Health Policy Review

An Updated Analysis of Utilization of Epidural Procedures in Managing Chronic Pain in the Medicare Population from 2000 to 2018

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Background: With increasing costs of health care in the United States, attention is focused on expensive conditions. Musculoskeletal disorders with low back and neck pain account for the third highest amount of various disease categories. Minimally invasive interventional techniques for managing spinal pain, including epidural injections, have been considered to be growing rapidly. However, recent analyses of utilization of interventional techniques from 2000 to 2018 has shown a decline of 2.6% and a decline of 21% from 2009 to 2018 for epidural and adhesiolysis procedures.

Objectives: The objectives of this analysis of epidural procedures from 2000 to 2018 are to provide an update on utilization of epidural injections in managing chronic pain in the fee-for-service (FFS) Medicare population, with a comparative analysis of 2000 to 2009 and 2009 to 2018.

Study Design: Utilization patterns and variables of epidural injections in managing chronic spinal pain from 2000 to 2009 and from 2009 to 2018 in the FFS Medicare population in the United States.

Methods: This analysis was performed by utilizing master data from CMS, physician/supplier procedure summary from 2000 to 2018. The analysis was performed by the assessment of utilization patterns using guidance from Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

Results: Overall, epidural procedures declined at a rate of 20.7% per 100,000 Medicare enrollees in FFS Medicare in the United States from 2009 to 2018, with an annual decline of 2.5%. However, from 2000 to 2009, there was an increase of 89.2%, with an annual increase of 7.3%. This analysis showed a decline in all categories, with an annual decrease of 4.7% for lumbar interlaminar and caudal epidural injections, 4.7% decline for cervical/thoracic transforaminal epidural injections, 1.1% decline for lumbar/sacral transforaminal epidural injections, and finally 0.4% decline for cervical/thoracic interlaminar epidural injections. Overall declines from 2009 to 2018 were highest for cervical and thoracic transforaminal injections with 35.1%, followed by lumbar interlaminar and caudal epidural injections of 34.9%, followed by 9.4% for lumbar/sacral transforaminal epidurals, and 3.5% for cervical and thoracic interlaminar epidurals.

Limitations: This analysis was limited by noninclusion of Medicare Advantage plans, which constitutes almost 30% of the Medicare population. In addition, utilization data for individual states continues to be sparse and may not be accurate or representative of the population.

Conclusions: The declining utilization of epidural injections in all categories with an annual of 2.5% and overall decrease of 20.7% from 2009 to 2018 compared with annual increases of 7.3% and overall increase of 89.2% from 2000 to 2009 shows a slow decline of utilization of all epidural injections.

Key words: Chronic spinal pain, interlaminar epidural injections, caudal epidural injections, transforaminal epidural injections, utilization patterns

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The Affordable Care Act (ACA) was enacted to improve access, quality of care, and reduce health care costs in US health care (1-3). The effectiveness of measures to control costs and the overall effectiveness of ACA, which was signed into law in March 2010, in achieving its primary goals has been questioned (2,4-11). US health care spending continues to increase and reached $3.65 trillion in 2018 (1). Further, the National Health Expenditures survey estimated an average annual growth rate of 5.5% from 2018 to 2027 (2). However, the analysis of growth in medical prices in 2018 showed that the majority of growth was with private health insurance of 6.7% compared with 3.7% in Medicare and 2.2% in Medicaid despite the expansion of the ACA (12). Overall, health care spending per person increased to $11,212. Further, US spending on personal and public health care from 1996 to 2013 showed an estimated spending of $134.5 billion in managing low back and neck pain, along with an additional $129.8 billion in managing other musculoskeletal disorders, with total spending on musculoskeletal disorders, including low back and neck pain, of approximately $264.3 billion in 2016 (13). Alongside increasing health care costs, disability in the United States continues to increase and half of the US health care burden is attributed to morbidity and chronic disability (14). Low back pain continues to rank as the number one cause of disability with neck pain as number 3 (14-16). However, despite increasing disability, there is also increase in utilization of various modalities in managing spinal pain (15-31).

Utilization of interventional techniques in managing spinal pain continues to be under scrutiny because of the application of various regulations and modes to reduce utilization. Over the years, all modalities of pain management have shown significant escalation in utilization, including opioids (11,15-31). Prescription opioids have created an opioid epidemic in the United States with escalating deaths, even though in recent years, there have been declines in prescriptions, as well as prescription opioid-related deaths (11,15,32,33). Further, best practices in pain management also have been established by the Department of Health and Human Services (4).

