

Higher Perioperative Costs of Anterior Cervical Discectomy and Fusion in Patients Aged 66 and Older: A Retrospective Analysis of 10 Years of Data from an Urban Academic Institution

Katrina Nietsch, Bashar Zaidat, Zachary S Gallate, Timothy Hoang, Jonathan Gal¹, Jun Sup Kim², Samuel Kang-Wook Cho

¹Icahn School of Medicine At Mount Sinai, ²Mt Sinai School of Medicine Affl Hosps

INTRODUCTION:

While the cost-effectiveness of spine surgery has been studied extensively, the sources of these perioperative costs to elderly patients undergoing anterior cervical discectomy and fusion (ACDF) procedures are yet to be studied. The purpose of this study is to elucidate the types of direct costs to better evaluate the financial repercussions for elderly patients using data from a high-volume urban academic hospital with a diverse patient population. The primary objective is to compare these subcategories between patients aged 18-35 and patients aged 66 and older who underwent ACDF. These subtypes of perioperative costs include the total direct cost, surgical direct cost, Intensive Care Unit (ICU) direct cost, laboratory direct cost, imaging direct cost, blood bank direct cost, pharmacy direct cost, Emergency Department (ED) direct cost, and rehabilitation direct cost. A granular assessment of factors associated with increased perioperative expenditures will yield a future of health care that is more equitable for patients regardless of age.

METHODS: A retrospective analysis was performed using data from a single urban institution from 2008 to 2019. A total of 2,231 patients, aged 18 and above, were identified from the institutional database using Current Procedural Terminology (CPT) codes 22551, 22552, and 22554. Exclusion criteria included patients aged 17 and younger, patients who underwent a non-elective procedure, and patients who underwent a procedure utilizing the posterior approach. Patients were divided into four cohorts: ages 18-35 (n=156), ages 36-50 (n=850), ages 51-65 (n=923), and ages 66 and older (n=302). Patient demographics, perioperative variables, and postoperative outcomes were compared using an unadjusted chi-squared analysis and student's t-test. Multivariable linear regression was then performed. Statistically significant p-values were less than 0.05.

RESULTS:

Univariate direct analysis showed that compared to the 18-35 year-old cohort, the 66+ year-old cohort had a higher prevalence of diabetes ($p < 0.001$), a higher prevalence of hypertension ($p < 0.001$), and a higher Elixhauser Comorbidity Index (ELIX) score ($p = 0.002$) (Table 1). The older cohort also had longer surgery times ($p < 0.001$), higher estimated blood loss ($p = 0.034$), and more segments fused ($p < 0.001$) (Table 2). There was no statistically significant difference in length of stay or Body Mass Index (BMI) between the older cohort and the younger cohorts (Table 2). Multivariable linear regression analysis revealed significant increases in total direct costs (Beta Coefficient: \$1,803.47, Confidence Interval (CI): \$985.06-\$2,621.87, $p < 0.001$), Surgery Direct Costs (Beta Coefficient: \$845.79, CI: \$285.74-\$1,405.83, $p = 0.003$), and Rehabilitation Direct Costs (Beta Coefficient: \$29.06, CI: \$9.87-\$48.25, $p = 0.003$) but a significant decrease in ED Direct Costs (Beta Coefficient: \$-5.42, CI: \$-10.07-\$-0.78, $p = 0.022$) as predicted by an increase in age (Table 3). No significant difference was seen in costs of ICU services, laboratory tests, imaging, blood bank services, or pharmacy services (all $p > 0.05$). Table 3 summarizes these results. As expected, univariate analysis also showed the 66+ year-old cohort had significantly higher total direct costs ($p < 0.001$), surgery direct costs ($p < 0.001$), and rehabilitation direct costs ($p < 0.001$) (Table 4). No significant differences were found in costs of ICU, laboratory tests, imaging, blood bank services, pharmacy services, or ED services (all $p > 0.05$) (Table 4).

DISCUSSION AND CONCLUSION:

Patients aged 66 and older undergoing ACDF have higher total direct costs than younger patients due to increases in surgery direct costs and rehabilitation direct costs. While length of surgery increased with patients' age, length of stay and BMI did not differ between age-stratified cohorts. Our results suggest that the intraoperative factors are the highest drivers of cost for the elderly population and the evidence shows these differences become more pronounced as patients age. As the first study of this kind to adequately scrutinize subgroups attributing to total direct cost, a more discrete examination of age-related differences may allow for better resource utilization both intraoperatively and postoperatively.

Table 1. Comorbidities by Age Subgroup. Standard deviations or percentages are shown in parentheses, as applicable. Statistically significant p-values are identified in bold.

