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Elderly Age as a Risk Factor for 30-Day Postoperative Outcomes Following Elective Anterior Cervical Discectomy and Fusion

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Abstract

Study Design: Retrospective analysis of prospectively collected data.

Objective: Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed spinal procedures. Considering the high success and low complications rate of ACDF and high prevalence of age-related degeneration of the cervical spine, the rates of ACDF are expected to continually rise. The objective is to identify the association between patient age and 30-day postoperative outcomes following elective ACDF.

Methods: The 2010-2014 ACS-NSQIP database was queried using Current Procedural Terminology (CPT) codes 22551 or 22554. Patients were divided into age quartiles (18-45, 46-52, 53-60, and ≥61 years). Bivariate and multivariate logistic regression analyses were employed to quantify the increased risk of 30-day postoperative complications in the elderly patient population.

Results: A total of 20 563 patients met the inclusion criteria for the study. The analyses found quartile 4 had an increased odds of length of stay (LOS) ≥5 days (odds ratio [OR] = 2.05, confidence interval [CI] = 1.62-2.60), pulmonary complications (OR = 3.25, CI = 1.81-5.84), urinary tract infections (UTI) (OR = 2.25, 1.04-4.87, *P* = .038), cardiac complication (OR = 6.01, CI = 1.36-26.62, *P* = .018), and sepsis (OR = 4.38, CI = 1.30-14.70, *P* = .017). Quartiles 2 and 4 had an increased odds of venous thromboembolism (OR = 3.13, CI = 1.14-8.56, *P* = .026; OR = 3.83, CI = 1.44-10.20, *P* = .007). Quartiles 3 and 4 experienced an increased odds of unplanned readmission (OR = 1.44, CI = 1.01-2.05, *P* = .045; OR = 1.88, CI = 1.33-2.66). All *P* values are <.001 unless otherwise noted.

Conclusion: Elderly patients experienced an increased odds of LOS ≥5 days, pulmonary complications, cardiac compilations, venous thromboembolism, UTI, sepsis, and unplanned readmission. Identification of these factors can improve the selection of appropriate surgical candidates and postoperative safety.

Keywords
complications, outcomes, ACDF, cervical, anterior, fusion, ACS-NSQIP, elderly

Introduction

Approximately 5 million adults in the United States are disabled to some degree from spine related disorders.[1] The elderly population, a growing demographic in the United States and much of the Western world, is commonly affected by spinal conditions.[1-5] Advances in surgery and anesthesia have reduced the physiologic impact of surgery, thus making the option of surgery available to older patients who may have a significant comorbidity burden.[2] With these population and medical factors in mind, it is no surprise the annual number of discharges for spinal fusion procedures, which increased by 137% between 1998 and 2008, is expected to continue to grow.[6] Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed spinal procedures for patients who present with cervical

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spondylosis and is also indicated for cervical realignment, trauma, and neoplasm.[7-9] Patients who require ACDF generally enjoy significant improvement in clinical symptoms, quick recovery times, and minimal surgical risk.[7,8,10-12] Considering the high success and low complications rate of ACDF,[7-9] the aging population in the United States[2] and high prevalence of age-related degeneration of the cervical spine,[1-4,7] the rates of ACDF are expected to continually rise.[1,4,8]

Postoperative complications following elective ACDF, while rare, can have significant impact on a patient's quality of life and can also place a significant burden on the health care system. The present study utilizes the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP) database to analyze the effect of patient age on 30-day complications following elective ACDF. The authors hope that identifying which acute postoperative complications elderly patients are at risk for may improve appropriate patient selection for surgery and direct postoperative management efforts in order to avoid common complications in the elderly populations.

Materials and Methods

Data Source

This was a retrospective study of prospectively collected data in the 2010-2014 ACS-NSQIP database. ACS-NSQIP is a large national database with risk adjusted 30-day postoperative morbidity and mortality outcomes. More than 500 hospitals that vary in size, socioeconomic location and academic affiliation contributed data to the 2010-2014 ACS-NSQIP database.[13] ACS-NSQIP data are collected prospectively by dedicated clinical abstractors at each institution on more than 150 demographic, preoperative, intraoperative and 30-day postoperative variables.[14] The success of quality improvement initiatives based on ACS-NSQIP data has been validated in the Veterans Administration and private sector.[15,16]

Inclusion and Exclusion Criteria

The ACS-NSQIP database from 2010 to 2014 was used in this study. Adult patients ($\geq$18 years) undergoing ACDF ($\leq$3 levels fused) were identified based on Current Procedural Terminology (CPT) codes 22551 or 22554. Cases with missing preoperative data, emergency cases, patients with a wound class of 2, 3, or 4, an open wound on their body, current sepsis, current pneumonia, prior surgeries within 30 days, cases requiring cardiopulmonary resuscitation (CPR) prior to surgery, any patients undergoing a nonelective procedure or cases with diagnoses of cervical spine, trauma or injury to spine, or neoplasm of spine were excluded in order to reduce the risk of confounding variables.