The recent analysis of utilization patterns of interventional techniques from 2000 to 2018 showed an overall decline of utilization of all interventional techniques at an annual rate of 0.8%, and from 2009 to 2018 with an overall decline of 6.7% (30). However, to follow the previous assessment of epidural procedures with an annual decline of 1.8% and overall decline of 12% from 2009 to 2016, the recent analysis from 2000 to 2018 showed an annual decline of 2.6% and overall decline of 21% for epidural injections and adhesiolysis procedures. Thus these data show continued de-escalation of interventional techniques in general and epidural procedures in particular (30-33). Further, recent analysis of epidural injections from 2000 to 2016 (31) showed a reversal of the utilization ratio of interlaminar epidurals to transforaminal epidurals from 7 in 2000 to 1 in 2016 (31). Despite the criticism and decline in utilization, there is an extensive and growing literature demonstrating the clinical and cost utility of epidural procedures in managing spinal pain in the form of randomized controlled trials (RCTs), systematic reviews, cost utility analysis, and evidence for real-word scenarios in managing spinal pain (34-64). Even then, discordant opinions and conclusions continue with discussions and at times arguments, with lack of agreement between proponents and opponents of the effectiveness and appropriateness of multiple interventional techniques (52,53,58,59). The lack of effectiveness is emphasized by the opponents, whereas proponents argue that there is significant evidence for conflicts of interest in interpretation leading to inappropriate conclusions as the basis for discordant results (52,53,58,59). Consequently, multiple attempts continue to be made to control the utilization of epidural injections and interventional techniques, and all types of modalities in general by means of reimbursement reductions, tightening of coverage regulations, coding changes, bundling, modification of local coverage determinations (LCDs), and increased oversight from multiple organizations and agencies.

This retrospective cohort study of utilization patterns of epidural injections was performed based on data from the fee-for-service (FFS) Medicare population in the United States from 2000 to 2018. This analysis also updates our recent publication (31).

Methods

The database used for this study were the public use files or nonidentifiable data, which is nonattributable and nonconfidential, available through the Centers for Medicare and Medicaid Services (CMS) (65). We also utilized Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidance (66).

Study Design

The design of the study was to assess usage or utilization patterns and variables of multiple epidural procedures, excluding adhesiolysis and continuous epidurals and neurolytic procedures, in managing chronic pain from 2000 to 2018 in the Medicare FFS population in the United States.

Setting

The National Database of Specialty Usage Data files from CMS in the FFS Medicare population in the United States (65).

Patients

All of the patients available from the database, which included all of the FFS Medicare recipients whether they were on Medicare due to Social Security disability, Social Security insurance, or retirement, from 2000 to 2018.

Variables

Variables assessed included not only the usage patterns of various types of epidurals procedures in the Medicare population from 2000 to 2018, but multiple characteristics in reference to the Medicare population and the growth of the Medicare population.

Historically, interventional pain physicians represented by the specialties of interventional pain management (-09), pain medicine (-72), anesthesiology (-05), physical medicine and rehabilitation (-25), neurology (-13), and psychiatry (-26) have performed epidural procedures. A multitude of other specialties perform interventional procedures infrequently. Thus based on Medicare designations, orthopedic surgery (-20), general surgery (-17), and neurosurgery (-14) as a surgical group; diagnostic radiology (-30) and interventional radiology (-94) as a radiologic group; all other physicians as a separate group; and all other providers were considered as other providers.

The Current Procedural Terminology (CPT) procedure codes for epidural procedures utilized were those in effect during 2000 to 2018 as follows:

- Epidural procedures (CPT 62310, 62311, 64479, 64480, 64483, 64484)

These data were also assessed based on the place of service – facility (ambulatory surgery center or hospital outpatient department) or nonfacility (office).

Data Sources

All of the analyzed data were obtained from the CMS Physician/Supplier Procedure Summary Master Data from 2000 to 2018 (65). These data included all FFS Medicare patients younger than the age of 65 years and older than the age of 65 years receiving epidural procedures irrespective of the type of disability.

Measures

The dataset from CMS consists of 100% data with CPT codes with modifiers indicating additional procedures or bilateral procedure, specialty codes, a place of service, a Medicare carrier number, total services and charges submitted, allowed and denied services, and amounts paid. The usage pattern analysis included all allowed services configured by taking services submitted minus services denied and any services with zero payments. Consequently, allowed services were assessed for each procedure, and rates were calculated based on Medicare beneficiaries for the corresponding year and are reported as rate of procedures per 100,000 Medicare beneficiaries. In this analysis, usage patterns were analyzed only once based on the location rather than duplicating the measurements for physician services and facility services.

Bias

The American Society of Interventional Pain Physicians (ASIPP) purchased the data from CMS. The study was conducted with the internal resources of the primary authors' practice without external funding or grants, either from industry or elsewhere.

