Published in final edited form as:

Ann Surg. 2015 March ; 261(3): 432–437. doi:10.1097/SLA.0000000000000767.

The Impact of Functional Dependency on Outcomes After Complex General and Vascular Surgery

John E. Scarborough, MD, Kyla M. Bennett, MD, Brian R. Englum, MD, Theodore N. Pappas, MD, and Sandhya A. Lagoo-Deenadayalan, MD, PhD

Department of Surgery, Duke University Medical Center, Durham, NC

Abstract

Objective—To describe the outcomes of functionally dependent patients who undergo major general or vascular surgery and to determine the relationship between functional health status and early postoperative outcomes.

Background—In contrast to frailty, functional health status is a relatively easy entity to define and to measure and therefore may be a more practical variable to assess in patients who are being considered for major surgery. To date, few studies have assessed the impact of functional health status on surgical outcomes.

Methods—Patients undergoing 1 of 10 complex general or vascular operations were extracted from the 2005 to 2010 American College of Surgeons National Surgical Quality Improvement Program database. Propensity score techniques were used to match patients with and without preoperative functional dependency on known patient- and procedure-related factors. The postoperative outcomes of this matched cohort were then compared.

Results—A total of 10,246 functionally dependent surgical patients were included for analysis. These patients were more acutely and chronically ill than functionally independent patients, and they had higher rates of mortality and morbidity for each of the 10 procedures analyzed. Propensity-matching techniques resulted in the creation of a cohort of functionally independent and dependent patients who were well matched for known patient- and procedure-related variables. Dependent patients from the matched cohort had a 1.75-fold greater odds of postoperative death (95% confidence interval: 1.54–1.98, $P < 0.0001$) than functionally independent patients.

Conclusions—Preoperative functional dependency is an independent risk factor for mortality after major operation. Functional health status should be routinely assessed in patients who are being considered for complex surgery.

Keywords

disability; frailty; functional health status; surgery; outcomes

Copyright © 2014 Wolters Kluwer Health, Inc. All rights reserved

Reprints: John E. Scarborough, MD, Department of Surgery, Duke University Medical Center, DUMC 2837, Durham, NC 27710. john.scarborough@dm.duke.edu.

Disclosure: The authors have no potential conflicts of interest, including specific financial interests, relationships, and affiliations relevant to the subject matter or materials discussed in the manuscript.

Although frailty is a known determinant of postoperative outcomes in elderly surgical patients, its use as a basis for preoperative risk stratification has important practical limitations.¹⁻⁹ Of primary concern is the current lack of a standard operational definition for frailty, and the absence of a universally accepted way to measure its severity.¹⁰ The term “frailty,” which is generally acknowledged to represent a multifactorial loss of physiologic and cognitive reserves resulting in increased susceptibility to adverse health outcomes, can be defined in either a rules-based context (in which a person is identified as frail if he/she exhibits at least 3–5 possible associated symptoms) or in an aggregate deficit-based context (in which frailty severity is measured by the number of accumulated deficits that they exhibit).¹¹ Such ambiguity has predictably led to the development of a variety of outcome instruments for measuring frailty, most of which have been shown to possess construct validity but none of which have proven superiority.¹² The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) and the American Geriatric Society currently recommend that geriatric patients in whom major elective surgery is being contemplated be assigned a baseline frailty score using a rules-based measurement tool.¹³ While this type of scoring system relies on the assessment of only 5 characteristics of frailty (weight loss, exhaustion, low energy expenditure, slowness, and weakness) and is therefore somewhat easier to implement in the setting of a busy clinical practice, its precision in predicting adverse outcomes is much lower than aggregate deficit-based measurement tools.¹¹

In contrast to frailty, functional disability (or dependent functional health status) is a relatively easy entity to define and measure. Generally agreed to connote “difficulty or dependency in carrying out activities essential to independent living,” functional dependency can be viewed as an advanced symptom of frailty.^{14,15} Although several objective measures have been developed to test a patient’s ability for self-care (activities of daily living) or engagement in basic household tasks (instrumental activities of daily living), more subjective assessment of functional health status through either patient self-report or clinician judgment has also proven highly predictive both of the presence of patient frailty and of the adverse outcomes that are typically associated with frailty.^{15,19,20} Because functional health status is easier to assess than frailty, surgeons may therefore view it as a much more practical variable to use when counseling elderly patients about the risks associated with major surgery.²⁰

