs and AIOD in the past 10 years using data from the National Surgical Quality Improvement Program (NSQIP) database.

METHODS

Data source. Information was collected from NSQIP database, a quality improvement initiative developed by the American College of Surgeons to provide reliable, risk-adjusted surgical outcomes data.[10] As of 2021, 695

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hospitals, both nationally and internationally, were participating, with standardized and validated perioperative data prospectively collected for a random sample of patients by dedicated surgical clinical reviewers.[11] The database is devoid of any protected health information because all the data have been de-identified. Therefore, institutional review board approval and patient consent were not required for the present study.

Patient selection. Patients who had undergone open abdominal aortic repair for nonruptured AAAs and AIOD between January 2009 and December 2018 were identified in the NSQIP through a combination of postoperative Current Procedural Terminology (CPT) and International Classification of Diseases (ICD), 9th and 10th revision, codes. Patients with a primary CPT code of 35102 or 35081 were considered to have undergone open repair for AAAs. Patients with a primary CPT code of 35361, 35363, 35537, 35538, 35539, 35540, 35637, 35638, 35646, or 35647 were considered to have undergone an open abdominal aortic procedure (eg, aortobi-iliac, aortobifemoral) and were initially placed in the open AIOD group. Because such procedures could be applicable to both AAA and AIOD patients, those with a discharge diagnosis of AAA (ICD, 9th revision, code 441.4 [abdominal aneurysm without mention of rupture] or ICD, 10th revision, code I71.4 [abdominal aortic aneurysm, without rupture]) were included in the open AAA group. Patients with aortic bypass surgery but no discharge diagnosis of AAA were included in the open AIOD group.

Data and outcomes. The retrieved preoperative patient baseline characteristics included age, gender, race, American Society of Anesthesiologists (ASA) score, baseline functional status, blood transfusion <72 hours before surgery, a history of steroid use, and weight loss of ≥10% body weight in the 6 months before surgery. Other comorbidities included a history of obesity, diabetes mellitus, dyspnea, chronic obstructive pulmonary disease (COPD), congestive heart failure, acute renal failure, renal failure requiring dialysis, bleeding disorder, and smoking <1 year before surgery. The primary outcome was 30-day mortality. The secondary outcomes included the 30-day return to the operating room, total operative time, total hospital stay, and postoperative complications. The complications were characterized as cardiopulmonary (ie, pneumonia, pulmonary embolism, myocardial infarction, reintubation, failure to wean from respirator after 48 hours), renal (ie, renal insufficiency, renal failure), and surgical wound infections (ie, superficial incisional, deep incisional, organ/space, wound disruption).

Statistical analysis. Descriptive statistics were summarized for all preoperative patient characteristics and postoperative outcome measures, using the χ^2 test to compare the differences between categorical variables and the Wilcoxon rank sum test for continuous variables. Because the preoperative risk factors were significantly different statistically between the AAA and AIOD cohort, we matched the outcomes for 4980 patients in each group using a propensity score and greedy algorithm for the following variables: year, age, gender, smoking status, insulin-dependent diabetes, obesity, and bleeding disorders. The outcomes for the matched analyses were compared using statistical methods similar to those used for the unmatched data to evaluate the differences in the outcomes if the risk factors were the same between the two groups. To investigate the changes in outcomes over time, the unmatched samples were categorized into the first 5 years from 2009 to 2013 and the second 5 years from 2014 to 2018, and we compared the differences in case numbers and postoperative complications within each operative group. Finally, stratified univariable logistic regression models were used to investigate the differential risk factors related to 30-day mortality within the two unmatched groups. The variables that had significantly predicted for 30-day mortality in each group were incorporated into a stratified multivariable logistic regression model. The results are presented in forest plots for comparison. For all analyses, alpha was set at 0.05, and the results were not adjusted for multiple comparisons. All analyses were conducted using SPSS, version 27 (IBM Corp, Armonk, NY).

