

# Functional Status and Major Complications and Death After EVAR



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# EVAR for AAA

- Even for young, good risk candidates, EVAR primary treatment modality for intact AAA
- Particular utility for patients who may be at greater perioperative risk for open repair
- Functional status is an important predictor of outcomes after major surgery
- Effect of functional status on outcomes, and how to appropriately measure it after EVAR is unclear

# Functional Dependence: Definition

- Risk assessment
  - Predict, pick out patients who may do poorly and try to optimize them prior to surgery
- Multiple ways to measure (ASA, Hopkins, Waterloo, STS, Parsonnet, Euro, French, Cleveland Clinic, Ontario)
  - Degrees of validation in different diseases is variable
- Scores that denote Frailty
- Functional Dependence based on activities of daily living (NSQIP)

# Functional dep status

Focuses on the patient's abilities to perform activities of daily living (**ADLs**) in the **30 days prior to surgery**. Activities of daily living are defined as 'the activities usually performed in the course of a normal day in a person's life'.

ADLs include: **bathing, feeding, dressing, toileting, and mobility**. The best functional status demonstrated by the patient within the 30 days prior to surgery is reported.

**(1) Independent:** The patient does not require assistance from another person for any activities of daily living. This includes a person who is able to function independently with prosthetics, equipment, or devices.

**(2) Partially dependent:** The patient requires some assistance from another person for activities of daily living. This includes a person who utilizes prosthetics, equipment, or devices but still requires some assistance from another person for ADLs.

**(3) Totally dependent:** The patient requires total assistance for all activities of daily living.

All patients with psychiatric illnesses should be evaluated for their ability to function just as the non-psychiatric patient.



## Activities of Daily Living Is a Critical Factor in Predicting Outcome After Carotid Endarterectomy in Asymptomatic Patients

Anand Dayama, MD; Pratik Pimple, MBBS, MPH; Barath B...  
James G. Reeves, MD

**Background and Purpose**—Activities of daily living (ADL) can be assessed in the clinic and may be a useful tool to predict postoperative outcomes after carotid endarterectomy (CEA).

**Methods**—National Surgical Adjuvant Breast and Bowel Project (NSABP) Carotid Artery Project (CAP) data were analyzed. Patients who underwent CEA on FNS: independent, partially dependent, or functionally dependent. Complications were identified and outcomes while controlling for other factors.

**Results**—Of 19748 CEAs, 10712 were functionally independent, 10712 were functionally partially dependent, and 23 (0.12%) were functionally dependent. There were 14 (3.71%) strokes, 84 (0.43%) deaths, and 14 (3.71%) strokes. In a multivariate model, using functionally independent as reference, functionally partially dependent (OR 3.3; 95% confidence interval [CI], 1.8-5.8) and other complications (OR 2.5; 95% CI, 1.5-4.1) were associated with death (odds ratio [OR], 3.3; P<0.001).

**Conclusions**—In this national database, ADL was associated with adverse postoperative outcomes after CEA. ADL should be considered along with other objective factors for gauging risk of adverse outcomes after CEA. (*Stroke*. 2014;45:1703-1708.)

**Key Words:** endarterectomy, carotid ■ outcome assessment

Analysis based on ADL's  
10712 CEA's

Multivariate analysis using functionally independent as reference

Functionally partially dependent associated with

- Death (OR 3.3, p<0.001)
- Stroke (OR 3, p<0.001)
- Other complications (OR 2.5, p<0.001)

Functionally dependent

# Frailty

## Simplified Frailty Index to Predict Adverse Outcomes and Mortality in Vascular Surgery Patients

*Joseph Karam,<sup>1</sup> Athanasios Tsiouris,<sup>1</sup> Alexander Shepard,<sup>1</sup> Vic and Ilan Rubinfeld,<sup>1</sup> Detroit, Michigan, and Tampa, Florida*

**Background:** Frailty has been established as an important predictor of adverse outcomes in vascular surgery patients. We hypothesized that the use of a modified frailty index would be associated with adverse occurrences in vascular surgery patients.