Although functional health status has been shown to contribute to the ability of statistical models to predict hospital-level surgical morbidity, little is known about the actual outcomes experienced by functionally dependent surgical patients.²¹⁻²⁴ The objective of our study was therefore to describe these outcomes in a large cohort of patients undergoing one of several complex elective general or vascular surgical procedures, and to quantify the degree to which functional dependency may impact the rates of postoperative morbidity and mortality.

METHODS

The 2005 to 2010 ACS-NSQIP participant user files were used for this analysis. Patients were included from analysis if they underwent one of the following elective procedures (as

identified by the primary Current Procedure Terminology code associated with the patient's index operation): endovascular abdominal aortic aneurysm (AAA) repair, open AAA repair, infrainguinal bypass graft, carotid endarterectomy, esophagectomy, gastrectomy, pancreaticoduodenectomy, hepatectomy, open colorectal resection, or laparoscopic colorectal resection. Patients were excluded for analysis if their index operation was classified as emergency, if they underwent prior operation within the 30 days preceding their index procedure, if they were pregnant, or if they had missing data for any of the variables included for risk adjustment (excepting preoperative serum albumin level, which was assumed to be normal for patients in whom this information was missing).

The primary predictor variable for our analysis was preoperative functional health status, which is recorded as a trichotomous variable within the ACS-NSQIP database and is currently the only variable contained within that data source which might serve as a marker of a patient's ability to engage in instrumental or other activities of daily living. According to the definition used by ACS-NSQIP, a patient's functional status is classified as "independent" if they do not require assistance from another person for any activities of daily living, "partially dependent" if the patient requires some assistance from another person for activities of daily living (including patients who utilize prosthetics, equipment, or devices but still requires some assistance from another person), or "totally dependent" if the patient requires total assistance for all activities of daily living.²⁵ This information is prospectively obtained for the database by an ACS-trained on-site clinical reviewer and is based on the patient's functional status at the time they are being considered as a candidate for surgery (which is no longer than 30 days before surgery). In the current analysis, patients were classified as being functionally "Independent" (if their functional health status was documented to be independent) or "Dependent" if their functional health status was documented to be partially or totally dependent.

The outcome variables for our analysis included 30-day postoperative mortality, 30-day postoperative major morbidity, failure-to-rescue rate (defined as the mortality rate of those patients who experienced 1 or more major complication), 30-day postoperative minor morbidity, and 30-day reoperation rate. Patients were considered a priori to have suffered major morbidity if they sustained 1 or more of the following complications postoperatively: organ/space surgical site infection, wound dehiscence, pneumonia, unplanned reintubation, prolonged postoperative mechanical ventilation (>48 hours), pulmonary embolism, progressive renal insufficiency, acute renal failure requiring dialysis, coma, stroke, myocardial infarction, cardiac arrest, graft/prosthetic failure, major bleeding (defined as transfusion requirement of 5 or more units of packed red blood cells in the first 72 hours after operation), sepsis, and/or septic shock. Patients were considered to have suffered minor morbidity if they sustained 1 or more of the following complications postoperatively: superficial incisional surgical site infection, deep incisional surgical site infection, urinary tract infection, and/or deep venous thrombosis.

Patient- and procedure-related variables other than preoperative functional health status that were included for analysis included patient age, sex, body mass index, preoperative do-not-resuscitate (DNR) status, presence of preoperative malnutrition (composite variable), acute preoperative cognitive dysfunction (composite variable), presence of known malignancy

(composite variable), preoperative physical immobility (composite variable), number of acute comorbid diagnoses (composite variable), number of chronic comorbid diagnoses (composite variable), American Society of Anesthesiologists (ASA) physical status classification (Class 1/2 vs 3 vs 4/5), operative time, total work related value units associated with index operation, need for intraoperative transfusion, and intraoperative surgical trainee participation. The individual components for each of the aforementioned composite variables are listed in Table 1.