ARTICLE HIGHLIGHTS

- **Type of Research:** A retrospective review of prospectively collected National Surgical Quality Improvement Program data
- **Key Findings:** Compared to patients who had undergone open abdominal aortic aneurysm surgery (n = 9481), those who had undergone open aortoiliac occlusive disease surgery (n = 9257) had had significantly higher 30-day mortality (5.1% vs 4.1%), a higher incidence of wound complications (7.4% vs 5.1%), and an increased 30-day return to the operating room (14.2% vs 9.1%) after propensity risk matching.
- **Take Home Message:** Multiple risk factors were found to increase the odds of perioperative mortality after open abdominal aortic repair and should be factored into the decision-making process when considering the treatment options for patients with abdominal aortic aneurysms and aortoiliac occlusive disease.

RESULTS

Baseline characteristics. A total of 18,738 patients had undergone open abdominal aortic repair from 2009 to 2018. Of the 18,738 patients, 9481 had had undergone repair for AAAs and 9257 for AIOD (Table I). Patients

Table I. Unmatched patient characteristics

Variable	AAA (n = 9481)	AIOD (n = 9257)	*P* value
Patient characteristics			
Age, years	70 (64-76)	60 (54-67)	<.0001
Male gender	74.3	57.6	<.0001
Race			<.0001
White	74.6	76.3	
Other/unknown	17.3	13.0	
Black/African American	5.9	10.0	
Asian/Pacific Islander	2.3	0.7	
ASA score ≥III	95.4	96.6	<.0001
Functional dependence	2.8	4.1	<.0001
Transfusion 72 hours before surgery	2.0	1.5	.009
Steroid use	3.0	2.4	.011
Recent weight loss	1.4	1.5	.494
Comorbidity			
Obesity	26.8	21.7	<.0001
Diabetes mellitus	2.8	8.9	<.0001
Dyspnea	16.6	16.1	.361
Severe COPD	19.2	17.0	<.0001
CHF	1.5	1.1	.039
Preoperative creatinine, mg/dL	1 (0.84-1.23)	0.86 (0.70-1.03)	<.0001
Acute renal failure	0.4	0.2	.052
Renal failure requiring dialysis	0.9	0.7	.128
Bleeding disorder	8.4	14	<.0001
Current smoker	47.3	71.8	<.0001

AAA, Abdominal aortic aneurysm; *AIOD,* aortoiliac occlusive disease; *ASA,* American Society of Anesthesiologists; *CHF,* congestive heart failure; *COPD,* chronic obstructive pulmonary disease.
Data presented as median (interquartile range) or %.

with an AAA were, on average, 10 years older (70 years vs 60 years; *P* < .0001), more often men (74.3% vs 57.6%; *P* < .0001), and were less often current smokers (47.3% vs 71.8%; *P* < .0001) compared with those with AIOD.

Postoperative outcomes: unmatched cohort. Before propensity matching, the AIOD patients had had a higher rate of return to the operating room within 30 days of surgery (14% vs 9.7%; *P* < .0001), although the AAA patients had had a higher rate of 30-day mortality (4.9% vs 3.7%; *P* < .0001; Table II). Wound complications had occurred more frequently in the AIOD group than in the AAA group (7.8% vs 4.7%; *P* < .0001). The AIOD procedures had also required an average of 30 minutes longer than the AAA procedures (245 minutes vs 218 minutes; *P* < .0001).

Postoperative outcomes: matched cohort. Because of the demographic differences found in the unmatched cohorts, propensity matching was conducted to account for inherent differences in the two disease populations. After propensity matching, 4980 well-matched pairs were identified and compared (Supplementary Table, online only). The two matched cohorts were relatively well balanced; the postoperative outcomes for these groups are listed in Table III. After matching, the AIOD group had a higher 30-day mortality rate than that of the AAA group (5.1% vs 4.1%; *P* = .021). The incidence of cardiopulmonary and renal complications was similar between the two groups after matching; however, the AIOD group still had a greater incidence of wound complications (7.4% vs 5.1%; *P* < .0001) and had required a return to the operating room more frequently (14.2% vs 9.1%; *P* < .0001).