Variable Definition

Patient demographic variables included sex and race (white, black, Hispanic, and other). Other race included American Indian, Alaska Native, Asian, Native Hawaiian, Pacific Islander or unknown/not reported. Preoperative variables included obesity ($\geq$30 kg/m^2), diabetes (non–insulin-dependent diabetes mellitus or insulin-dependent diabetes mellitus), current smoking (within 1 year of surgery), dyspnea ($\leq$30 days prior to surgery), functional status prior to surgery (independent or partially/totally dependent $\leq$30 days prior to surgery), pulmonary comorbidity (ventilator dependent $\leq$48 hours prior to surgery or history of chronic obstructive pulmonary disease $\leq$30 days prior to surgery), cardiac comorbidity (use of hypertensive medication or history of chronic heart failure $\leq$30 days prior to surgery), renal comorbidity (acute renal failure $\leq$24 hours prior to surgery or dialysis treatment $\leq$2 weeks prior to surgery), steroid use for chronic condition ($\leq$30 days prior to surgery), $\geq$10% loss of body weight (in the past 6 months), bleeding disorder (chronic, active condition), preoperative transfusion of $\geq$1 unit of whole/packed red blood cells (RBCs) ($\leq$72 hours prior to surgery) and American Society of Anesthesiologists (ASA) physical status classification ($\geq$3).

Intraoperative variables included operation year (2010-2014), surgery setting (inpatient vs outpatient), operative time ($\geq$4 hours) and total relative value units (TRVU). Thirty-day postoperative outcome variables include mortality, length of stay (LOS) $\geq$5 days, wound complication (superficial or deep surgical site infection, organ space infection, or wound dehiscence), pulmonary complication (pneumonia, unplanned reintubation, or duration of ventilator-assisted respiration $\geq$48 hours), venous thromboembolism (pulmonary embolism or deep vein thrombosis), renal complication (progressive renal insufficiency or acute renal failure), urinary tract infection (UTI), cardiac complication (cardiac arrest requiring CPR or myocardial infarction), intra-/postoperative RBC transfusion, sepsis, reoperation (related to initial procedure) and unplanned readmission (related to initial procedure). ACS-NSQIP provides further information on variable characteristics.[14]

The patient population was divided into age quartiles. Quartile 1 included patients 18 to 45 years old. Quartile 2 included patients aged 46 to 52 years. Quartile 3 included patients aged 53-60 years. Quartile 4 included patients $\geq$61 years old. Patients were divided into quartiles in order to allow for a more granular analysis of age's effect on postoperative outcomes.

Statistical Analysis

Patients were divided into cohorts based on age. A bivariate analysis was performed on patient demographic, preoperative, intraoperative, and postoperative characteristics using Pearson's chi-square test. Fischer's exact test was used where appropriate. Multivariable logistic regression models were employed, adjusting for patient demographic, preoperative, and intraoperative variables, to identify the influence of patient age on 30-day postoperative outcomes. The *c*-statistic, which is the area under the receiver operating characteristic (ROC) curve, was also retrieved from the multivariate logistic regression analysis and determined the accuracy of this model. The ROC curve is a graph of the fall out rate (1 − specificity) against the sensitivity (true-positive rate). The area under this

Table 1. Bivariate Analysis of Patient Demographic, Preoperative and Intraoperative Variables Between Age Cohorts (N = 20 563).