In this analysis, we have utilized all patients enrolled in FFS Medicare, instead of only patients aged 65 years or older as in other evaluations (67,68), because of the finding that a significant proportion of patients younger than the age of 65 years undergo epidural procedures (69,70). With emerging affordable insurance under Obamacare, increasing disability and increasing population over the age of 65 years, Medicare represents the second largest health care payer next to Medicaid in the United States, with over 59.6 million beneficiaries in 2018 (71). Consequently, the epidural procedures performed on Medicare beneficiaries increasingly represent a large proportion of the procedures for chronic pain in the United States.

Study Size

The study size is large, with the inclusion of all patients under Medicare FFS undergoing epidural procedures in all settings for all regions in the United States for chronic spinal pain from 2000 to 2018.

Data Compilation

These data were compiled using Microsoft Access 2003 and Microsoft Excel 2003 (Microsoft Corporation, Redmond, WA).

Results

Patients

Patients in this assessment included all FFS Medicare recipients from 2000 to 2018.

Descriptive Data of Population Characteristics

As shown in Table 1, from 2000 to 2018, the US population older than 65 years of age increased 49.2% at an annual growth rate of 2.2%. Total US population also increased 15.9% at an annual growth rate of 0.8%. The number of individuals participating in Medicare grew at an annual rate of 2.3%, 1.6%, and 3% from 2000 to 2018, 2000 to 2009, and 2009 to 2018, respectively.

The rate of all epidural procedures except adhesiolysis per 100,000 individuals of the Medicare population declined from 2009 to 2018 at an annual rate of 2.5%, in contrast to an annual growth rate of 3.1% and 9%, from 2000 to 2018, and from 2000 to 2009, respectively. Figure 1 shows a comparative analysis of annual US population growth, Medicare participation, and utilization of epidural injection procedures.

Utilization Characteristics

Table 2 and Figs. 2 to 4 show the utilization characteristics of epidural injection procedures in the FFS Medicare population from 2000 to 2018.

The utilization patterns showed that in 2000, 73.7% of the procedures consisted of lumbar interlaminar epidural injections, whereas in 2018, the utilization declined to 34.5%, with lumbar transforaminal increasing from 14.6% in 2000 to 53% in 2018. In addition, as shown in Fig. 3, epidural injections constituted 57% of all interventional services in 2000 compared with 39% in 2018.

Figure 4 illustrates frequency of utilization of epidural injections with annual changes for all types of procedures.

Appendix Table 1 shows utilization of epidural injections with only primary codes indicating number of encounters rather than services. Overall, there was a significant decline of 2.5% of the patients from 2009 to 2018 per year with a total of 20.7%. Further, lumbar interlaminar and caudal epidural injections faced the highest reductions with annual decline of 4.7% with a total decline of 34.9% from 2009 to 2018.

Appendix Fig. 1 shows change of the rate for 2000 to 2009 and 2009 to 2018.

Specialty Characteristics

Appendix Table 2 and Appendix Fig. 2 shows frequency of utilization of epidural injection procedures based on specialty designation.

State Distribution Characteristics

Appendix Table 3 shows the rate of utilization of epidural injections (rates per 100,000) in the Medicare population from 2009 to 2018 based on Medicare carrier of 2016.

Further analysis was also carried out as shown in Appendix Tables 4 and 5, with Appendix Table 4 showing lumbar interlaminar or caudal epidural injection with CPT 62311, and Appendix Table 5 showing primary code of lumbar/sacral transforaminal epidural injections. CPT 64483 showed no significant changes in utilization declines, either with caudal or interlaminar epidural injections or with transforaminal epidural injections overall. However, transforaminal epidural injections showed a 0.1% annual increase in Noridian states, and 1.2% in the states covered by Palmetto.

We also assessed the rate of utilization of epidural techniques from 2009 to 2018 based on the rates of highest to lowest utilization, as shown in Appendix Table 6. The greatest declines were observed in Maine, Texas, Minnesota, Michigan, West Virginia, Ohio, New Mexico, Tennessee, Wisconsin, and Rhode Island, with annual declines of 4% or more. As shown in Appendix Table 6, Utah showed the highest increase of annual rate of 2.4% with Delaware of 2.1% and Alaska of 1.4% and Arizona of 1.2%. The largest declines were seen in Maine, Texas, Minnesota, Michigan, West Virginia, Ohio, New Mexico, Tennessee, Wisconsin, and Rhode Island, up to 4% in annual rate.

Appendix Table 7 shows utilization of epidural injection services in the Medicare population in alphabetical order.