Patient- and procedure-related characteristics and 30-day post-operative outcomes Independent versus Dependent patients were compared using Pearson's χ^2 tests for categorical variables and Wilcoxon rank sum tests for continuous variables. Propensity-matching techniques were then used to create a cohort of Independent patients who were matched as closely as possible to those patients from our study sample who were classified as Dependent. Specifically, a nonparsimonious multivariate logistic regression model was then created to determine predictors of a patient's being classified as Dependent before major surgery, with all of the previously listed preoperative and intraoperative variables being used as potential predictor variables in this model to adjust as much as possible for patient condition and procedure difficulty. A propensity score for classification as Dependent ranging from 0 to 1 was then calculated for each patient using the logit coefficients derived from the logistic regression model. These propensity scores were then used to create 2 evenly matched groups based on preoperative functional health status using a caliper matching algorithm with a caliper distance of 0.005, and with controls being used only once in the matching.

Comparison of the preoperative and intraoperative characteristics and postoperative outcomes of the matched cohort of patients was then performed using Wilcoxon signed rank tests for continuous variables, McNemar's χ^2 tests for 2-level categorical variables, and univariate conditional logistic regression for multilevel categorical variables. All statistical analyses were performed using Stata Version 11.1 (College Station, TX).

RESULTS

A total of 174,143 patients undergoing complex general or vascular surgery were included for analysis (163,897 Independent and 10,246 Dependent). The preoperative and intraoperative characteristics of these patients, stratified by preoperative functional health status, are shown in Table 2. Patients classified as Dependent were older than patients who were classified as being Independent, and they were notably more likely to exhibit evidence of malnutrition or to have some limitation in physical mobility. Dependent patients were also more likely than Independent patients to carry 1 or more acute and/or chronic comorbid diagnoses, and to receive a high ASA physical status classification. There did not seem to be clinically relevant differences in operative time or complexity (as measured by total work relative value units) between Dependent and Independent patients, although Dependent patients were more likely than Independent patients to require intraoperative blood transfusion.

Table 3 demonstrates procedure-specific postoperative outcome rates for Independent and Dependent patients. Significant univariate differences in 30-day postoperative mortality and major morbidity between the 2 groups were demonstrable for all 10 of the procedures included for analysis. Among those patients who were classified as Dependent, postoperative mortality rates ranged from 3.3% (for patients undergoing carotid endarterectomy) to 13.7% (for patients undergoing open AAA repair). Postoperative major morbidity rates for this group ranged from 12.0% (carotid endarterectomy) to 64.1% (esophagectomy).

Our propensity-matching algorithm resulted in a cohort of 9782 Independent and 9782 Dependent patients, the characteristics of whom are shown in Table 4. The Independent and Dependent patients in this cohort were in general well-matched for most characteristics, although statistically significant differences between the 2 groups in body mass index, preoperative DNR status, ASA physical status classification, and incidence of acute preoperative cognitive dysfunction did persist. Figure 1 demonstrates the independent impact of preoperative functional health status on early postoperative outcomes in our propensity-matched cohort, with Dependent patients having a significantly higher incidence of 30-day postoperative mortality, morbidity, failure-to-rescue, and reoperation than Independent patients. A total of 464 Dependent patients from the overall study sample could not be successfully matched to Independent patients via the algorithm used for our analysis. Compared with those Dependent patients who were included in the matched cohort, the patients who could not be matched were generally more acutely and chronically ill and had a higher incidence of postoperative death and major morbidity (data not shown).

DISCUSSION

In this analysis of patients in the ACS-NSQIP who underwent major general or vascular surgery, we compared the preoperative characteristics of 10,246 functionally dependent patients with those of 163,897 functionally independent patients. The dependent patients in our overall study sample had a higher incidence of comorbid disease and were more likely than independent patients to exhibit signs of frailty (such as malnutrition and cognitive dysfunction), a finding which serves to emphasize the interconnectivity of comorbidity, frailty, and functional dependency.¹⁴ In an attempt to adjust for the markedly different preoperative profiles of these 2 groups, we next used propensity-matching techniques to create a smaller cohort of functionally dependent and independent patients who were reasonably comparable in their incidence of comorbid disease and other patient- and procedure-related factors. Comparing the adjusted 30-day postoperative outcomes of this matched cohort, we found that functionally dependent patients experienced a 75% greater odds of mortality and 51% greater odds of major morbidity than functionally independent patients. These findings suggest that preoperative functional dependency is an independent predictor of adverse outcomes after major general and vascular surgery.