Differences over time. The postoperative outcomes were divided between the first (2009-2013) and second (2014-2018) 5-year periods (Table IV). The outcomes were compared within each operative group between the two periods, with no major differences found. However, a significant increase was found in the number of open AIOD cases (*P* = .02) in the second half of the decade compared with the first (*P* = .02). In contrast, a significant decrease in the number of open AAA cases was observed in the second half of the decade compared with the first (*P* = .04).

Table II. Unmatched postoperative outcomes

Postoperative outcome	AAA (n = 9481)	AIOD (n = 9257)	*P* value
Total operative time, minutes	218 (168-289)	245 (189-319)	<.0001
Total hospital stay, days	7 (5-11)	7 (5-10)	<.0001
Cardiopulmonary complications	17.9	13.5	<.0001
Pneumonia	7.5	6.3	.0021
Pulmonary embolism	0.6	0.4	.0141
Myocardial infarction	3.5	2.8	.0035
Reintubation	6.6	5.7	.0066
Failure to wean	10.2	6.5	<.0001
Renal complications	6.5	3.8	<.0001
Renal insufficiency	2.7	1.5	<.0001
Renal failure	4.1	2.5	<.0001
Wound complications	4.7	7.8	<.0001
Superficial incisional SSI	1.9	4.0	<.0001
Deep incisional SSI	0.6	1.7	<.0001
Organ/space SSI	1.0	1.0	.7002
Wound disruption	1.6	1.9	.1827
30-Day return to operating room	9.7	14.0	<.0001
30-Day mortality	4.9	3.7	<.0001

AAA, Abdominal aortic aneurysm; *AIOD*, aortoiliac occlusive disease; *SSI*, surgical site infection.
Data presented as median (interquartile range) or %.

Table III. Matched postoperative outcomes

Postoperative outcome	AAA (n = 4980)	AIOD (n = 4980)	*P* value
Total operative time, minutes	221 (170-291)	246 (188-322)	<.0001
Total hospital stay, days	7 (5-10)	7 (5-11)	.846
Cardiopulmonary complications	16.6	15.3	.09
Pneumonia	7.3	6.7	.223
Pulmonary embolism	0.5	0.4	.306
Myocardial infarction	3.0	3.6	.081
Reintubation	5.9	5.9	.966
Failure to wean	9.2	7.4	.001
Renal complications	5.6	4.8	.064
Renal insufficiency	2.5	1.8	.023
Renal failure	3.4	3.1	.497
Wound complications	5.1	7.4	<.0001
Superficial incisional SSI	2.1	3.5	<.0001
Deep incisional SSI	0.7	1.6	<.0001
Organ/space SSI	1.0	1.0	.841
Wound disruption	1.6	2.0	.202
30-Day return to operating room	9.1	14.2	<.0001
30-Day mortality	4.1	5.1	.021

AAA, Abdominal aortic aneurysm; *AIOD*, aortoiliac occlusive disease; *SSI*, surgical site infection.
Data presented as median (interquartile range) or %.

Risk factors for mortality. Univariate logistic regression analysis was performed to identify the risk factors significantly associated with mortality in each unmatched group (Fig 1). The factors associated with an increased odds of 30-day mortality included increasing age, ASA score of ≥III, dependent functional status, blood transfusion <72 hours before surgery, ≥10% weight loss in the previous 6 months, steroid use, and a history of

Table IV. Postoperative outcomes stratified by 5-year period

	AAA			AIOD		
Postoperative outcome	2009-2013	2014-2018	*P* value	2009-2013	2014-2018	*P* value
Patients, No.	5005	4476	.036	4246	5024	.020
Cardiopulmonary complications, %	18.3	17.5	.310	14.4	12.8	.021
Renal complications, %	6.4	6.6	.704	3.6	4.0	.309
Wound complications, %	4.7	4.8	.852	8.3	7.4	.105
30-Day return to operating room, %	9.6	9.8	.728	13.8	14.1	.718
30-Day mortality, %	4.7	5.0	.456	3.8	3.6	.574

AAA, Abdominal aortic aneurysm; *AIOD,* aortoiliac occlusive disease; *SSI,* surgical site infection.

