

# Projections of Single and Multi-Level Spinal Instrumentation Procedure Volume and Associated Costs for Medicare Patients to 2050

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**INTRODUCTION:** Spinal instrumentation procedures are powerful modalities that utilize implants and devices to treat spinal fractures, instability, and deformities such as scoliosis or kyphosis. This study sought to identify past trends and project future trends in the implementation rates and associated costs of single and multi-level instrumentation (e.g., pedicle fixation, dual rods with multiple hooks, and sublaminar wires) in Medicare patients aged >65 in the USA.

**METHODS:** This retrospective cross-sectional study used data from the Centers for Medicare & Medicaid Services (CMS) Medicare/Medicaid Part B National Summary from 1/1/2000 to 12/31/2019. Combined procedure costs and counts were abstracted using Current Procedural Terminology (CPT) codes to identify the number of spinal levels involved in the instrumentation procedure, categorized as single-level, two to four, five to seven, or eight to twelve levels. The Prophet machine learning algorithm was employed, using a Bayesian Inference framework, to generate point forecasts for 2020-2050 and 95% forecast intervals (FIs). Sensitivity analyses were utilized by comparing projections with those from Log-linear, Poisson and Negative-Binomial, and Auto Regressive Integrated Moving Average models. CMS procedure counts were adjusted for Medicare advantage (MA) patients using Kaiser Family Foundation data and costs were adjusted for inflation using the U.S. Bureau of Labor Statistics' Consumer Price Index.

## RESULTS:

Between 2000 and 2019, the adjusted annual spinal instrumentation volume increased by 776% (from 7,342 to 64,350 cases) for single-level, by 329% (from 20,319 to 87,253 cases) for two-four-levels, by 1049% (from 1,218 to 14,000 cases) for five-seven-levels, and by 739% (from 193 to 1,620 cases) for eight-twelve-levels (Table 1). The adjusted cost of spinal instrumentation procedures increased by 502% (from \$8,429,736 to \$50,747,629) for single-level, by 206% (from \$22,704,431 to \$69,404,647) for two-four-levels, by 670% (from \$1,545,433 to \$11,893,724) for five-seven-levels, and by 459% (from \$297,185 to \$1,662,171) for eight-twelve-levels (Table 2). From 2000 to 2019, the mean inflation-adjusted reimbursement for single-level spinal instrumentation procedures decreased 45.6% from \$1,148.15 to \$788.62. The mean inflation-adjusted reimbursement for single-level spinal instrumentation procedures is projected to decrease an additional 4.2% by 2050, to \$756.89. By 2050, the number of single-level spinal instrumentation procedures performed yearly is projected to be 124,061 (95% FI, 87,027 to 142,907, Table 3), with an associated cost of \$93,900,672 (95% FI, \$80,281,788 to \$108,220,932, Table 4, Figure 1), and the number of two-four level spinal instrumentation procedures performed yearly is projected to be 214,517 (95% FI, 191,425 to 237,425), with an associated cost of \$146,323,437 (95% FI, \$135,874,961 to \$157,427,669).

**DISCUSSION AND CONCLUSION:** Significant projected increases in the demand for and utilization of single and multi-level spinal instrumentation offer a measurable foundation for predicting resource allocation and procedural distribution. It is important to note that these findings pertain exclusively to a Medicare population and necessitate additional analysis to determine if they extend to other demographic groups.

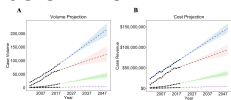


Table 1: Spinal Instrumentation Volume Between 2000 and 2019, Adjusted to Include Medicare Advantage Patients

