From the Society for Vascular Surgery

Occurrence of "never events" after major open vascular surgery procedures

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Objective: **"Never events" refers to harmful hospital-acquired conditions that the Centers for Medicare and Medicaid Services identified in 2008 as largely preventable and that would no longer be reimbursed. Our goal was to identify the incidence, predictive factors, temporal trend, and associated consequences of never events after major open vascular surgery procedures.**

Methods: **The Nationwide Inpatient Sample (NIS) (2003-2011) was queried to identify never events applicable to vascular surgery patients, including air embolism, catheter-based urinary tract infections (UTIs), stage 3 and 4 pressure ulcers, falls/trauma, blood incompatibility, vascular catheter infections, complications of poor glucose control, retained foreign objects, and wrong-site surgery. We specifically evaluated open abdominal aortic aneurysm repair, carotid endarterectomy, and lower extremity bypass/femoral endarterectomy. Multivariable logistic regression was used to predict never events based on preoperative variables. Multivariable logistic and gamma regression models were used to study mortality, hospital length of stay (LOS), and charges.**

Results: **Never events were identified in 774 of 267,734 patients. The distribution of never events were falls/trauma (59%), pressure ulcers (19%), catheter-based UTI (9%), vascular catheter infection (6%), complications of poor glucose control (5%), and retained objects (4%). Rates of falls and catheter-based UTIs have increased since 2008. Multivariable predictors of any never event included lower extremity bypass, abdominal aortic aneurysm, weight loss, nonelective admission, paralysis, repair, congestive heart failure, altered mental status, renal failure, weekend admission, diabetes, female gender, and age. Race, insurance, hospital type, income level, geography, July to September admission, and other comorbidities were not predictive. After risk factor adjustment, never events were associated with increased perioperative mortality (odds ratio, 2.7; 95% confidence interval [CI], 1.5-34.8; $P < .001$), LOS (means ratio, 1.9; 95% CI, 1.7-2.0; $P < .001$), and total charges (means ratio, 1.7; 95% CI, 1.6-1.8; $P < .001$).**

Conclusions: **Never events after major vascular surgery are associated with a number of perioperative factors and are predictive of increased charges, LOS, and mortality. Falls and catheter-based UTIs have increased in frequency since the Centers for Medicare and Medicaid Services announced that it would no longer reimburse for these complications. This study establishes baseline never event rates in the vascular surgery patient population and identifies high-risk patients to target for quality improvement. (J Vasc Surg 2016;63:738-45.)**

"Never events" refer to hospital-acquired conditions that are considered to be largely preventable. The Centers for Medicare and Medicaid Services (CMS) evaluated these events in 2008 and decided that the increased charges associated with their treatment will no longer be reimbursed in the inpatient setting.[1-3] The never events that specifically affect vascular surgery patients include air embolism, catheter-based urinary tract infection (UTI), stage 3 and 4 pressure ulcers, falls/trauma, blood incompatibility, vascular catheter infection, complications with poor glucose control, foreign objects, and wrong-site surgery.[4,5]

Reducing the occurrence of never events could potentially lower morbidity, mortality, and total charges.[5,6] There is a need to conduct a closer analysis of the prevalence of never events in specific patient populations and to identify risk factors that are associated with these events. Previous analyses of never events in neurosurgery and urology have identified associated factors and have shown increased morbidity and resource utilization.[5,7]

Evaluation of never events, including their associated factors and consequences, has not been examined in patients undergoing vascular surgery. These patients are at high risk for morbidity, increased length of stay (LOS), and readmission; therefore, establishment of baseline prevalence and risk factors of never events can help guide policy for this at-risk population.[8,9] We queried the national Nationwide Inpatient Sample (NIS) to identify never events in patients undergoing open major vascular surgery procedures. The goal of this study was to quantify the prevalence, risk factors, and in-hospital consequence of never events after major vascular procedures to provide baseline data to set targets for quality improvement.

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Table I. Relationship of "never events" and patient characteristics