With its inclusion of more than 10,000 functionally disabled surgical patients and 10 complex surgical operations, our analysis represents the largest and most comprehensive effort to date to investigate the association between preoperative functional health status and surgical outcomes. Our results confirm the findings of several smaller studies which have

shown that functional health status provides a unique contribution to surgical risk, and that patients with preoperative functional dependency are more likely to suffer postoperative morbidity or mortality than functionally independent patients.^{2,9,21–24} Although the specific pathophysiologic mechanism underlying the relationship between functional health and surgical outcomes has not been elucidated, it is reasonable to assume that functional health status provides information about how a patient's age and comorbid disease burden might ultimately combine to impact that particular patient's ability to care for themselves.^{21,26} A concerted effort should therefore be made by surgeons to evaluate the degree of functional dependency in patients in whom major surgery is being contemplated, because the presence of such dependency may alter a patient's anticipated postoperative outcome beyond what can be predicted simply by an assessment of the dichotomous presence or absence of specific comorbid diseases. Although a similar argument can be made regarding the importance of evaluating a potential surgical candidate's degree of frailty, the absence of a simple tool for measuring this attribute limits its practical utility as tool for preoperative risk assessment. Until further consensus can be reached on how best to measure frailty in a busy clinical setting, functional health status should therefore be considered a reasonable alternative for determining how a patient's individual constellation of comorbid diseases and other physiologic parameters affect their functional quality of life and their marginal risk of adverse outcomes after major surgery.

Routine preoperative assessment of functional health status in patients undergoing evaluation for major elective operation has several potential benefits. First, it is possible that functional health can be modified in the preoperative period. There is some evidence from the geriatric literature that home-based physical therapy programs can successfully halt the progression of functional decline in frail patients.^{27–29} Whether similar programs might reduce the degree of functional dependency in patients who are scheduled to undergo complex surgery, and thereby mitigate the adverse impact of such disability on postoperative outcomes, is currently unknown. The findings of our study suggest that further investigation of preoperative prehabilitation for functionally dependent surgical patients is warranted. Second, knowledge of the presence and extent of functional dependency before operation will permit patient resource managers to prospectively identify those patients who are most likely to require supplemental nursing care upon hospital discharge, either in the form of home health care or short-term skilled nursing facility placement. Proactive attention to potential postdischarge care needs will help to avoid the financial costs associated with delays in hospital discharge that are incurred when such needs aren't adequately anticipated. Finally, surgeons will be able to provide functionally dependent patients with a clearer understanding of the risks associated with major operation. Unlike most other studies that have examined the association between functional health status or frailty and surgical outcomes, our analysis provides procedure-specific 30-day mortality rates for a large sample of functionally dependent patients who have undergone 1 of 10 complex general or vascular operations. This information can be used by surgeons to improve the informed nature of consent that they obtain from their prospective patients and can help the patients themselves to determine whether the anticipated outcomes associated with major operation align with their overall treatment goals.