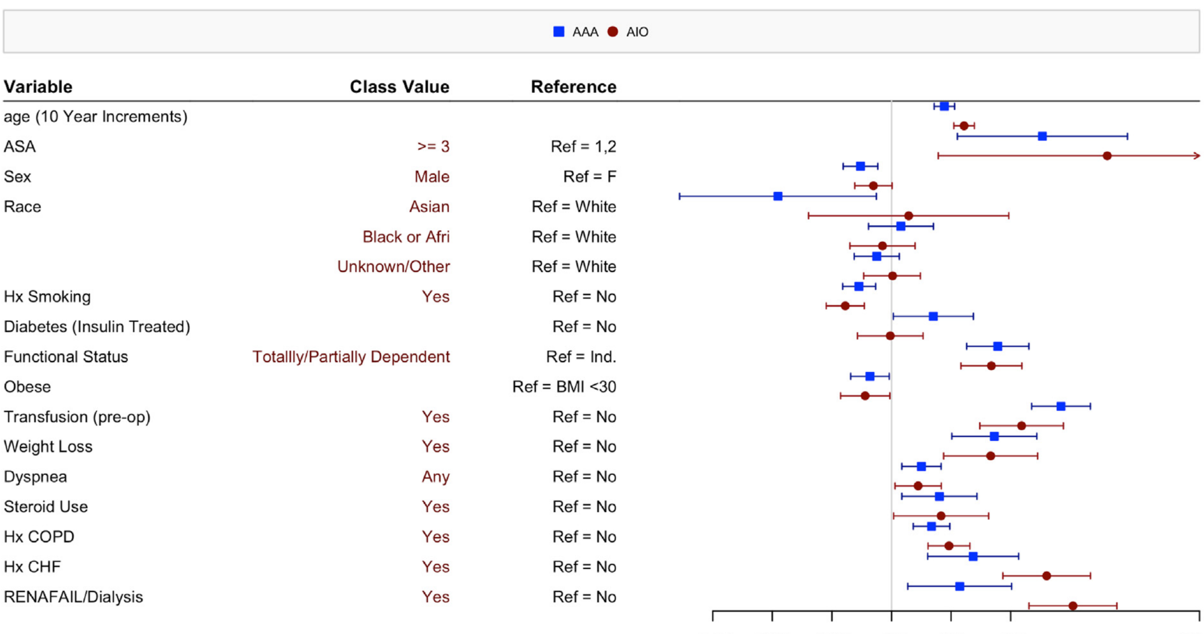

Fig 1. Forest plot depicting results from univariate logistic regression analysis. *AAA,* Abdominal aortic aneurysm; *Afri,* African American; *AIO,* aortoiliac occlusive (disease); *ASA,* American Society of Anesthesiologists; *BMI,* body mass index; *CHF,* congestive heart failure; *COPD,* chronic obstructive pulmonary disease; *F,* female; *Hx,* history; *pre-op,* preoperative; *Ref,* reference; *RENAFAIL,* renal failure.

dyspnea, severe COPD, congestive heart failure, or renal failure. The factors protective against mortality for the open abdominal aortic repair group included smoking (AAA: odds ratio [OR], 0.69; 95% confidence interval [CI], 0.57-0.83; *P* < .0001; AIOD: OR, 0.58; 95% CI, 0.47-0.73; *P* < .0001) and obesity (AAA: OR, 0.78; 95% CI, 0.62-0.97; *P* = .028; AIOD: OR, 0.74; 95% CI, 0.55-0.98; *P* = .037). Asian-American/Pacific Islander race was protective against mortality for the open AAA repair group (OR, 0.27; 95% CI, 0.09-0.84; *P* = .024).