**Methods:** Under the data use agreement of the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Participant Utilization File was accessed for the years 2000-2009. All vascular surgery patients were matched to the Canadian Study of Health and Aging Frailty Index (FI) database. An increase in FI implies increased frailty. Variables assessed were mortality, wound infection, and any occurrence. We analyzed the relationship between FI, age, functional status, relative value units (RVU), American Society of Anesthesiologists (ASA) class, emergency status, and wound status on mortality. Statistical analysis was done using multivariate logistic regression analysis and stepwise logistic regression.

**Results:** A total of 67,308 patients were identified in the database, 3913 wound occurrences, 6691 infections, 12,847 occurrences of all kinds, and 2800 deaths. As the FI increased, postoperative wound infection, all occurrences, and mortality increased ( $P < 0.001$ ). Stepwise logistic regression using the FI with the NSQIP variables of age, work RVU, ASA class, wound classification, emergency status, and functional status showed FI to have the highest odds ratio (OR) for mortality (OR = 2.058,  $P < 0.001$ ).

**Conclusions:** A simplified FI can be obtained by easily identifiable patient characteristics, allowing for accurate prediction of postoperative morbidity and mortality in the vascular surgery population.

Analysis of outcomes and mortality in Vascular surgery patients

67,308 patients  
12,847 occurrences  
2,800 deaths

# Frailty

**Table I.** Items of the CSHA-FI mapped onto the NSQIP preoperative risk factors

CSHA-FI	NSQIP
Chronic obstructive pulmonary disease	Functional health status dependent
Proteinuria	Functional health status dependent
History of stroke	Diabetes mellitus, non-insulin dependent
History of stroke	Diabetes mellitus, insulin dependent
Lung disease	History of severe COPD
Respiratory problems	Current pneumonia
Coronary artery disease	Congestive heart failure
Myocardial infarction	History of myocardial infarction to surgery
Cardiac problems	Previous percutaneous coronary intervention
Cardiac problems	Previous cardiac surgery
Cardiac problems	History of angina with myocardial infarction
Cardiac problems	Hypertension requiring medication
Cardiac problems	Impaired sensorium
Arterial hypertension	History of transient ischemic attack
Clouding or delirium	Cerebrovascular accident
History relevant to cognitive impairment or loss	History of revascularization
Family history relevant to cognitive impairment	vascular disease
Cerebrovascular problems	Rest pain/gangrene
History of stroke	
Decreased peripheral pulses	

Canadian study on Health and Aging FI (CSHA-FI)

**mFI**  
(11 variables)

- Diabetes
- Functional status (ND)
- COPD
- Pneumonia
- CHF
- MI
- PCI, angina, surgery
- HTN w meds
- PVD or rest pain
- Impaired sensorium
- TIA or CVA, or CVA or neuro deficit

1 point for each/11 (0-1)  
Increasing number implies increasing frailty



# Frailty

**Table III.** Modified frailty index and postoperative outcomes (all  $P < 0.001$ )

Frailty index	0	0.09	0.18	0.27	0.36	0.45	0.55	0.64	0.73
Any occurrence (%)	11.3	13.8	15.7	20.7	24.5	31.4	37.9	42.9	47.2
Surgical site infection (%)	5.5	6.9	8.3	10.7	13.2	16.8	19.6	25.8	22.2
Myocardial infarction (%)	0.1	0.3	0.4	0.7	0.8	1.0	1.1	0.7	2.2
Clavien IV complications (%)	1.7	5.0	6.1	8.3	9.4	13.7	18.2	76.4	67.2
Mortality (%)	2.1	2.4	2.8	4.5	5.7	9.3	13.5	16.0	24.3