Our study has several important limitations. First, the Independent and Dependent patients in our propensity-matched cohort were not perfectly matched for several factors, including body mass index, incidence of preoperative cognitive dysfunction, and ASA physical status classification. To account for these differences, we included those factors as predictor variables in the conditional logistic regression models that were used to determine the association between preoperative functional health status and postoperative outcomes. Second, we did not stratify patients on the basis of their extent of functional dependency (ie, partially vs totally dependent on others for completion of activities of daily living). Therefore, we are only able to associate the presence of functional dependency (and not the degree) with increased postoperative morbidity and mortality. Third, the multivariate regression model that we used to create a matched cohort of Independent and Dependent surgical patients included only a few variables that are frequently associated with patient frailty. Although we are therefore not able to state that the effect of functional health on surgical outcomes is entirely independent of any coexisting effect of frailty, disability, and frailty are generally accepted by geriatric researchers to represent 2 distinct clinical entities.¹⁴ Fourth, although frailty and functional health are generally discussed in the literature specifically within the context of the geriatric patient assessment, we did not exclude nonelderly patients from our analysis. We are therefore not able to draw conclusions about the relative impact of functional of functional dependence on elderly versus nonelderly surgical patients. Finally, although our propensity-matching algorithm did result in the creation of a cohort of Independent and Dependent patients who were generally well-matched for known patient- and procedure-related variables, significant differences between the 2 groups of this cohort did exist which might confound the association between functional health status and postoperative outcomes that we report.

Despite these limitations, our analysis of patients undergoing 10 different complex general and vascular surgical procedures shows a clear association between preoperative functional health status and postoperative outcomes. Given its unique contribution in determining operative risk, and the relative ease with which it can be measured, functional dependency should be routinely assessed in patients who are being considered for complex surgery. In addition, it is hoped that the procedure-specific outcomes that are described in our study can be used by both surgeons and functionally dependent patients to improve their understanding of the anticipated outcomes associated with major surgery.

ACKNOWLEDGMENTS

The ACS-NSQIP and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

REFERENCES

1. Audisio RA, Pope D, Ramesh HS, et al. Shall we operate? Preoperative assessment in elderly cancer patients (PACE) can help: a SIOG surgical task for prospective study. *Crit Rev Oncol/Hematol*. 2008; 65:156–163.
2. Robinson TN, Eiseman B, Wallace JI, et al. Redefining geriatric preoperative assessment using frailty, disability and co-morbidity. *Ann Surg*. 2009; 250:449–455. [PubMed: 19730176]

3. Lee DH, Buth KJ, Martin BJ, et al. Frail patients are at increased risk for mortality and prolonged institutional care after cardiac surgery. *Circulation*. 2010; 121:973–978. [PubMed: 20159833]
4. Makary MA, Segev DL, Pronovost PJ, et al. Frailty as a predictor of surgical outcomes in older patients. *J Am Coll Surg*. 2010; 210:901–908. [PubMed: 20510798]
5. Kristjansson SR, Nesbakken A, Jordhoy MS, et al. Comprehensive geriatric assessment can predict complications in elderly patients after elective surgery for colorectal cancer: a prospective observational cohort study. *Crit Rev Oncol/Hematol*. 2010; 76:208–217.
6. Saxton A, Velanovich V. Preoperative frailty and quality of life as predictors of postoperative complications. *Ann Surg*. 2011; 253:1223–1229. [PubMed: 21412145]
7. Robinson TN, Wallace JI, Wu DS, et al. Accumulated frailty characteristics predict postoperative discharge institutionalization in the geriatric patient. *J Am Coll Surg*. 2011; 213:37–44. [PubMed: 21435921]
8. Karam J, Tsiouris A, Shepard A, et al. Simplified frailty index to predict adverse outcomes and mortality in vascular surgery patients. *Ann Vasc Surg*. 2013; 27:904–908. [PubMed: 23711971]
9. Kim KI, Park KH, Koo KH, et al. Comprehensive geriatric assessment can predict postoperative morbidity and mortality in elderly patients undergoing elective surgery. *Arch Gerontol Geriatr*. 2013; 56:507–512. [PubMed: 23246499]
10. Theou O, Brothers TD, Mitnitski A, et al. Operationalization of frailty using eight commonly used scales and comparison of their ability to predict all-cause mortality. *J Am Geriatr Soc*. 2013; 61:1537–1551. [PubMed: 24028357]
11. Rockwood K, Andrew M, Mitnitski A. A comparison of two approaches to measuring frailty in elderly people. *J Gerontol Med Scie*. 2007; 62A:738–743.
12. de Vries NM, Stall JB, van Ravensberg CD, et al. Outcome instruments to measure frailty: a systematic review. *Age Res Rev*. 2011; 10:104–114.
13. Chow WB, Rosenthal RA, Merkow RP, et al. Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society. *J Am Coll Surg*. 2012; 215:453–466. [PubMed: 22917646]
14. Fried LP, Ferrucci L, Darer J, et al. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. *J Gerontol Med Scie*. 2004; 59:255–263.
15. Pel-Littel RE, Schuurmans MJ, Emmelot-Vonk MH, et al. Frailty: defining and measuring of a concept. *J Nutr Health Aging*. 2009; 11:390–394. [PubMed: 19300888]
16. Katz S, Ford AB, Moskowitz RQ, et al. Studies of illness in the aged: the index of ADL: a standardized measure of biologic and psychological function. *JAMA*. 1963; 185:914–919. [PubMed: 14044222]
17. Mahoney FJ, Barthel DW. Functional evaluation. *Md Med J*. 1965; 14:61–65.
18. Lawton MP, Brody EM. Assessment of older people: self-maintenance and instrumental activities of daily living. *Gerontologist*. 1969; 9:179–186. [PubMed: 5349366]
19. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. *J Clin Epidemiol*. 2005; 58:1188–1198.
20. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. *Can Med Assoc Journ*. 2005; 173:489–495.
21. Cohen ME, Bilimoria KY, Ko CY, et al. Effect of subjective preoperative variables on risk-adjusted assessment of hospital morbidity and mortality. *Ann Surg*. 2009; 682–689. [PubMed: 19300217]
22. Kilic A, Beaty CA, Merlo CA, et al. Functional status is highly predictive of outcomes after redo lung transplantation: an analysis of 390 cases in the modern era. *Ann Thorac Surg*. 2013; 96:1804–1811. [PubMed: 23968759]
23. de la Fuente SG, Bennett KM, Scarborough JE. Functional status determines postoperative outcomes in elderly patients undergoing hepatic resections. *J Surg Oncol*. 2013; 107:865–870. [PubMed: 23585324]
24. Khan MA, Grinberg R, Johnson S, et al. Perioperative risk factors for 30-day mortality after bariatric surgery: is functional status important? *Surg Endosc*. 2013; 27:1772–1777. [PubMed: 23299129]