Category	≤45 Years (n)	≤45 Years (%)	46-52 Years (n)	46-52 Years (%)	53-60 Years (n)	53-60 Years (%)	≥61 Years (n)	≥61 Years (%)	P[a]
Sex									
Female	2777	53.4	2757	54.6	2512	49.7	2559	48.7	**<.001**
Male	2421	46.6	2292	45.4	2546	50.3	2699	51.3	
Race									
White	4237	81.5	4101	81.2	4098	81.0	4436	84.4	**<.001**
Other	465	8.9	427	8.5	401	7.9	365	6.9	
Black	441	8.5	474	9.4	516	10.2	427	8.1	
Hispanic	55	1.1	47	0.9	43	0.9	30	0.6	
Obese	2269	43.7	2268	44.9	2298	45.4	2315	44.0	.248
Diabetes	321	6.2	561	11.1	790	15.6	1221	23.2	**<.001**
Dyspnea	148	2.8	218	4.3	315	6.2	423	8.0	**<.001**
Functional status									
Independent	5158	99.2	5004	99.1	4982	98.5	5129	97.5	**<.001**
Partially or totally dependent	40	0.8	45	0.9	76	1.5	129	2.5	
Pulmonary comorbidity	191	3.7	328	6.5	500	9.9	658	12.5	**<.001**
Cardiac comorbidity	1005	19.3	1771	35.1	2465	48.7	3529	67.1	**<.001**
Renal comorbidity	3	0.1	4	0.1	13	0.3	22	0.4	**<.001**
Smoke	1913	36.8	1827	36.2	1526	30.2	827	15.7	**<.001**
Steroid use	113	2.2	119	2.4	158	3.1	223	4.2	**<.001**
Recent weight loss	8	0.2	9	0.2	8	0.2	9	0.2	.989
Bleeding disorder	20	0.4	30	0.6	47	0.9	91	1.7	**<.001**
Preoperative RBC transfusion	0	0.0	3	0.1	1	0.0	0	0.0	.103
ASA class ≥3	1028	19.8	1594	31.6	2065	40.8	3011	57.3	**<.001**
Operation time ≥4 hours	148	2.8	216	4.3	283	5.6	339	6.4	**<.001**
Operation year									
2010	390	7.5	364	7.2	321	6.3	312	5.9	**.001**
2011	755	14.5	663	13.1	647	12.8	668	12.7	
2012	998	19.2	959	19.0	940	18.6	980	18.6	
2013	1405	27.0	1391	27.6	1496	29.6	1488	28.3	
2014	1650	31.7	1672	33.1	1654	32.7	1810	34.4	
Surgery setting									
Inpatient	3664	70.5	3719	73.7	3830	75.7	4510	85.8	**<.001**
Outpatient	1534	29.5	1330	26.3	1228	24.3	748	14.2	
Osteotomy	55	1.1	57	1.1	59	1.2	76	1.4	.282

Abbreviations: RBC, red blood cells; ASA, American Society of Anesthesiologists.
[a]Values in boldface indicate statistical significance.

curve measures the ability of the model to correctly classify those with the complication and those without. SAS Studio Version 3.4 (SAS Institute Inc, Cary, NC, USA) was used for all statistical analysis.

Results

Study Population

A total of 20 563 patients met the inclusion criteria for the study of which 5198 (25.3%) patients were ≤45 years, 5049 (24.6%) patients were 46 to 52 years, 5058 (24.6%) patients were 53 to 60 years, and 5258 (25.6%) patients were ≥61 years. Patient ages ranged from 18 to 90 years, with an interquartile range of 16 years and a mean age of 53.3 ± 11.4 years.

On bivariate analysis, statistical differences were found for patient sex, race, diabetes, dyspnea, functional status, pulmonary comorbidity, renal comorbidity, cardiac comorbidity, smoking, steroid use, bleeding disorder, ASA class, operation time ≥4 hours, operation year, and surgery setting (Table 1).

Unadjusted Analysis

There were statistically significant differences in 30-day unadjusted morbidity and mortality between the patient cohorts. The proportion of patients who experienced mortality was significantly higher for elderly patients (quartile 1, 0.0%; quartile 2, 0.0%; quartile 3, 0.1%; and quartile 4, 0.3%). A similar trend was seen for age quartiles 1 to 4 for LOS ≥5 days (2.1%, 2.5%, 3.5%, and 6.5%, respectively), pulmonary complications (0.3%, 0.6%, 0.7%, and 1.7%, respectively), venous thromboembolism (0.1%, 0.3%, 0.2%, and 0.4%, respectively, $P =$ .019), UTI (0.2%, 0.3%, 0.3%, and 0.8%, respectively), cardiac complication (0.0%, 0.1%, 0.1%, and 0.4%, respectively), intra-/postoperative RBC transfusion (0.3%, 0.2%, 0.3%, and

Table 2. Bivariate Analysis of 30-Day Postoperative Outcomes Between Age Cohorts (N = 20 563).