**Table IV.** Multivariate logistic regression analysis of variables affecting 30-day mortality (all  $P < 0.001$ )

Frailty index	2.058
Work RVU	1.026
Age	1.031
Functional status	
Partially dependent	0.145
Dependent	0.351
ASA classification	
2	0.022
3	0.026
4	0.058
5	0.185
Wound classification	
Clean-contaminated	0.682
Contaminated	1.208
Dirty/infected	1.123



# ADL's

## Gender and 30-day outcome in patients undergoing endovascular aneurysm repair (EVAR) using the ACS NSQIP dataset

Nick N. Abedi, MD, Daniel L. Davenport, PhD, Eleftherios Xenos, MD, PhD, David J. Minion, MD, and Eric D. Endean, MD, *Lexington, Ky*

**Purpose:** Prior studies have demonstrated higher in-hospital mortality in women undergoing endovascular aneurysm repair. The current study evaluates the relationship between gender and 30-day outcome in endovascular aneurysm repair (EVAR) in a multicenter, contemporary patient population.

**Methods:** Patients in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) participant use file that underwent EVAR of abdominal aortic aneurysm (AAA) from 2005 to 2007 were identified by CPT codes. Outcomes analyzed were 30-day mortality, morbidity (one or more of 21 complications defined by the ACS NSQIP protocol), length of hospital stay, and six complication subgroups.

Results were compared across genders using  $\chi^2$  (binary) and Fisher's exact test. The relationship of gender to outcomes was further evaluated using multivariate analysis adjusting for risk variables.

In total, 647 (17.7%) were women and 3015 were men. Tube graft (360, 9.8%); bifurcated, open (218, 5.9%); unibody (218, 5.9%); and aorto-uni-iliac (218, 5.9%) were more common in women (3.9% vs 1.8%,  $P = .011$ ) and iliac or brachial exposure (11.9% and 2.1%, respectively. Mortality was 17.8% vs 10.6%,  $P < .001$ ). Of thirteen in-hospital complications, women had a higher incidence in five: emergent operation (11.9% vs 2.1%,  $P < .001$ ), obesity, and severe chronic obstructive pulmonary disease (OR for mortality in women vs men was 1.65 (95% CI 1.28-2.14,  $P < .001$ ). Female patients had longer length of stay (10.7 days, 95% CI 0.2-1.2,  $P = .006$ ), infectious complications (OR 1.80, 95% CI 1.12-2.90,  $P = .015$ ) and postoperative complications (OR 1.22, 95% CI 1.02-1.44,  $P = .028$ ).

**Conclusions:** Mortality and morbidity were higher in women than men undergoing EVAR. Multivariate analysis showed that the increased risk of mortality was related to women presenting more emergently, more debilitated (recent weight loss and functional dependence), and requiring iliac or brachial exposure. After adjustment for multiple preoperative and operative factors, women remained at significantly higher risk for the development of a broad range of complications and increased length of stay. (*J Vasc Surg* 2009;50:486-91.)

3662 EVAR patients  
647 women, 3015 men  
Multiple configurations, but women with more aorto uni-grafts

Increased risk factor for morbidity, LOS and some complications

Present more emergent, debilitated and with more functional dependence

Higher mortality in women (3.4 vs. 2.1,  $p=0.14$ )  
Women with higher incidence in five pre-operative risk factors for mortality and morbidity  
emergency, **functional status**, recent weight loss, underweight status or morbid obesity, severe COPD

# 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

**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

(*Ann Surg* 2015;261:432–437)

- Patients undergoing 1 of 10 complex general and vascular procedures
- Open colorectal resection
- Laparoscopic colorectal resection
- cEA
- Infrainguinal bypass
- Endo AAA
- Whipple
- Hepatectomy
- Open AAA
- Gastrectomy
- Esophagectomy
- Used **propensity scoring** to match patients with and without functional dependency.
- Argued that frailty is a good indicator but its too complicated to be of utility



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

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**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
Acute comorbid conditions	Radiotherapy within 90 d of operation Disseminated cancer 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
Chronic comorbid conditions	Preoperative transfusion Congestive heart failure 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.