Site-of-Service Characteristics

Epidural injection procedures, along with other interventional techniques, are provided in multiple settings including hospital outpatient departments, ambulatory surgical centers, and in physician offices with resultant implications for payment. There has been a

Table 1. *Characteristics of Medicare beneficiaries and epidural procedures excluding percutaneous adhesiolysis, continuous epidurals, and neurolytic epidurals.*

	US Population			Medicare Beneficiaries				Epidural Services*			
Year	Total Population (,000)	≥ 65 Years (,000)		Number (,000)	% to US Population	≥ 65 years (,000) (Percent)	< 65 years (,000) Percent	Services (all codes)	Rate	Services (primary codes only)	Rate
		Number	Percent								
2000	282,172	35,077	12.4%	39,632	14.0%	34,262 (86.5%)	5,370 (13.5%)	839,474 (80%)	2,118	792,563	2,000
2001	285,040	35,332	12.4%	40,045	14.0%	34,478 (86.1%)	5,567 (13.9%)	989,034 (78%)	2,470	927,364	2,316
2002	288,369	35,605	12.3%	40,503	14.0%	34,698 (85.7%)	5,805 (14.3%)	1,172,248 (74%)	2,894	1,082,298	2,672
2003	290,211	35,952	12.4%	41,126	14.2%	35,050 (85.2%)	6,078 (14.8%)	1,342,829 (71%)	3,265	1,213,014	2,950
2004	292,892	36,302	12.4%	41,729	14.2%	35,328 (84.7%)	6,402 (15.3%)	1,611,887 (65%)	3,863	1,397,749	3,350
2005	295,561	36,752	12.4%	42,496	14.4%	35,777 (84.2%)	6,723 (15.8%)	1,747,771 (65%)	4,113	1,510,354	3,554
2006	299,395	37,264	12.4%	43,339	14.5%	36,317 (83.8%)	7,022 (16.2%)	1,844,182 (63%)	4,255	1,575,656	3,636
2007	301,290	37,942	12.6%	44,263	14.7%	36,966 (83.5%)	7,297 (16.5%)	1,915,227 (62%)	4,327	1,618,656	3,657
2008	304,056	38,870	12.8%	45,412	14.9%	37,896 (83.4%)	7,516 (16.6%)	2,017,132 (61%)	4,442	1,675,681	3,690
2009	307,006	39,570	12.9%	45,801	14.9%	38,177 (83.4%)	7,624 (16.6%)	2,112,511 (59%)	4,612	1,733,339	3,785
2010	308,746	40,268	13.0%	46,914	15.2%	38,991 (83.1%)	7,923 (16.9%)	2,205,307 (57%)	4,701	1,792,291	3,820
2011	311,583	41,370	13.3%	48,300	15.5%	40,000 (82.8%)	8,300 (17.2%)	2,289,213 (58%)	4,740	1,864,066	3,859
2012	313,874	43,144	13.8%	50,300	16.0%	41,900 (83.3%)	8,500 (16.9%)	2,304,993 (58%)	4,582	1,892,951	3,763
2013	316,129	44,704	14.1%	51,900	16.4%	43,100 (83.0%)	8,800 (17.0%)	2,259,887 (58%)	4,354	1,854,380	3,573
2014	318,892	46,179	14.5%	53,500	16.8%	44,600 (83.4%)	8,900 (16.5%)	2,255,668 (57%)	4,216	1,826,336	3,414
2015	320,897	47,734	14.88%	54,900	17.1%	46,000 (83.8%)	9,000 (16.4%)	2,276,267 (57%)	4,146	1,845,604	3,362
2016	323,127	49,244	15.24%	56,500	17.5%	47,500 (84.1%)	9,000 (15.9%)	2,316,285 (58%)	4,100	1,882,269	3,331
2017	326,625	51,055	15.63%	58,000	17.8%	49,200 (84.83%)	8,900 (15.34%)	2,247,240 (54%)	3,875	1,835,796	3,165
2018	327,167	52,347	16.00%	59,600	18.2%	50,800 (85.23%)	8,800 (14.77%)	2,186,893 (54%)	3,669	1,788,915	3,002
Percentage of Change from											
2000-2018	15.9%	49.2%		50.4%		48.3%	63.9%	160.5%	73.2%	125.7%	50.1%
GM	0.8%	2.3%		2.3%		2.2%	2.8%	5.5)%	3.1%	4.6%	2.3%
2000-2009	8.8%	12.8%		15.6%		11.4%	42.0%	151.6%	117.8%	118.7%	89.2%
GM	0.9%	1.3%		1.6%		1.2%	4.0%	10.8%	9.0%	9.1%	7.3%
2009-2018	6.6%	32.3%		30.1%		33.1%	15.4%	3.5%	-20.4%	3.2%	-20.7%
GM	0.7%	3.2%		3.0%		3.2%	1.6%	0.4%	-2.5%	0.4%	-2.5%

Rate = rate per 100,000 Medicare beneficiaries; GM = geometric average change. Epidural Services = 62310-C/T or interlaminar epidural injections; 62311-L/S interlaminar epidural injections; 64479-C/T transforaminal epidural injections; 64480-C/T transforaminal epidural injections add-on; 64483-L/S transforaminal epidural injections; 64484-L/S transforaminal epidural injections add-on.