25. ACS-NSQIP variables and definitions. Available at: https://acsnsqip.org/documents_section/documents_chapter_4.pdf. Accessed October 15, 2013.
26. Ponzetto M, Maero B, Maina P, et al. Risk factors for early and late mortality in hospitalized older patients: the continuing importance of functional status. *J Gerontol Med Scien*. 2003; 58A:1049–1054.
27. Wilson JF. Frailty—and its dangerous effects—might be preventable. *Ann Intern Med*. 2004; 141:489–492. [PubMed: 15381535]
28. Gill TM, Baker DI, Gottschalk M, et al. A prehabilitation program for the prevention of functional decline: effect on higher-level physical function. *Arch Phys Med Rehab*. 2004; 85:1043–1049.
29. Gill TM, Baker DI, Gottschalk M, et al. A program to prevent functional decline in physically frail, elderly persons who live at home. *New Engl J Med*. 2002; 347:1068–1074. [PubMed: 12362007]
30. Weeks JC, Cook EF, O'Day SJ, et al. Relationship between cancer patients' predictions of prognosis and their treatment preferences. *J Am Med Assoc*. 2000; 284:2469–2475.

FIGURE 1.

Thirty-day outcomes of propensity-matched patient cohort after complex general or vascular surgery, stratified by preoperative functional health status.

TABLE 1

Classification Scheme for Composite Predictor Variables

Composite Predictor Variable	Component Variables
Malnutrition	Preoperative serum albumin <3.4 mg/dL >10% weight loss in 6 months before operation
Physical immobility	Paraplegia Quadriplegia Hemiplegia
Acute cognitive dysfunction	Impaired sensorium before operation Coma before operation
Malignancy	Tumor of central nervous system Chemotherapy within 30 d of operation Radiotherapy within 90 d of operation Disseminated cancer
Acute comorbid conditions	Myocardial infarction within 6 mo of operation Angina within 1 mo of operation Acute renal failure Gangrene and/or rest pain of lower extremity Preoperative mechanical ventilation Preoperative pneumonia Preoperative SIRS, sepsis, or septic shock Preoperative transfusion Congestive heart failure
Chronic comorbid conditions	Diabetes mellitus Chronic obstructive pulmonary disease Prior percutaneous coronary intervention Prior cardiac bypass graft surgery Prior lower extremity revascularization procedure History of transient ischemic attack History of cerebrovascular accident End stage renal disease Chronic steroid usage Bleeding disorder (including anticoagulation medications not stopped before operation)

SIRS indicates systemic inflammatory response syndrome.