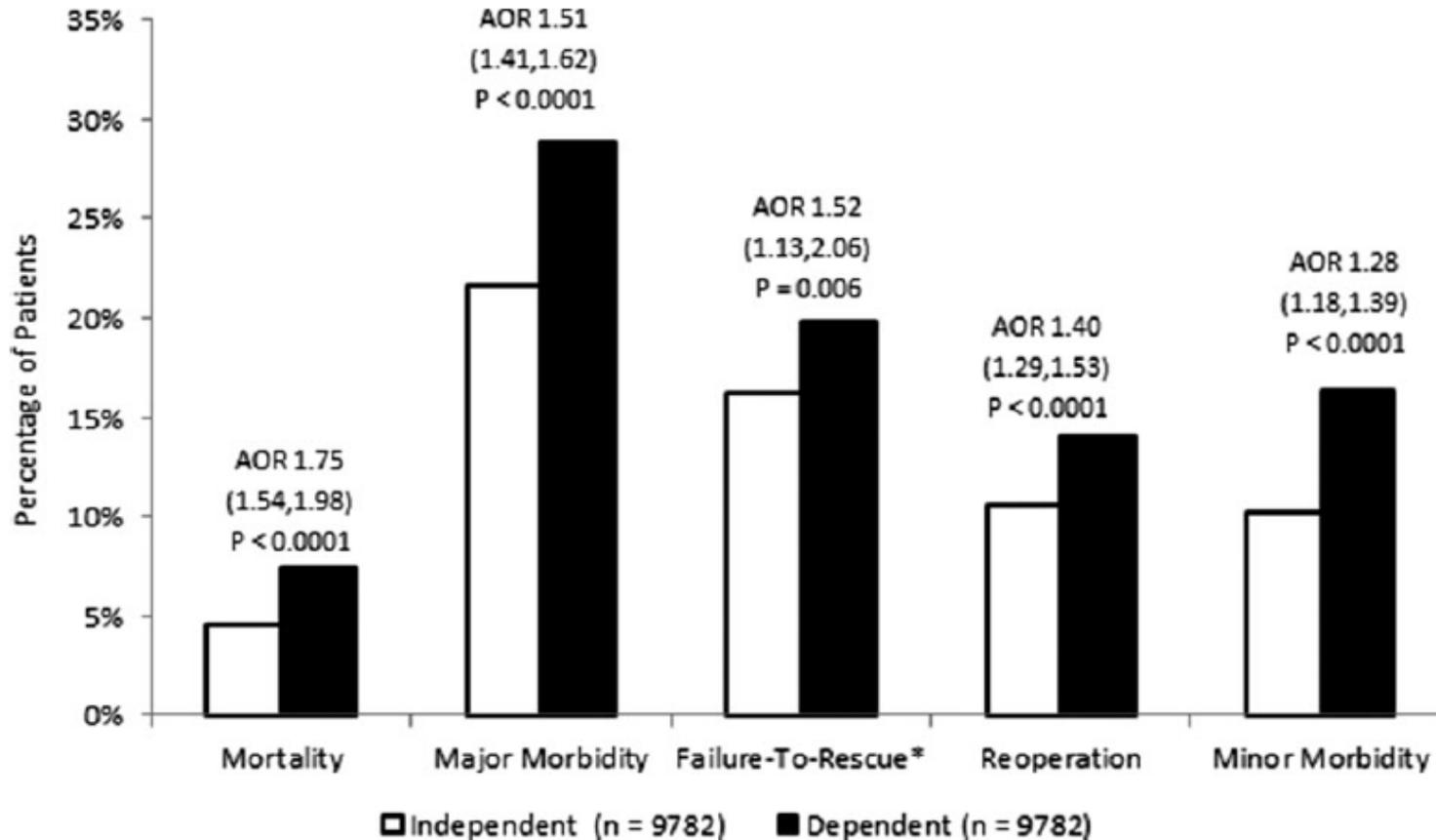
**TABLE 2.** Patient- and Procedure-Related Characteristics of Patients Undergoing Complex General or Vascular Surgery, Stratified by Preoperative Functional Health Status