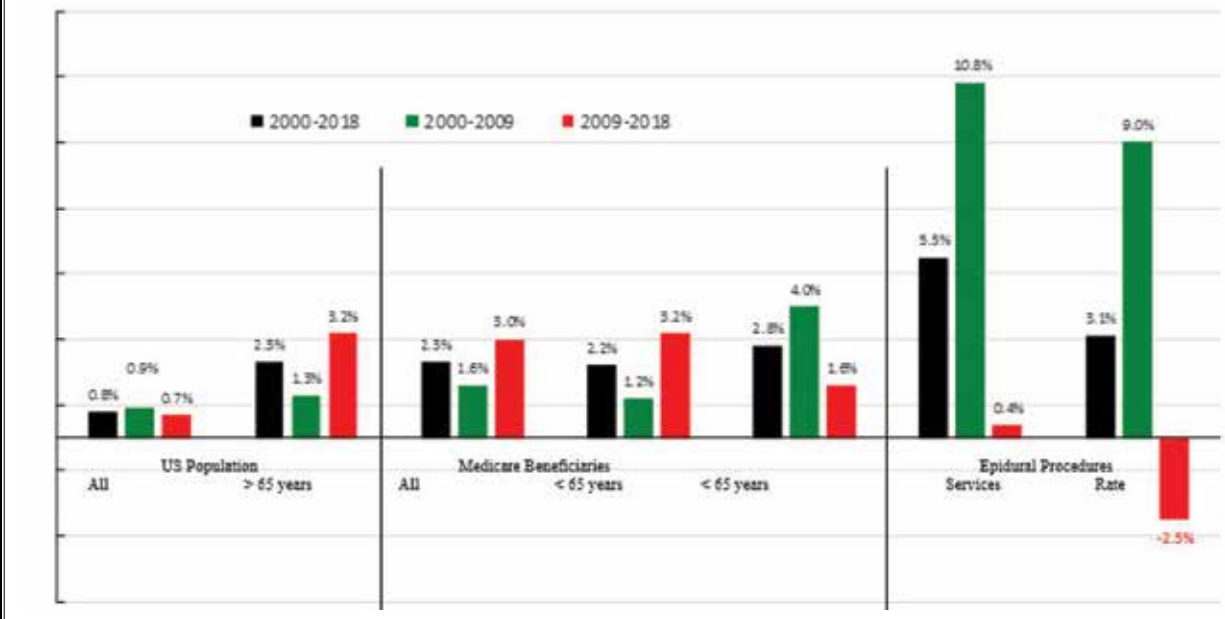
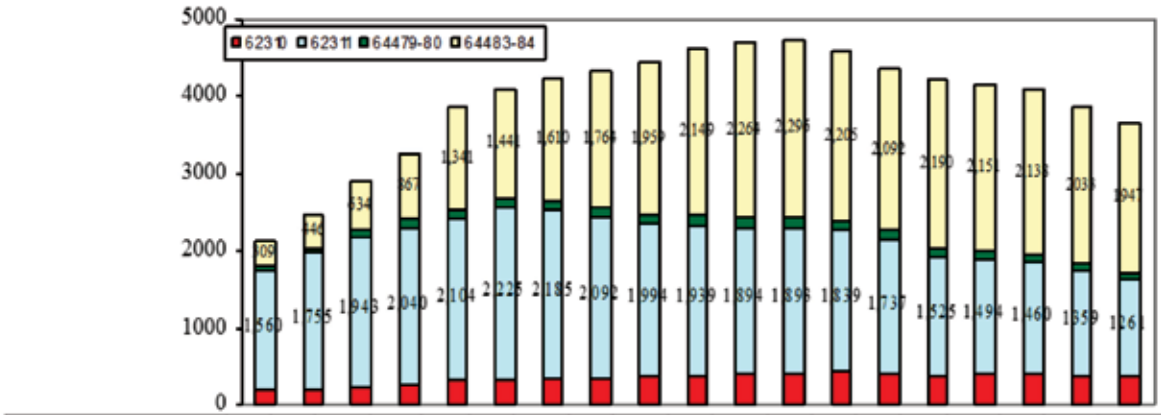


Fig. 1. *Comparative analysis of annual US population growth, Medicare participation and utilization of epidural services.*



YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
C/T Interlaminar Epidurals (62310)	9.0%	8.5%	8.5%	8.2%	8.1%	8.1%	8.0%	8.2%	8.2%	8.3%	8.4%	8.7%	9.3%	9.6%	9.3%	9.5%	9.7%	9.9%	10.1%
L/S Interlaminar Epidurals (62311)	73.7%	71.1%	67.1%	62.5%	54.5%	54.1%	51.3%	48.4%	44.9%	42.0%	40.3%	39.9%	40.1%	39.9%	36.2%	36.0%	35.6%	35.1%	34.5%
C/T Transforaminal Epidurals (64479, 80)	2.7%	2.4%	2.5%	2.6%	2.7%	2.6%	2.9%	2.7%	2.8%	3.1%	3.2%	2.9%	2.5%	2.4%	2.6%	2.6%	2.6%	2.5%	2.4%
L/S Transforaminal Epidurals(64483, 84)	14.6%	18.1%	21.9%	26.6%	34.7%	36.0%	37.8%	40.8%	44.1%	46.6%	48.2%	48.5%	48.1%	48.1%	51.9%	51.9%	52.1%	52.5%	53.0%
All Epidurals (Rate)	2,118	2,470	2,894	3,265	3,863	4,113	4,255	4,327	4,442	4,612	4,701	4,740	4,582	4,354	4,216	4,146	4,100	3,875	3,669

Fig. 2. *Frequency of utilization of epidural injections by procedures from 2000 to 2018, in Medicare recipients.*

Table 2. *Utilizations of epidural injections in the FFS Medicare population from 2000 to 2018.*

Year	Cervical/Thoracic Interlaminar Epidurals (CPT 62310)			Lumbar Interlaminar and Caudal Epidurals (CPT 62311)			Cervical/Thoracic Transforaminal Epidurals					Lumbar/Sacral Transforaminal Epidurals				
							CPT 64479	CPT 64480	Total	Rate	CFPY	CPT 64483	CPT 64484	Total	Rate	CFPY
	Services	Rate	CFPY*	Services	Rate	CFPY	Services	Services	Services			Services	Services	Services		
2000	75,741	191	-	618,362	1,560	-	13,454	9,434	22,888	58	-	85,006	37,477	122,483	309	-
2001	84,385	211	10.3%	702,713	1,755	12.5%	14,732	8,537	23,269	58	0.6%	125,534	53,133	178,667	446	44.4%
2002	99,117	245	16.1%	786,919	1,943	10.7%	18,583	10,835	29,418	73	25.0%	177,679	79,115	256,794	634	42.1%
2003	109,783	267	9.1%	838,858	2,040	5.0%	21,882	15,769	37,651	92	26.0%	242,491	114,046	356,537	867	36.7%
2004	130,649	313	17.3%	878,174	2,104	3.2%	25,182	18,094	43,276	104	13.3%	363,744	196,044	559,788	1,341	54.7%
2005	141,652	333	6.5%	945,350	2,225	5.7%	27,844	20,525	48,369	114	9.8%	395,508	216,892	612,400	1,441	7.4%
2006	146,748	339	1.6%	946,961	2,185	-1.8%	29,822	23,073	52,895	122	7.2%	452,125	245,453	697,578	1,610	11.7%
2007	156,415	353	4.4%	926,029	2,092	-4.3%	29,938	22,266	52,204	118	-3.4%	506,274	274,305	780,579	1,764	9.6%
2008	165,636	365	3.2%	905,419	1,994	-4.7%	32,286	24,003	56,289	124	5.1%	572,340	317,448	889,788	1,959	11.1%
2009	175,503	383	5.1%	888,166	1,939	-2.7%	37,012	27,487	64,499	141	13.6%	632,658	351,685	984,343	2,149	9.7%
2010	184,750	394	2.8%	888,421	1,894	-2.3%	40,003	29,888	69,891	149	5.8%	679,117	383,128	1,062,245	2,264	5.4%
2011	200,134	414	5.2%	914,324	1,893	0.0%	38,970	26,628	65,598	136	-8.8%	710,638	398,519	1,109,157	2,296	1.4%
2012	213,390	424	2.4%	925,179	1,839	-2.8%	35,945	21,293	57,238	114	-16.2%	718,437	390,749	1,109,186	2,205	-4.0%
2013	217,393	419	-1.3%	901,468	1,737	-5.6%	34,699	20,409	55,108	106	-6.7%	700,820	385,098	1,085,918	2,092	-5.1%
2014	208,741	390	-6.9%	815,858	1,525	-12.2%	37,944	21,587	59,531	111	4.8%	763,793	407,745	1,171,538	2,190	4.7%
2015	215,897	393	0.8%	820,227	1,494	-2.0%	37,855	21,115	58,970	107	-3.5%	771,625	409,548	1,181,173	2,151	-1.7%
2016	224,118	397	0.9%	824,822	1,460	-2.3%	38,741	20,467	59,208	105	-2.4%	794,588	413,549	1,208,137	2,138	-0.6%
2017	223,060	385	-3.0%	788,456	1,359	-6.9%	37,648	18,915	56,563	98	-6.9%	786,632	392,529	1,179,161	2,033	-4.9%
2018	220,470	370	-3.8%	751,846	1,261	-7.2%	37,184	17,251	54,435	91	-6.3%	779,415	380,727	1,160,142	1,947	-4.3%
2000-2018	191.1%	93.6%		21.6%	-19.1%		176.4%	82.9%	137.8%	58.2%		816.9%	915.9%	847.2%	529.8%	
GM	6.1%	3.7%		1.1%	-1.2%		5.8%	3.4%	4.9%	2.6%		13.1%	13.8%	13.3%	10.8%	
2000-2009	131.7%	100.5%		43.6%	24.3%		175.1%	191.4%	181.8%	143.8%		644.3%	838.4%	703.7%	595.4%	
GM	9.8%	8.0%		4.1%	2.4%		11.9%	12.6%	12.2%	10.4%		25.0%	28.2%	26.1%	24.0%	
2009-2018	25.6%	-3.5%		-15.3%	-34.9%		0.5%	-37.2%	-15.6%	-35.1%		23.2%	8.3%	17.9%	-9.4%	
GM	2.6%	-0.4%		-1.8%	-4.7%		0.1%	-5.0%	-1.9%	-4.7%		2.3%	0.9%	1.8%	-1.1%	