Characteristic[a]	*Overall (N = 82,700)*	*Never event (n = 364)*	*No never event (n = 82,336)*	*OR (95% CI)*	P *value*
Procedure					
Open AAA	4022 (4.86)	34 (9.24)	3988 (4.84)	3.23 (2.22-4.69)	<.001
LEB	20,599 (24.91)	177 (48.63)	20,422 (24.8)	3.28 (2.64-4.08)	
CEA	58,079 (70.23)	153 (42.03)	57,926 (70.35)	Reference	
Patient characteristics					
Age, years	70.3 ± 10	72.3 ± 10.8	70.3 ± 10	1.02 (1.01-1.03)	<.001
Male gender	49,254 (59.56)	194 (53.30)	49,060 (59.59)	0.77 (0.63-0.95)	.014
Caucasian	61,524 (74.39)	261 (71.70)	61,263 (74.41)	0.67 (0.51-0.88)	.003
Medicare	58,385 (70.60)	299 (82.14)	58,086 (70.55)	Reference	<.001
Medicaid	3240 (3.92%)	13 (3.57)	3227 (3.92)	0.78 (0.45-1.37)	
Private insurance	18,209 (22.02)	41 (11.26)	18,168 (22.07)	0.44 (0.32-0.61)	
Admission					
Elective	67,970 (82.19)	170 (46.70)	67,800 (82.35)	0.19 (0.15-0.23)	<.001
July-September	18,747 (22.67)	86 (23.63)	18,661 (22.66)	1.08 (0.84-1.38)	.548
Weekend	2425 (2.93)	46 (12.64)	2379 (2.89)	4.86 (3.56-6.64)	<.001
First quartile income	22,061 (26.68)	97 (26.65)	21,964 (26.68)	Reference	.318
Fourth quartile income	15,401 (18.62)	81 (22.25)	15,320 (18.61)	1.20 (0.89-1.61)	
Hospital details					
Hospital size					
Small	8593 (10.39)	30 (8.24)	8563 (10.40)	0.80 (0.55-1.17)	.243
Medium	16,968 (20.52)	84 (23.08)	16,884 (20.51)	1.14 (0.89-1.46)	
Large	56,072 (67.80)	244 (67.03)	55,828 (67.81)	Reference	
Rural hospital	7093 (8.58)	26 (7.14)	7067 (8.58)	0.82 (0.55-1.23)	.337
Regional location					
Northeast	13,255 (16.03)	56 (15.38)	13,199 (16.03)	Reference	.378
Midwest	21,890 (26.47)	84 (23.08)	21,806 (26.48)	0.91 (0.65-1.27)	
South	34,588 (41.82)	159 (43.68)	34,429 (41.82)	1.09 (0.80-1.48)	
West	12,967 (15.68)	65 (17.86)	12,902 (15.67)	1.19 (0.83-1.70)	
Teaching hospital	39,857 (48.82)	185 (50.82)	39,672 (48.18)	1.12 (0.91-1.38)	.279
Comorbidities					
Hypertension	56,757 (68.63)	160 (43.96)	56,597 (68.74)	0.36 (0.29-0.44)	<.001
CHF	6307 (7.63)	86 (23.63)	6221 (7.56)	3.78 (2.97-4.83)	<.001
Valvular disease	5025 (6.08)	28 (7.69)	4997 (6.07)	1.29 (0.88-1.9)	.196
PVD	20,111 (24.32)	99 (27.20)	20,012 (24.31)	1.16 (0.92-1.47)	.199
Paralysis	2603 (3.15)	42 (11.54)	2561 (3.11)	4.06 (2.94-5.62)	<.001
COPD	19,740 (23.87)	106 (29.12)	19,634 (23.85)	1.31 (1.05-1.65)	.018
Diabetes	27,561 (33.33)	162 (44.51)	27,399 (33.28)	1.61 (1.31-1.98)	<.001
Hypothyroidism	8045 (9.73)	56 (15.38)	7989 (9.7)	Reference	<.001
Renal failure	1757 (2.12)	31 (8.52)	1726 (2.1)	1.69 (1.27-2.25)	<.001
Liver disease	645 (.78)	4 (1.1)	641 (.78)	4.35 (3-6.3)	.488
AIDS	50 (.06)	0 (0)	50 (.06)	0	.638
Metastatic cancer	184 (.22)	1 (.27)	183 (.22)	1.24 (0.17-8.85)	.832
Coagulopathy	1679 (2.03)	32 (8.79)	1647 (2)	4.72 (3.27-6.81)	<.001
Obesity	6250 (7.56)	35 (9.62)	6215 (7.55)	1.30 (0.92-1.85)	.137
Weight loss	1058 (1.28)	56 (15.38)	1002 (1.22)	14.7 (11-19.75)	<.001
Fluid/electrolyte imbalance	6559 (7.93)	109 (29.95)	6450 (7.83)	5.03 (4.01-6.30)	<.001
Alcohol abuse	1656 (2.00)	13 (3.57)	1643 (2)	1.82 (1.04-3.17)	.032
Drug abuse	409 (.49)	2 (.55)	407 (.49)	1.11 (0.28-4.48)	.881
Altered mental status	945 (1.14)	13 (3.57)	932 (1.13)	3.23 (1.85-5.65)	<.001
Depression	5127 (6.20)	35 (9.62)	5092 (6.18)	1.61 (1.14-2.29)	.007

AAA, Abdominal aortic aneurysm; *AIDS,* acquired immune deficiency syndrome; *CEA,* carotid endarterectomy; *CHF,* congestive heart failure; *CI,* confidence interval; *COPD,* chronic obstructive pulmonary disease; *LEB,* lower extremity bypass; *OR,* odds ratio; *PVD,* peripheral vascular disease.
[a]Categoric data are shown as number (%) and continuous data as mean ± standard deviation.

METHODS

The NIS collects information from 20% of discharges from the United States nongovernment hospitals that contribute to the Healthcare Cost and Utilization Project. NIS is the largest all-payer inpatient care database and provides information about 8 million inpatient stays from 1000 hospitals in the United States.[10] NIS provides data on primary and secondary diagnoses, procedures, demographics, source of payment, total charge, LOS, and comorbidity for each hospital visit.[10] In this study, the data from NIS was used to analyze temporal trends of the occurrences of never events from 2003 to 2011. Never events were defined as the occurrence of an air embolism, catheter-based UTI, stage 3 and 4 pressure ulcers, falls, blood incompatibility, vascular catheter infection, complication with poor glucose control, foreign objects, or wrong-site surgery.