Characteristic	Preoperative Functional Health Status		P	
	Independent (n = 163,897)	Dependent (n = 10,246)		
Age, mean ± SD, yr	64.8 ± 14.1	72.2 ± 13.2	<0.0001	plex
Female	72,743 (44.4%)	5156 (50.3%)	<0.0001	
Body mass index, mean ± SD, kg/m <sup>2</sup>	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	P*
Acute cognitive dysfunction	269 (0.2%)	396 (3.9%)	<0.0001	
Malignancy	11,886 (7.3%)	577 (5.6%)	<0.0001	0.65
Physical immobility	2625 (1.6%)	1470 (14.4%)	<0.0001	0.90
Acute comorbid condition	15,120 (9.2%)	3884 (37.9%)	<0.0001	0.03
No. conditions, median (IQR)	0 (0,0)	0 (0,1)	<0.0001	0.02
Chronic comorbid condition	81,543 (49.8%)	7772 (75.9%)	<0.0001	0.34
No. conditions, median (IQR)	0 (0,1)	1 (1,3)	<0.0001	0.02
ASA classification			<0.0001	0.80
Class 1 or 2	56,252 (34.3%)	722 (7.1%)		0.06
Class 3	94,644 (57.8%)	6582 (64.2%)		0.12
Class 4 or 5	13,001 (7.9%)	2942 (28.7%)		0.14
Operative time, mean ± SD	183 ± 108	179 ± 107	<0.0001	0.006
Total work relative value units, median (IQR)	30 (22–44)	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	0.12
Open colorectal resection	47,697 (29.1%)	3856 (37.6%)		0.59
Laparoscopic colorectal resection	30,982 (18.9%)	865 (8.4%)		0.88
Carotid endarterectomy	31,793 (19.4%)	1675 (16.4%)		0.67
Intraaortic bypass graft	15,406 (9.4%)	2523 (24.6%)		0.62
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.				
Open AAA repair	201 (1.1%)	211 (2.2%)		
Gastrectomy	271 (2.8%)	277 (2.8%)		
Esophagectomy	39 (0.4%)	39 (0.4%)		
IQR indicates interquartile range.				



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

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# Hypothesis

Even in patients undergoing EVAR, Impaired functional status is an important predictor associated with greater morbidity and mortality.

# Methods

- ACS National Surgical Quality Improvement Project (NSQIP) analysis
- Non-emergent EVAR for AAA, 2010 – 2014
- Stratification by preoperative functional status
  - Independent vs
  - Dependent (partial or total)

# Outcomes

- 30 day mortality
- Major operative complications  
Deep wound infection, dehiscence, major bleeding, device complications
- Major systemic complications  
Cardiac events, respiratory failure, stroke, renal failure
- Secondary outcomes  
Length of stay, reoperation, readmission



# Results

- 13,432 elective EVAR patients
  - 13,043 (97%) Independent
  - 389 (3%) Dependent (Partially or totally)

# Patient Characteristics

Demographics	Independent	Dependent	P
Age, years	73 ± 8	77 ± 8	< 0.0001
Male, %	81%	67%	< 0.0001
Dyspnea at rest, %	1%	9%	< 0.0001
Heart failure, %	1%	6%	< 0.0001
ESRD, %	1%	4%	< 0.0001
ASA 4 or 5, %	22%	46%	< 0.0001

# Outcomes

Demographics	Independent	Dependent	P
<b>Complications, %</b>			
Major operative	11%	34%	< 0.0001
Major systemic	4%	13%	< 0.0001
<b>30 day mortality, %</b>	1%	6%	< 0.0001
<b>Secondary outcomes</b>			
Length of stay, days	2 (1 – 3)	4 (2 – 9)	< 0.0001
Reoperation, %	3%	5%	0.03
Readmission, %	2%	4%	0.01