Multivariate logistic regression analysis was used to identify the risk factors associated with mortality after controlling for all other factors (Fig 2). For both groups, the factors that remained associated with a greater odds of death included every 10-year increase in age (AAA: OR, 1.74; 95% CI, 1.5-1.9; *P* < .0001; AIOD: OR, 2.1; 95% CI, 1.8-2.3; *P* < .0001), ASA class ≥III (AAA: OR, 4.2; 95% CI, 1.5-11; *P* = .005; AIOD: OR, 7.6; 95% CI, 1.066-54.9; *P* = .04), functional dependence (AAA: OR, 2.0; 95% CI, 1.4-3.0; *P* < .0001; AIOD: OR, 2.15; 95% CI, 1.4-3.1; *P* < .0001), blood transfusion <72 hours before surgery (AAA: OR, 5.8; 95% CI, 4.0-8.3; *P* < .0001; AIOD: OR, 2.8; 95% CI, 1.7-4.8; *P* < .0001); weight loss in the past 6 months (AAA: OR, 2.86; 95% CI, 1.7-4.7; *P* < .0001; AIOD: OR, 2.2; 95% CI, 1.2-3.9; *P* = .007), and a history of COPD (AAA: OR, 1.4; 95% CI, 1.1-1.8; *P* = .002; AIOD: OR, 1.5; 95% CI, 1.1-1.9; *P* = .002). Smoking, obesity, and Asian-American/Pacific Islander race were not protective against mortality on multivariable analysis.

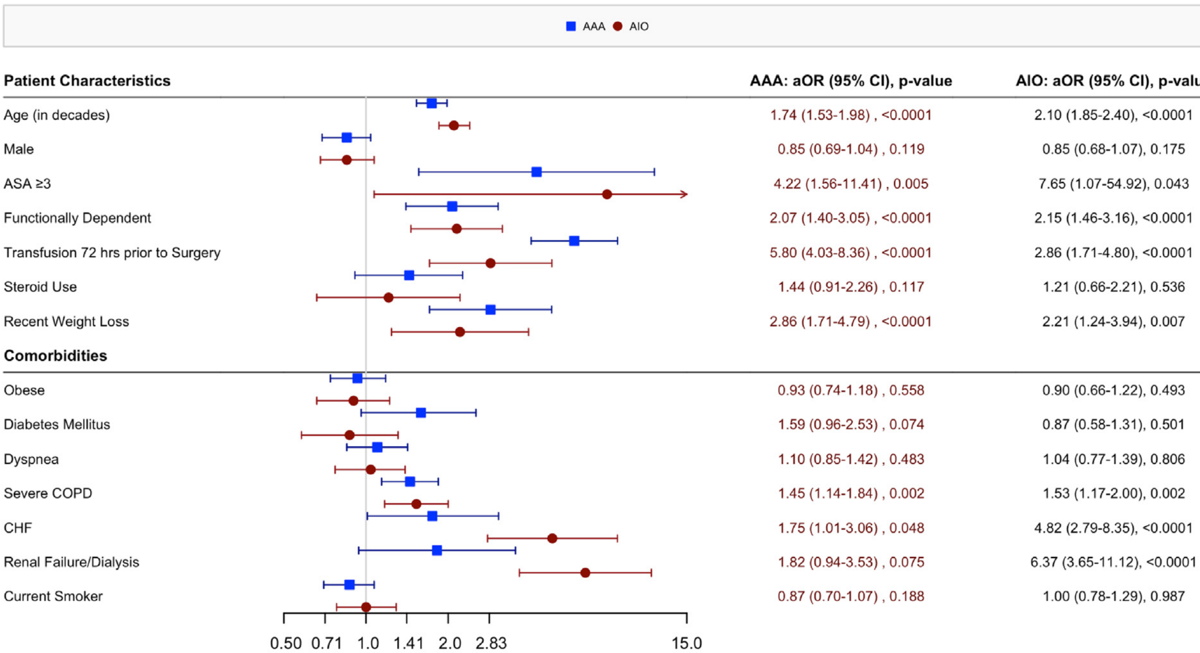

Fig 2. Forest plot depicting results from multivariate logistic regression analysis. *AAA,* Abdominal aortic aneurysm; *AIO,* aortoiliac occlusive (disease); *aOR,* adjusted odds ratio; *ASA,* American Society of Anesthesiologists; *CHF,* congestive heart failure; *CI,* confidence interval; *COPD,* chronic obstructive pulmonary disease.