ACDE Cost Variable	Mean (SD)	p-value
Diabetes		
Age 19-25	6.8 (3.5%)	ref.
Age 36-50	44 (7.5%)	0.136
Age 51-65	171 (18.5%)	<0.001
Age 66+	84 (27.3%)	<0.001
Hypertension		
Age 19-25	31 (7.1%)	ref.
Age 36-50	187 (29.6%)	<0.001
Age 51-65	404 (43.8%)	<0.001
Age 66+	207 (68.5%)	<0.001
EHAScore Comorbidity Index (EHAScore)		
<6		
Age 19-25	23 (14.7%)	ref.
Age 36-50	124 (14.6%)	0.681
Age 51-65	145 (15.7%)	0.189
Age 66+	29 (9.6%)	0.002
6-10		
Age 19-25	106 (67.9%)	ref.
Age 36-50	597 (70.2%)	0.681
Age 51-65	569 (61.3%)	0.189
Age 66+	185 (61.3%)	0.002
11-14		
Age 19-25	19 (12.2%)	ref.
Age 36-50	78 (9.2%)	0.681
Age 51-65	113 (12.2%)	0.189
Age 66+	35 (11.6%)	0.002
≥ 15		
Age 19-25	8 (5.1%)	ref.
Age 36-50	51 (6.0%)	0.681
Age 51-65	96 (10.4%)	0.189
Age 66+	51 (17.5%)	0.002

Table 2. Outcomes by Age Subgroup. Standard deviations or percentages are shown in parentheses, as applicable. Statistically significant p-values are identified in bold.

ACDE Cost Variable	Mean (SD)	p-value
APR		
Age 19-25	309 (3.3)	-
Age 36-50	442 (4.4)	-
Age 51-65	572 (4.2)	-
Age 66+	71 (6.5)	-
Length of Surgery (min)		
Age 19-25	134 (150.3)	ref.
Age 36-50	145 (155.9)	0.015
Age 51-65	156 (160.3)	<0.001
Age 66+	168 (7 (70.3))	<0.001
Estimated Blood Loss (cc)		
Age 19-25	432 (63.9)	ref.
Age 36-50	514 (69.1)	0.168
Age 51-65	585 (85.9)	0.029
Age 66+	585 (77.0)	0.024
Length of Stay (days)		
Age 19-25	1.3 (0.6)	ref.
Age 36-50	1.3 (0.6)	0.631
Age 51-65	1.5 (1.1)	0.01
Age 66+	2.0 (1.5)	0.116
Segments		
Age 19-25	2.4 (0.5)	ref.
Age 36-50	2.7 (0.7)	0.681
Age 51-65	2.9 (0.7)	<0.001
Age 66+	2.9 (0.5)	<0.001
BMI		
Age 19-25	27.0 (6.3)	ref.
Age 36-50	28.36 (5.67)	0.007
Age 51-65	28.43 (5.86)	0.005
Age 66+	26.74 (4.9)	0.636

Table 3. Comparison of Age Cohorts Showing Differences of Total Direct Cost and Cost Breakdowns Categories for Anterior Cervical Discectomy and Fusion. Multivariable linear regression was used to compare total direct cost associated with ACDF, and direct costs attributed to surgery, ICU stay, laboratory tests, imaging, blood bank utilization, pharmacy, ED stay, and rehabilitation between four different age cohorts (ages 19-25, age 36-50, age 51-65, and age 66+).