CFPY - percentage of change from previous year of rate; GM = geometric average change.

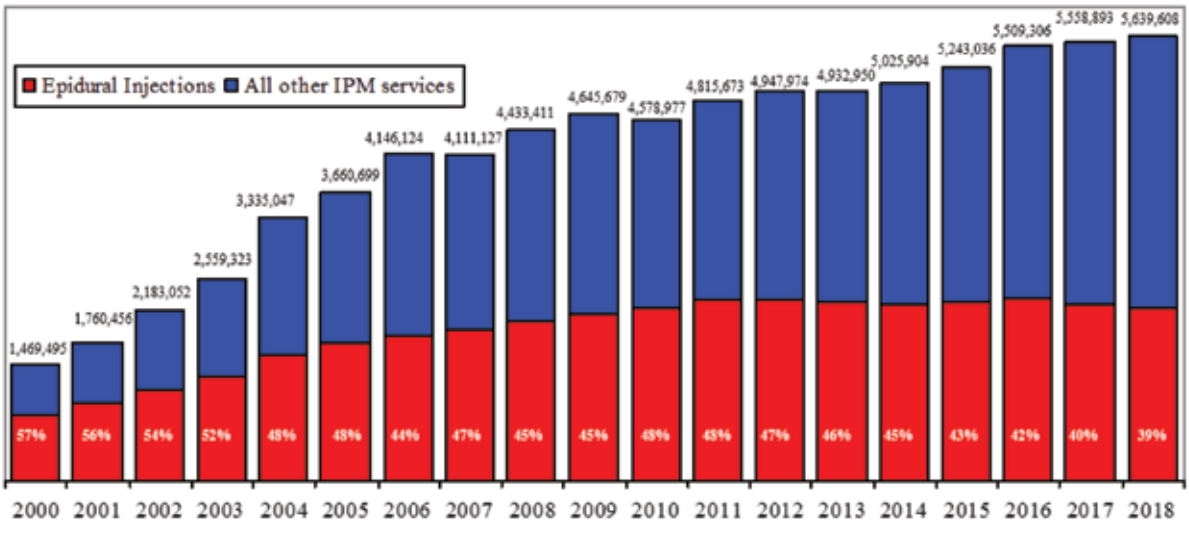


Fig. 3. *Frequency of utilization of epidural injections and all other interventional pain management procedures from 2000 to 2018 in Medicare recipients.*