Year	Prevalence of Medicare Advantage		Adjusted Volume and Cost				95% FI	
	Single	AVC	Two-Four	Five-Seven	AVC	Eight-Twelve	AVC	AVC
2000	7,342	1,218	20,319	1,218	193	193	193	193
2001	10,482	42,876	23,844	12,776	1,319	1,319	1,319	1,319
2002	11,400	31,426	26,811	13,616	1,518	1,518	1,518	1,518
2003	11,800	38,000	28,000	14,000	1,600	1,600	1,600	1,600
2004	13,400	31,500	32,657	16,671	2,224	2,224	2,224	2,224
2005	15,241	34,726	36,111	19,511	2,662	2,662	2,662	2,662
2006	18,401	31,726	38,346	22,381	3,020	3,020	3,020	3,020
2007	22,421	34,726	40,571	25,251	3,378	3,378	3,378	3,378
2008	27,211	31,726	42,796	28,121	3,736	3,736	3,736	3,736
2009	32,001	34,726	45,021	31,001	4,094	4,094	4,094	4,094
2010	36,791	31,726	47,246	33,871	4,452	4,452	4,452	4,452
2011	41,581	34,726	49,471	36,741	4,810	4,810	4,810	4,810
2012	46,371	31,726	51,696	39,611	5,168	5,168	5,168	5,168
2013	51,161	34,726	53,921	42,481	5,526	5,526	5,526	5,526
2014	55,951	31,726	56,146	45,351	5,884	5,884	5,884	5,884
2015	60,741	34,726	58,371	48,221	6,242	6,242	6,242	6,242
2016	65,531	31,726	60,596	51,091	6,600	6,600	6,600	6,600
2017	70,321	34,726	62,821	53,961	6,958	6,958	6,958	6,958
2018	75,111	31,726	65,046	56,831	7,316	7,316	7,316	7,316
2019	79,901	34,726	67,271	59,701	7,674	7,674	7,674	7,674
2020	84,691	31,726	69,496	62,571	8,032	8,032	8,032	8,032
2021	89,481	34,726	71,721	65,441	8,390	8,390	8,390	8,390
2022	94,271	31,726	73,946	68,311	8,748	8,748	8,748	8,748
2023	99,061	34,726	76,171	71,181	9,106	9,106	9,106	9,106
2024	103,851	31,726	78,396	74,051	9,464	9,464	9,464	9,464
2025	108,641	34,726	80,621	76,921	9,822	9,822	9,822	9,822
2026	113,431	31,726	82,846	79,791	10,180	10,180	10,180	10,180
2027	118,221	34,726	85,071	82,661	10,538	10,538	10,538	10,538
2028	123,011	31,726	87,296	85,531	10,896	10,896	10,896	10,896
2029	127,801	34,726	89,521	88,401	11,254	11,254	11,254	11,254
2030	132,591	31,726	91,746	91,271	11,612	11,612	11,612	11,612

Table 2: Spinal Instrumentation Cost Between 2000 and 2019, Adjusted to Include Medicare Advantage Patients and the Cost of Inflation

Year	Prevalence of Medicare Advantage		Adjusted Cost				95% FI	
	Single	AVC	Two-Four	Five-Seven	AVC	Eight-Twelve	AVC	AVC
2000	\$8,429,736	\$1,545,433	\$22,704,431	\$1,545,433	\$297,185	\$297,185	\$297,185	\$297,185
2001	\$11,893,724	\$1,545,433	\$25,169,876	\$1,545,433	\$321,839	\$321,839	\$321,839	\$321,839
2002	\$13,146,219	\$1,545,433	\$27,635,321	\$1,545,433	\$346,493	\$346,493	\$346,493	\$346,493
2003	\$14,398,714	\$1,545,433	\$30,100,766	\$1,545,433	\$371,147	\$371,147	\$371,147	\$371,147
2004	\$15,651,209	\$1,545,433	\$32,566,211	\$1,545,433	\$395,801	\$395,801	\$395,801	\$395,801
2005	\$16,903,704	\$1,545,433	\$35,031,656	\$1,545,433	\$420,455	\$420,455	\$420,455	\$420,455
2006	\$18,156,199	\$1,545,433	\$37,497,101	\$1,545,433	\$445,109	\$445,109	\$445,109	\$445,109
2007	\$19,408,694	\$1,545,433	\$39,962,546	\$1,545,433	\$469,763	\$469,763	\$469,763	\$469,763
2008	\$20,661,189	\$1,545,433	\$42,428,000	\$1,545,433	\$494,417	\$494,417	\$494,417	\$494,417
2009	\$21,913,684	\$1,545,433	\$44,893,445	\$1,545,433	\$519,071	\$519,071	\$519,071	\$519,071
2010	\$23,166,179	\$1,545,433	\$47,358,890	\$1,545,433	\$543,725	\$543,725	\$543,725	\$543,725
2011	\$24,418,674	\$1,545,433	\$49,824,335	\$1,545,433	\$568,379	\$568,379	\$568,379	\$568,379
2012	\$25,671,169	\$1,545,433	\$52,289,780	\$1,545,433	\$593,033	\$593,033	\$593,033	\$593,033
2013	\$26,923,664	\$1,545,433	\$54,755,225	\$1,545,433	\$617,687	\$617,687	\$617,687	\$617,687
2014	\$28,176,159	\$1,545,433	\$57,220,670	\$1,545,433	\$642,341	\$642,341	\$642,341	\$642,341
2015	\$29,428,654	\$1,545,433	\$59,686,115	\$1,545,433	\$666,995	\$666,995	\$666,995	\$666,995
2016	\$30,681,149	\$1,545,433	\$62,151,560	\$1,545,433	\$691,649	\$691,649	\$691,649	\$691,649
2017	\$31,933,644	\$1,545,433	\$64,617,005	\$1,545,433	\$716,303	\$716,303	\$716,303	\$716,303
2018	\$33,186,139	\$1,545,433	\$67,082,450	\$1,545,433	\$740,957	\$740,957	\$740,957	\$740,957
2019	\$34,438,634	\$1,545,433	\$69,547,895	\$1,545,433	\$765,611	\$765,611	\$765,611	\$765,611
2020	\$35,691,129	\$1,545,433	\$72,013,340	\$1,545,433	\$790,265	\$790,265	\$790,265	\$790,265
2021	\$36,943,624	\$1,545,433	\$74,478,785	\$1,545,433	\$814,919	\$814,919	\$814,919	\$814,919
2022	\$38,196,119	\$1,545,433	\$76,944,230	\$1,545,433	\$839,573	\$839,573	\$839,573	\$839,573
2023	\$39,448,614	\$1,545,433	\$79,409,675	\$1,545,433	\$864,227	\$864,227	\$864,227	\$864,227
2024	\$40,701,109	\$1,545,433	\$81,875,120	\$1,545,433	\$888,881	\$888,881	\$888,881	\$888,881
2025	\$41,953,604	\$1,545,433	\$84,340,565	\$1,545,433	\$913,535	\$913,535	\$913,535	\$913,535
2026	\$43,206,099	\$1,545,433	\$86,806,010	\$1,545,433	\$938,189	\$938,189	\$938,189	\$938,189
2027	\$44,458,594	\$1,545,433	\$89,271,455	\$1,545,433	\$962,843	\$962,843	\$962,843	\$962,843
2028	\$45,711,089	\$1,545,433	\$91,736,900	\$1,545,433	\$987,497	\$987,497	\$987,497	\$987,497
2029	\$46,963,584	\$1,545,433	\$94,202,345	\$1,545,433	\$1,012,151	\$1,012,151	\$1,012,151	\$1,012,151
2030	\$48,216,079	\$1,545,433	\$96,667,790	\$1,545,433	\$1,036,805	\$1,036,805	\$1,036,805	\$1,036,805