DISCUSSION

Vascular surgery has embraced the endovascular age; however, data from the past 10 years have shown that a significant number of open aortic surgeries are still performed each year. We expected the number of open aortic cases to have decreased over time and found such a trend with open AAA surgery concomitant with an increased proportion of endovascular abdominal aortic repair among all age groups.[12] The EVAR (endovascular abdominal aortic repair) trial 1 reported a 30-day operative mortality rate for patients undergoing open AAA surgery of 4.3%.[1] This percentage has not changed in the past 20 years and is in line with the results from the present study (4.9%).[13] The 30-day mortality rate for patients undergoing AIOD repair was 3.7%, lower than that for those undergoing AAA repair. However, the results were reversed, with worse mortality for the AIOD group when age and other risk factors were matched. Additionally, more AIOD patients had required a return to the operating room within 30 days. Therefore, patients undergoing open AAA repair had had better outcomes than those undergoing open AIOD repair under the same demographic conditions, despite the decrease in such cases during the past decade.

Advances in endovascular technology have allowed vascular surgeons to expand the indications for challenging anatomy. However, we observed an increasing number of open AIOD cases during the study period, with more cases performed in the second half of the decade than in the first. This could have resulted from a greater proportion of patients with unfavorable anatomy or an increase in AIOD patients for whom an initial endovascular intervention had failed. Many studies have shown a high rate of short-term success with endovascular AIOD repair; however, long-term patency rates have remain higher for patients who had undergone open repair, especially with longer follow-up.[4,6,7,14] The present study has shown poorer open abdominal outcomes with increased age for both open AAA and AIOD. As the indications for endovascular therapy are expanded and vascular surgeons find themselves with a larger armamentarium, we must consider tailoring primary interventions to specific patient populations for the best long-term outcomes. Thus, if a younger patient with AIOD, few comorbidities, and unfavorable anatomy were to undergo an initial open repair, could we avoid the need for a higher risk secondary repair 5 to 10 years postoperatively.

The results from the present study have identified additional risk factors that could influence patient selection for open aortic surgery. Using the matched cohorts, we studied the differences in surgical outcomes between open AAA and open AIOD repair with similar risk factors. The AIOD patients had had a higher mortality rate; thus, we have reason to be more cautious when performing surgery for these patients, especially given the independent risk factors identified from the unmatched logistic regression analysis, such as increased age, higher ASA score, transfusion <72 hours before surgery, and recent weight loss of ≥10%. Although the univariate models found a history of smoking and obesity to be protective against postoperative mortality, the multivariate models did not confirm this association. Asian-American/Pacific Islander race appeared to be associated with a 0.27 decreased odds of mortality with open AAA repair compared with White race. Perhaps the Asian-American patients had had fewer comorbidities overall and risk factors that allowed for better perioperative outcomes. Although we were unable to explore this relationship further in the present study, future studies should elucidate the characteristics of this population that might make them better candidates for open repair.

Advanced age, ASA score of ≥III, dependent functional status, comorbidities, preoperative blood transfusion, and a history of recent weight loss were independent risk factors for increased mortality. It is preferable to select younger and healthier patients for open surgery because they will recover faster and have lower complication rates. Studies of weight loss before surgery in the context of bariatric surgery and surgical oncology have found increased morbidity and mortality, possibly owing to a compromised nutritional status in such patients, leading to poorer recovery outcomes.[15,16] It has been shown that patients considered low risk for various surgeries have had an 8- to 10-fold increased odds for adverse surgical outcomes when given a blood transfusion before surgery.[17] The results from the present study support these findings and add to the broad surgical literature showing significantly worse outcomes with blood transfusions before open aortic repair.[18] We found that the patients who had received a preoperative blood transfusion <72 hours before aortic surgery had a three- to sixfold increased odds of mortality in the 30-day postoperative period. Previous investigators have found that blood transfusions do not provide an immediate oxygenation benefit to patients and that the treatment of anemia (ie, iron supplementation) should occur weeks before surgery if it is of concern.[19]