TABLE 2

Patient- and Procedure-Related Characteristics of Patients Undergoing Complex General or Vascular Surgery, Stratified by Preoperative Functional Health Status

Characteristic	Preoperative Functional Health Status		<i>P</i>
	Independent (n = 163,897)	Dependent (n = 10,246)	
Age, mean ± SD, yr	64.8 ± 14.1	72.2 ± 13.2	<0.0001
Female	72,743 (44.4%)	5156 (50.3%)	<0.0001
Body mass index, mean ± SD, kg/m ²	28.0 ± 6.3	27.1 ± 7.2	<0.0001
DNR status	651 (0.4%)	509 (5.0%)	<0.0001
Malnutrition	23,270 (14.2%)	4561 (44.5%)	<0.0001
Acute cognitive dysfunction	269 (0.2%)	396 (3.9%)	<0.0001
Malignancy	11,886 (7.3%)	577 (5.6%)	<0.0001
Physical immobility	2625 (1.6%)	1470 (14.4%)	<0.0001
Acute comorbid condition	15,120 (9.2%)	3884 (37.9%)	<0.0001
No. conditions, median (IQR)	0 (0,0)	0 (0,1)	<0.0001
Chronic comorbid condition	81,543 (49.8%)	7772 (75.9%)	<0.0001
No. conditions, median (IQR)	0 (0,1)	1 (1,3)	<0.0001
ASA classification			<0.0001
Class 1 or 2	56,252 (34.3%)	722 (7.1%)	
Class 3	94,644 (57.8%)	6582 (64.2%)	
Class 4 or 5	13,001 (7.9%)	2942 (28.7%)	
Operative time, mean ± SD	183 ± 108	179 ± 107	<0.0001
Total work relative value units, median (IQR)	30 (21–44)	30 (22–42)	0.002
Intraoperative transfusion	13,957 (8.5%)	1899 (18.5%)	<0.0001
Surgical trainee participation	106,616 (65.1%)	6370 (62.2%)	<0.0001
Procedure type			<0.0001
Open colorectal resection	47,697 (29.1%)	3856 (37.6%)	
Laparoscopic colorectal resection	30,982 (18.9%)	865 (8.4%)	
Carotid endarterectomy	31,793 (19.4%)	1675 (16.4%)	
Infrainguinal bypass graft	15,406 (9.4%)	2523 (24.6%)	
Endovascular AAA repair	11,232 (6.9%)	455 (4.4%)	
Pancreaticoduodenectomy	8118 (5.0%)	212 (2.1%)	
Hepatectomy	7084 (4.3%)	122 (1.2%)	
Open AAA repair	5264 (3.2%)	211 (2.1%)	
Gastrectomy	4468 (2.7%)	288 (2.8%)	
Esophagectomy	1853 (1.1%)	39 (0.4%)	

IQR indicates interquartile range.

TABLE 3

Procedure-Specific 30-Day Postoperative Mortality and Major Morbidity Rates for Patients Undergoing Complex General or Vascular Surgery, Stratified by Procedure Type and Functional Health Status