# Multivariable Analysis: Mortality

Risk Factor	Odds Ratio	95% CI	P
<b>Dependent status</b>	<b>3.4</b>	<b>2.0 – 5.5</b>	<b>&lt; 0.0001</b>
Age > 80 years	2.4	1.7 – 3.4	< 0.0001
COPD	2.3	1.6 – 3.2	< 0.0001
ESRD	4.6	2.3 – 8.6	< 0.0001
ASA 4 or 5	2.2	1.5 – 3.1	< 0.0001

# Multivariable Analysis: Morbidity

Risk Factor	Odds Ratio	95% CI	P
<b>Dependent status</b>	<b>3.0</b>	<b>2.4 – 3.8</b>	<b>&lt; 0.0001</b>
Age > 80 years	1.8	1.6 – 2.0	< 0.0001
COPD	1.4	1.2 – 1.6	< 0.0001
ESRD	1.7	1.2 – 2.4	< 0.0001
ASA 4 or 5	1.7	1.5 – 1.9	< 0.0001

# Conclusions

- Impaired preoperative functional status is an independent risk factor for major complications and death after EVAR for AAA
- Functional status is a simple to use screening tool to identify high risk patients prior to intervention
- These patients may benefit from preoperative medical and functional optimization and perhaps different anesthetic strategies





# Thank you



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# Performance of endovascular aortic aneurysm repair in high-risk patients: Results from the Veterans Affairs National Surgical and Endovascular Aneurysm Repair Improvement Program

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**Objective:** Recent results after endovascular abdominal aortic aneurysm repair (EVAR) in high-risk patients are not well defined. The National Surgical and Endovascular Aneurysm Repair Quality Improvement Program (NSQIP) is the largest prospective database representing current clinical practice. The purpose of this study was to evaluate the performance of EVAR in high-risk veterans.

Participating VA hospitals were identified from the NSQIP database from December 2004. High-risk criteria analyzed included age  $\geq 60$  years, American Society of Anesthesiologists class III or IV, and the comorbidity variables of history of cardiac, respiratory, or hepatic insufficiency, and low serum albumin level. Our primary end points were 30-day mortality and 1-year mortality. We also analyzed a secondary end point of perioperative complications. Statistical analysis was performed using logistic regression modeling.

High-risk patients who underwent elective EVAR with significantly lower 30-day mortality (9.5% vs 12.4%,  $P = .038$ ) than patients having open repair. EVAR also had significantly lower 1-year mortality (adjusted odds ratio [OR], 0.65; 95% confidence interval [CI], 0.51 to 0.84;  $P = .001$ ) as well as 1-year mortality (adjusted OR, 0.68; 95% CI, 0.51 to 0.91;  $P = .001$ ) compared with open repair. The risk of perioperative complications was significantly lower in EVAR patients (adjusted OR, 0.41; 95% CI, 0.33 to 0.52;  $P < .0001$ ). A subset analysis of higher-risk patients (those with age  $\geq 60$  years and the above comorbidity variables) still demonstrated an acceptable 30-day mortality rate.

**Conclusion:** In veterans deemed high-risk for surgical therapy, outcomes after elective EVAR are excellent, and the procedure is relatively safe in this special patient population. Our retrospective data demonstrate that patients with considerable medical comorbidities and infrarenal abdominal aortic aneurysms benefit from and should be considered for primary EVAR. (*J Vasc Surg* 2007;45:227-34.)

- High risk patients undergoing EVAR in NSQIP Hospitals
- Compared to Open
- Age >60, ASA 3 or 4, various comorbid conditions
- 30 day and 1 year all cause mortality

- Patients having EVAR have significantly lower 30-day (3.4 vs. 5.2,  $p=0.04$ ) and one year (9.5 vs. 12.4,  $p=0.038$ ) mortality.
- Also lower morbidity, compared to open repair.