Category	≤45 Years (n)	≤45 Years (%)	46-52 Years (n)	46-52 Years (%)	53-60 Years (n)	53-60 Years (%)	≥61 Years (n)	≥61 Years (%)	P^a
Mortality	0	0.0	2	0.0	3	0.1	18	0.3	**<.001**
Length of stay ≥5 days	107	2.1	127	2.5	176	3.5	340	6.5	**<.001**
Wound complication	35	0.7	30	0.6	20	0.4	24	0.5	.195
Pulmonary complication	14	0.3	30	0.6	37	0.7	88	1.7	**<.001**
Venous thromboembolism	5	0.1	16	0.3	12	0.2	21	0.4	**.019**
Renal complication	0	0.0	2	0.0	2	0.0	5	0.1	.140
Urinary tract infection	9	0.2	14	0.3	17	0.3	42	0.8	**<.001**
Cardiac complication	2	0.0	3	0.1	7	0.1	22	0.4	**<.001**
Intra-/Postoperative red blood cell transfusion	16	0.3	10	0.2	13	0.3	36	0.7	**<.001**
Sepsis	3	0.1	5	0.1	8	0.2	35	0.7	**<.001**
Reoperation	40	0.8	53	1.1	80	1.6	26	0.5	**<.001**
Unplanned readmission	81	1.7	99	2.1	158	3.1	51	1.0	**<.001**

[a]Values in boldface indicate statistical significance.

0.7%, respectively), sepsis (0.1%, 0.1%, 0.2%, and 0.7%, respectively), reoperation (0.8%, 1.1%, 1.6%, and 0.5%, respectively), and unplanned readmission (1.7%, 2.1%, 3.1%, and 1.0%, respectively) (Table 2). *P* values are <.001 unless otherwise noted.

Multivariate Analysis

Multivariate logistic regression analysis found increasing age to be significantly associated with several 30-day postoperative outcomes. The analyses found, with reference to quartile 1, quartile 4 had an increased odds of LOS ≥5 days (odds ratio [OR] = 2.05, confidence interval [CI] = 1.62-2.60, *c*-statistic = 0.75), pulmonary complications (OR = 3.25, CI = 1.81-5.84, *c*-statistic = 0.76), UTI (OR = 2.25, CI = 1.04-4.87, *P* = .038, *c*-statistic = 0.73), cardiac complication (OR = 6.01, CI = 1.36-26.62, *P* = .018, *c*-statistic = 0.82), and sepsis (OR = 4.38, CI = 1.30-14.70, *P* = .017, *c*-statistic = 0.86). With reference to quartile 1, quartiles 2 and 4 had an increased odds of venous thromboembolism (OR = 3.13, CI = 1.14-8.56, *P* = .026; OR = 3.83, CI = 1.44-10.20, *P* = .007; *c*-statistic = 0.75). With reference to quartile 1, quartiles 3 and 4 experienced an increased odds of unplanned readmission (OR = 1.44, CI = 1.01-2.05, *P* = .045; OR = 1.88, CI = 1.33-2.66; *c*-statistic = 0.67) (Table 3). All *P* values are <.001 unless otherwise noted.

Discussion

Elderly patients are a growing demographic in the United States and most of the Western world[1-4] and are commonly affected by a larger comorbidity burden, lower physiologic reserve of multiple organ systems and restricted access to personal and social resources.[17] This retrospective analysis of 20 569 patients undergoing elective ACDF in the 2010-2014 ACS-NSQIP database identified several 30-day postoperative complications elderly patients were at increased risk for. On multivariate analysis, elderly patients had a greater odds of LOS ≥5 days, pulmonary complications, venous thromboembolism, UTI, cardiac complications, sepsis, and unplanned readmission. The analysis was conducted in the ACS-NSQIP database, a well-established database in the surgical literature containing preoperative, intraoperative, and 30-day postoperative patient data from more than 500 medical centers across the US.[13,14,16,18,19] The success of quality improvement initiatives based on ACS-NSQIP data has been validated by the decreased mortality rates in the Veterans Administration system, as well as decreased surgical site infection rates in the private sector.[15,16]