Procedure Type	30-d Mortality			30-d Major Morbidity		
	Functional Health Status		<i>P</i>	Functional Health Status		<i>P</i>
	Independent	Dependent		Independent	Dependent	
Open colorectal resection	760/47,697 (1.6%)	445/3856 (11.5%)	<0.0001	7647/47,697 (16.0%)	1467/3856 (38.0%)	<0.0001
Laparoscopic colorectal resection	194/30,982 (0.6%)	52/865 (6.0%)	<0.0001	2,577/30,982 (8.3%)	213/865 (24.6%)	<0.0001
Carotid endarterectomy	197/31,793 (0.6%)	55/1675 (3.3%)	<0.0001	1341/31,793 (4.2%)	201/1675 (12.0%)	<0.0001
Infrainguinal bypass graft	222/15,406 (1.4%)	149/2523 (5.9%)	<0.0001	2285/15,406 (14.8%)	671/2523 (26.6%)	<0.0001
Endovascular AAA repair	131/11,232 (1.2%)	25/455 (5.5%)	<0.0001	894/11,232 (8.0%)	107/455 (23.5%)	<0.0001
Pancreaticoduodenectomy	232/8118 (2.9%)	23/212 (10.9%)	<0.0001	2367/8118 (29.2%)	101/212 (47.6%)	<0.0001
Hepatectomy	166/7084 (2.3%)	16/122 (13.1%)	<0.0001	1448/7084 (20.4%)	47/122 (38.5%)	<0.0001
Open AAA repair	199/5264 (3.8%)	29/211 (13.7%)	<0.0001	1679/5264 (31.9%)	98/211 (46.5%)	<0.0001
Gastrectomy	119/4468 (2.7%)	29/288 (10.1%)	<0.0001	939/4468 (21.0%)	109/288 (37.9%)	<0.0001
Esophagectomy	60/1853 (3.2%)	4/39 (10.3%)	0.02	729/1853 (39.3%)	25/39 (64.1%)	0.002

TABLE 4

Patient- and Procedure-Related Characteristics of Propensity-Matched Cohort of Patients Undergoing Complex General or Vascular Surgery, Stratified by Preoperative Functional Health Status

Characteristic	Preoperative Functional Health Status		P*
	Independent (n = 9782)	Dependent (n = 9782)	
Age, mean $\pm$ SD, yr	72.2 $\pm$ 11.5	72.0 $\pm$ 13.4	0.65
Female	4877 (49.9%)	4886 (50.0%)	0.90
Body mass index, mean $\pm$ SD, kg/m ²	27.2 $\pm$ 6.4	27.1 $\pm$ 7.2	0.03
DNR status	318 (3.3%)	375 (3.8%)	0.02
Malnutrition	4238 (43.3%)	4180 (42.7)	0.34
Acute cognitive dysfunction	194 (2.0%)	238 (2.4%)	0.02
Malignancy	547 (5.6%)	555 (5.7%)	0.80
Physical immobility	1160 (11.9%)	1238 (12.7%)	0.06
Acute comorbid condition	3630 (37.1%)	3537 (36.2%)	0.12
Chronic comorbid condition	7445 (76.1%)	7360 (75.2%)	0.14
ASA classification			0.006
Class 1 or 2	628 (6.4%)	721 (7.4%)	
Class 3	6513 (66.6%)	6402 (65.5%)	
Class 4 or 5	2641 (27.0%)	2659 (27.2%)	
Operative time, mean $\pm$ SD, min	182 $\pm$ 106	180 $\pm$ 108	0.12
Total work relative value units, median (IQR)	29 (21–42)	30 (22–42)	0.59
Intraoperative transfusion	1743 (17.8%)	1751 (17.9%)	0.88
Surgical trainee participation	6114 (62.5%)	6085 (62.2%)	0.67
Procedure type			0.62
Open colorectal resection	3535 (36.1%)	3596 (36.7%)	
Laparoscopic colorectal resection	852 (8.7%)	848 (8.7%)	
Carotid endarterectomy	1595 (16.3%)	1635 (16.7%)	
Infrainguinal bypass graft	2513 (25.7%)	2392 (24.5%)	
Endovascular AAA repair	441 (4.5%)	451 (4.6%)	
Pancreaticoduodenectomy	213 (2.2%)	212 (2.2%)	
Hepatectomy	122 (1.3%)	121 (1.2%)	
Open AAA repair	201 (2.1%)	211 (2.2%)	
Gastrectomy	271 (2.8%)	277 (2.8%)	
Esophagectomy	39 (0.4%)	39 (0.4%)	

IQR indicates interquartile range.