Table 3: Projected Spinal Instrumentation Volume Projections (2020 to 2050) for Spinal Instrumentation

Year of Year	Spinal Instrumentation by procedure		95% FI	
	Single	Two-Four	Five-Seven	Eight-Twelve
2020	64,350	87,253	14,000	1,620
2021	69,140	92,043	14,890	1,710
2022	73,930	96,833	15,780	1,800
2023	78,720	101,623	16,670	1,890
2024	83,510	106,413	17,560	1,980
2025	88,300	111,203	18,450	2,070
2026	93,090	115,993	19,340	2,160
2027	97,880	120,783	20,230	2,250
2028	102,670	125,573	21,120	2,340
2029	107,460	130,363	22,010	2,430
2030	112,250	135,153	22,900	2,520
2031	117,040	139,943	23,790	2,610
2032	121,830	144,733	24,680	2,700
2033	126,620	149,523	25,570	2,790
2034	131,410	154,313	26,460	2,880
2035	136,200	159,103	27,350	2,970
2036	140,990	163,893	28,240	3,060
2037	145,780	168,683	29,130	3,150
2038	150,570	173,473	30,020	3,240
2039	155,360	178,263	30,910	3,330
2040	160,150	183,053	31,800	3,420
2041	164,940	187,843	32,690	3,510
2042	169,730	192,633	33,580	3,600
2043	174,520	197,423	34,470	3,690
2044	179,310	202,213	35,360	3,780
2045	184,100	207,003	36,250	3,870
2046	188,890	211,793	37,140	3,960
2047	193,680	216,583	38,030	4,050
2048	198,470	221,373	38,920	4,140
2049	203,260	226,163	39,810	4,230
2050	208,050	230,953	40,700	4,320

Table 4: Projected Spinal Instrumentation Cost Projections (2020 to 2050) for Spinal Instrumentation

Year of Year	Spinal Instrumentation by procedure		95% FI	
	Single	Two-Four	Five-Seven	Eight-Twelve
2020	\$93,900,672	\$146,323,437	\$22,704,431	\$1,545,433
2021	\$101,456,129	\$156,843,129	\$24,219,886	\$1,650,888
2022	\$109,011,686	\$167,362,821	\$25,735,341	\$1,756,343
2023	\$116,567,243	\$177,882,513	\$27,250,796	\$1,861,798
2024	\$124,122,800	\$188,402,205	\$28,766,251	\$1,967,253</