ACDE Cost Variable	Dollar Change, β (95% CI)	p-value
Total Direct Cost		
Age 19-25	ref.	
Age 36-50	\$41.46 (\$19.17, \$63.76)	0.004
Age 51-65	\$108.76 (\$116.06, \$101.54)	0.11
Age 66+	\$130.14 (\$106.06, \$154.22)	<0.001
Emergency Department Cost		
Age 19-25	ref.	
Age 36-50	\$66.94 (\$40.01, \$93.88)	0.007
Age 51-65	\$40.71 (\$10.01, \$71.41)	0.11
Age 66+	\$167.74 (\$20.71, \$116.01)	0.001
ICU Direct Cost		
Age 19-25	ref.	
Age 36-50	\$39.79 (\$10.38, \$69.15)	0.016
Age 51-65	\$45.11 (\$10.31, \$80.01)	0.009
Age 66+	\$101.88 (\$21.51, \$182.25)	0.025
Laboratory Direct Cost		
Age 19-25	ref.	
Age 36-50	\$2.77 (\$18.08, \$12.64)	0.722
Age 51-65	\$6.49 (\$11.78, \$14.98)	0.075
Age 66+	\$10.88 (\$4.45, \$17.31)	0.018
Imaging Direct Cost		
Age 19-25	ref.	
Age 36-50	\$4.37 (\$21.18, \$12.43)	0.312
Age 51-65	\$6.39 (\$21.05, \$18.26)	0.433
Age 66+	\$6.31 (\$18.96, \$17.35)	0.532
Blood Bank Direct Cost		
Age 19-25	ref.	
Age 36-50	\$48.81 (\$11.01, \$86.61)	0.009
Age 51-65	\$45.26 (\$12.96, \$77.57)	0.007
Age 66+	\$27.74 (\$10.01, \$45.48)	0.009
Pharmacy Direct Cost		
Age 19-25	ref.	
Age 36-50	\$1.88 (\$10.36, \$12.18)	0.867
Age 51-65	\$27.74 (\$10.01, \$45.48)	0.009
Age 66+	\$128.85 (\$52.76, \$204.95)	0.005
ED Direct Cost		
Age 19-25	ref.	
Age 36-50	\$4.87 (\$10.05, \$4.17)	0.004
Age 51-65	\$4.81 (\$10.06, \$4.23)	0.001
Age 66+	\$5.42 (\$10.05, \$4.78)	0.002
Rehabilitation Direct Cost		
Age 19-25	ref.	
Age 36-50	\$10.88 (\$20.14, \$7.38)	0.205
Age 51-65	\$11.99 (\$1.06, \$23.91)	0.167
Age 66+	\$20.68 (\$1.11, \$40.25)	0.001

Table 4. Effect of Age on Total Direct Cost and Cost Breakdowns Categories for Anterior Cervical Discectomy and Fusion. Univariate analysis was used to compare total direct cost associated with ACDF, and direct costs attributed to surgery, ICU stay, laboratory tests, imaging, blood bank utilization, pharmacy, ED stay, and rehabilitation between four different age cohorts (ages 19-25, age 36-50, age 51-65, and age 66+).

ACDE Cost Variable	Dollar Amount, β (95% CI)	p-value
Total Direct Cost		
Age 19-25	\$6675.40 (\$2665.50)	ref.
Age 36-50	\$11016.50 (\$2675.76)	<0.001
Age 51-65	\$12170.20 (\$4187.40)	<0.001
Age 66+	\$13328.60 (\$4565.40)	<0.001
Emergency Department Cost		
Age 19-25	\$10.00 (\$2655.40)	ref.
Age 36-50	\$9154.71 (\$2000.40)	<0.001
Age 51-65	\$10101.00 (\$2000.40)	<0.001
Age 66+	\$10101.00 (\$2000.40)	<0.001
ICU Direct Cost		
Age 19-25	\$45.75 (\$100.30)	ref.
Age 36-50	\$26.99 (\$170.79)	0.146
Age 51-65	\$65.04 (\$54.46)	0.05
Age 66+	\$177.70 (\$159.01)	0.055
Laboratory Direct Cost		
Age 19-25	\$39.89 (\$33.90)	ref.
Age 36-50	\$28.48 (\$21.81)	0.009
Age 51-65	\$41.81 (\$10.61)	0.01
Age 66+	\$57.45 (\$20.43)	0.04
Imaging Direct Cost		
Age 19-25	\$39.48 (\$122.34)	ref.
Age 36-50	\$23.97 (\$60.18)	0.109
Age 51-65	\$27.47 (\$75.25)	0.756
Age 66+	\$52.20 (\$77.54)	0.01
Blood Bank Direct Cost		
Age 19-25	\$48.66 (\$1.81)	ref.
Age 36-50	\$48.81 (\$1.81)	0.868
Age 51-65	\$45.81 (\$1.81)	0.869
Age 66+	\$31.77 (\$1.25)	0.02
Pharmacy Direct Cost		
Age 19-25	\$156.77 (\$60.1)	ref.
Age 36-50	\$146.50 (\$138.48)	0.209
Age 51-65	\$179.74 (\$22.71)	0.006
Age 66+	\$281.60 (\$208.1)	0.017
ED Direct Cost		
Age 19-25	\$6.40 (\$10.20)	ref.
Age 36-50	\$4.81 (\$11.3)	0.04
Age 51-65	\$4.81 (\$11.3)	0.04
Age 66+	\$1.35 (\$11.3)	0.209
Rehabilitation Direct Cost		
Age 19-25	\$17.21 (\$79.1)	ref.
Age 36-50	\$14.26 (\$24.61)	0.605
Age 51-65	\$19.27 (\$107.2)	0.004
Age 66+	\$15.20 (\$10.20)	<0.001