Patients ≥61 years of age were twice as likely to experience LOS ≥5 days. LOS following any surgical procedure is of great importance to a patient's sense of well-being and health care system expenditure.[20,21] At baseline, it costs approximately US$1000 to keep a patient in the hospital per day.[20-22] Carreon et al[5] found in an analysis of elderly patients undergoing lumbar decompression and arthrodesis that patients ≥75 years of age had a 1.6-day longer LOS compared with patients aged 65 to 69 years (9.3 vs 10.9 days).[5] Additionally, in a retrospective analysis of 6,253 patients undergoing ACDF, Buerba et al[23] identified patients 65 to 74 years old experienced a 1.59 greater odds of LOS ≥3 days and patients >75 years old experienced a 2.50 greater odds of LOS ≥3 days. Patients ≥61 years of age were more than 3 times as likely to experience pulmonary complications. In a prospective analysis of 2806 patients admitted to a single institution, Roche et al[24] found patients 80 to 89 years of age had a 2.1 greater odds of chest infection while patients ≥90 years of age had a 4.0 greater odds of infection following treatment for hip fracture. Their analysis also identified previous respiratory disease, male sex, enteral steroids, and older age to be significant risk factors for developing chest infections, similar to our analysis.[24] In a large retrospective analysis of patients undergoing a variety of surgical procedures in the Veterans Administration health system, Hamel et al[25] found that patients ≥80 years of age had a greater risk of respiratory complications (pneumonia, >48 hours on a ventilator, reintubation, and pulmonary embolism). Additionally, on multivariate

Table 3. Multivariate Analysis of Age as a Risk Factor for 30-Day Postoperative Outcomes Following Elective ACDF (N = 20 569).

Outcome	Age	Odds Ratio	Lower Confidence Limit	Upper Confidence Limit	P[a]	c statistic
Length of stay ≥5 days[b]	46-52 vs ≤45 years	1.03	0.79	1.34	.834	0.749
	53-60 vs ≤45 years	1.24	0.96	1.59	.100	
	≥61 vs ≤45 years	2.05	1.62	2.60	**<.001**	
Pulmonary complication	46-52 vs ≤45 years	1.79	0.94	3.40	.074	0.757
	53-60 vs ≤45 years	1.80	0.96	3.36	.066	
	≥61 vs ≤45 years	3.25	1.81	5.84	**<.001**	
Venous thromboembolism	46-52 vs ≤45 years	3.13	1.14	8.56	**.026**	0.746
	53-60 vs ≤45 years	2.14	0.75	6.10	.153	
	≥61 vs ≤45 years	3.83	1.44	10.20	**.007**	
Urinary tract infection	46-52 vs ≤45 years	1.17	0.50	2.75	.716	0.737
	53-60 vs ≤45 years	1.22	0.53	2.79	.645	
	≥ 61 vs ≤45 years	2.25	1.04	4.87	**.038**	
Cardiac complication	46-52 vs ≤45 years	1.29	0.21	7.79	.780	0.824
	53-60 vs ≤45 years	2.47	0.50	12.08	.266	
	≥ 61 vs ≤45 years	6.01	1.36	26.62	**.018**	
Sepsis	46-52 vs ≤45 years	1.24	0.29	5.21	.774	0.857
	53-60 vs ≤45 years	1.55	0.41	5.94	.520	
	≥61 vs ≤45 years	4.38	1.30	14.70	**.017**	
Unplanned readmission[c]	46-52 vs ≤45 years	1.36	0.94	1.94	.099	0.674
	53-60 vs ≤45 years	1.44	1.01	2.05	**.045**	
	≥61 vs ≤45 years	1.88	1.33	2.66	**<.001**	

Abbreviation: ACDF, anterior cervical discectomy and fusion.
[a]Values in boldface indicate statistical significance.
[b]N = 20 563.
[c]N = 19 181.

analysis, Buerba et al[23] found that patients >75 years old had a 6.05 greater odds of respiratory complications following ACDF. Patient age was also significantly associated with increasing odds of venous thromboembolism. The analysis by Hamel et al[25] found that patients ≥80 years of age had a greater incidence of deep vein thrombosis (0.4% vs 0.6%, $P < .001$). Buerba et al[23] identified that patients aged 65 to 74 years experienced a 4.14 greater odds of venous thromboembolism following ACDF.