The present study was a highly powered, cross-sectional study of >18,000 patients who had undergone open aortic repair using 10 years of NSQIP data. However, our study was limited by the variables provided in the dataset and how the original variables might have been coded. We had to rely on the correct input of the ICD and CPT codes applicable to the patients' procedures. It is possible that human error could have misclassified an open AIOD procedure as open AAA repair and vice versa. Additionally, we were unable to separate the small subset of patients with concomitant AAA and AIOD disease owing to the nature of data entry. This is a limitation with all research using national databases. The AAA cohort will have been coded homogenously, despite the variety within open AAA repair types. Knowing the types of AAA bypass grafts is important because the type can reflect the magnitude and complexity of the operation. However, because CPT codes of open AAA repair contain no information on the type of bypass surgery used, we were unable to determine whether a tube graft or bifurcated graft had been used in the open AAA cohort. Also, extra-anatomic AIOD bypass was excluded from the present study, because we sought to explore the differences in outcomes between open aortic surgery for AAA and AOID. AIOD patients requiring extra-anatomic reconstruction are known to have more risk factors with an increased odds of mortality making them unsuitable for open aortic repair.[20]

wIn the present study, we found that AIOD patients had had a higher incidence of wound infection; however, owing to the limitations in NSQIP data collection, we could not determine the exact location of the infection site. Furthermore, the ability to determine temporality or causality in the associations found was limited by the study design. Finally, we considered the short-term mortality and complications, and more research is needed to investigate the long-term outcomes. Owing to the limitations in the scope of the present study, our findings warrant further research to determine the causes for the excess return to the operating room in the AIOD cohort and the risk factors associated with renal complications during open aortic repair.

CONCLUSIONS

In the era of endovascular aortic repair, open abdominal aortic surgery still plays an important role in the management of AAA and AIOD. The number of open AAA cases has been decreasing as the number of open abdominal AIOD cases have increased. However, the perioperative outcomes have not improved during the past 10 years. Multiple risks factors were identified to be associated with 30-day mortality. We would recommend open abdominal aortic repair for AAA and AIOD patients who are younger, have a lower ASA score, have good cardiopulmonary function, and can function independently. The high odds of perioperative mortality should preclude open repair for patients with significant recent weight loss and AIOD patients with renal failure and/or requiring dialysis. Caution should also be exercised when selecting patients who have undergone transfusion <72 hours before a scheduled open procedure.

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AUTHOR CONTRIBUTIONS

Conception and design: YT, AK, QP
Analysis and interpretation: YT, AK, MI, TJ, AS, MA, RR, QP
Data collection: YT, AK, QP
Writing the article: YT, AK, QP
Critical revision of the article: YT, AK, MI, TJ, AS, MA, RR, QP
Final approval of the article: YT, AK, MI, TJ, AS, MA, RR, QP
Statistical analysis: YT, AK, QP
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APPENDIX (online only).

Supplementary Table (online only). Matched preoperative risk factors stratified by disease type

Risk factor	AAA (n = 4980)	AIOD (n = 4980)	*P* value
Patient characteristic			
Age, years	66 (60-72)	65 (60-71)	<.001
Male gender	64.1	67.3	<.001
Race			<.001
White	74.0	75.2	
Other/unknown	16.6	14.9	
Black/African American	7.0	9.2	
Asian/Pacific Islander	2.4	0.8	
ASA score ≥III	95.5	96.2	.166
Functional dependence	2.6	4.2	<.001
Transfusion 72 hours before surgery	1.8	1.7	.705
Steroid use	3.2	2.3	.009
Recent weight loss			
Comorbidity			
Obesity	23.6	23.1	.554
Diabetes mellitus	95.5	95.8	.463
Dyspnea	17.0	16.4	.436
Severe COPD	20.1	18.4	.035
CHF	1.7	1.3	.188
Acute renal failure	0.4	0.3	.422
Renal failure requiring dialysis	1.0	0.9	.610
Bleeding disorder	11.7	9.7	.001
Current smoker	61.6	61.5	.918

AAA, Abdominal aortic aneurysm; *AIOD,* aortoiliac occlusive disease; *CHF,* congestive heart failure; *COPD,* chronic obstructive pulmonary disease. Data presented as median (interquartile range) or %.