Patients ≥61 years of age were more than twice as likely to experience UTI. In the analysis conducted by Carreon et al,[5] the most common minor complication identified was UTI, which affected 33 (34%) of patients. The analysis by Hamel et al[25] also found that patients ≥80 years of age were at greater risk of UTI (2.2% vs 5.6%, $P < .001$). On multivariate adjustment, Buerba et al[23] found that patients aged 65 to 74 and >75 years had a significantly greater odds of developing a UTI (OR = 2.25 and OR = 3.13, respectively). Patients ≥61 years of age were six times more likely to experience cardiac complications, making this the largest association in the present analysis. Roche et al[24] found that patients ≥90 years of age had a 4.1 greater odds of developing cardiac failure before hospital discharge following treatment for hip fracture. Their analysis identified old age, male sex, and a history of cardiovascular disease to be significant factors for developing cardiac failure, similar to our analysis.[24] Moreover, the analysis by Hamel et al[25] identified patients ≥80 years of age to be at greater risk of cardiac complications (myocardial infarction or cardiac arrest). Patients ≥61 years were more than 4 times as likely to develop sepsis. Hamel et al[25] also found patients aged ≥80 years to be at greater risk for sepsis (1.2% vs 1.7%, $P < .001$). Patients ≥53 years were more likely to have an unplanned readmission within 30 days of the initial ACDF procedure. Unplanned readmission following a surgical procedure is taxing to a patient's health and well-being and also drives increasing health care costs. Under the Affordable Care Act, any cost associated with patient readmission up to 30 days following discharge become the financial burden of the hospital. Considering the overall frailty of many elderly patients, care should be taken to prevent premature discharge of patients following any hospital stay.

There are many similarities between the present analysis and the analysis conducted by Buerba et al.[23] Both analyses utilize the ACS-NSQIP database to identify the extent of association between patient age and acute postoperative outcomes following ACDF surgery. The present analysis seeks to build on that of Buerba et al[23] through the use of a more recent version of the ACS-NSQIP database and the inclusion of a 3 times larger patient population. While the statistical analyses and variable definitions are reasonably similar, the 2 studies produced differing statistical results. The present analysis found age to be related to LOS ≥5 days, pulmonary complications, venous thromboembolism, UTI, cardiac complications, sepsis, and unplanned readmission while the analysis by Buerba et al[23] found age to be related to mortality, central nervous system complications, venous thromboembolism, RBC transfusion, reoperation, UTI, LOS ≥3 days, pulmonary complications, and the occurrence of any postoperative morbidity. The most striking difference between the 2 analyses is that Buerba et al found patients >75 years old had a 8.43 greater odds of mortality while our analysis did not find any association between age and mortality. These divergent results may be due to different methodology used to create the age cohorts. The present analysis categorized patients into quartiles while Buerba et al categorized patients by mean and standard deviation, which creates an inherently wider spread of ages and is more likely to be influenced by outliers. Further studies should be conducted to refine our understanding of the relationship between advanced age and postoperative outcomes following ACDF.

There are several limitations for this study. The ACS-NSQIP database classifies cases based on CPT codes. However, differences between procedural techniques cannot be accounted for using this modality. Additionally, differences in institutional protocols, such as anticoagulation and Foley catheter placement, are potentially confounding variables that are not captured by the ACS-NSQIP database. ACS-NSQIP also significantly over represents academic medical centers and therefore may not be fully representative of all US hospitals. Contributing hospital is kept anonymous, limiting the ability to adjust for institution size, patient volume, academic affiliation, and surgeon experience. Additionally, long-term complications are not captured in the ACS-NSQIP database, which only evaluates complications up to 30-days postoperatively, leading to a potential underestimation of risk. Finally, we were unable to identifying patients who received ACDF for myelopathy due to limitations in the ICD-9 (International Classification of Diseases, Ninth Revision) records of the ACS-NSQIP database.

Despite these limitations, this is the first national study to evaluate patient age as a risk factor for several 30-day postoperative outcomes following elective ACDF. Age is a nonmodifiable risk factor and therefore presents a fixed source of postoperative risk following elective ACDF. The authors hope the results of this study be used by health care teams to improve surgical patient selection, risk stratification, and patient safety.

Authors' Note

The manuscript submitted does not contain information about medical device(s)/drug(s). This study was qualified as exempt by the Mount Sinai Hospital Institutional Review Board.

Declaration of Conflicting Interests

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