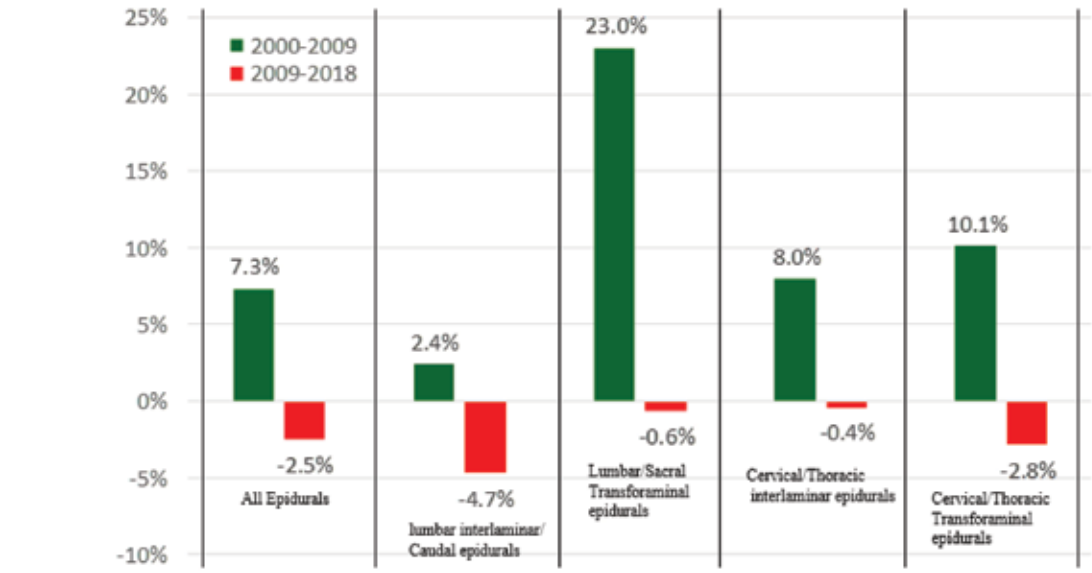


Fig. 4. *Frequency of utilization of epidural injections (annual change in the rate) by procedures from 2000 to 2018, in Medicare recipients.*

significant shift over the years in the performance of epidural injection procedures based on the location of the procedures performed, as shown in Fig. 5.

Services Compared with Rate

This manuscript provides both total number of services and rate per 100,000 population from 2000 to 2018, as shown in Fig. 6. Total number of services consistently continue to increase at a very slow pace, whereas rates of services per 100,000 Medicare population show slight declines starting in 2010.

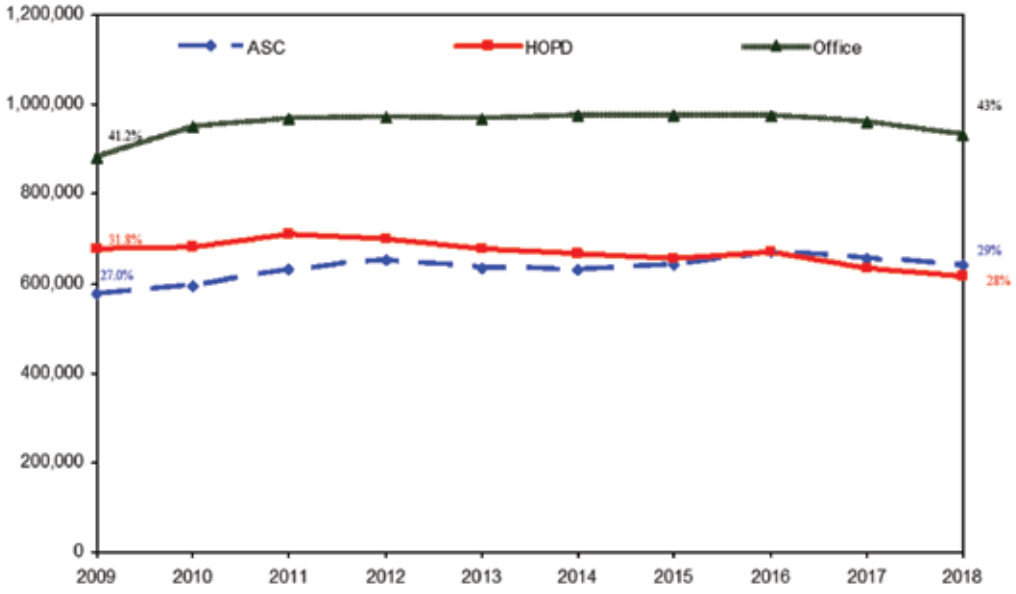


Fig. 5. *Epidural services by place of services for Medicare beneficiaries from 2009 to 2018.*
ASC = ambulatory surgery center; HOPD = hospital outpatient department.

Fig. 6. *Total number of epidural services and rate per 100,000 population from 2000 to 2018.*

Discussion

Utilization of epidural injections in the Medicare FFS population shows continued decline of 20.7% from 2009 to 2018, with an annual decline of 2.5%. The results of this updated assessment are similar to the previous assessment wherein epidural injections declined 1.8% annually and a total of 12% from 2009 to 2016. This is also similar to overall utilization of interventional techniques showing a decline of 6.7% from 2009 to 2018, with an annual decline of 0.8% per 100,000 FFS Medicare population, despite an increase of 0.7% per year of population growth (3.2% of those age 65 years or older) and a 3% annual increase in Medicare population from 2009 to 2018.

All epidural injections declined at a rate of 2.5%, with an overall decline from 2000 to 2018 of 20.7%. Further analysis also showed that the greatest decline was in cervical and thoracic transforaminal epidural injections, 35.1%, with an annual decline of 4.7%, followed by lumbar interlaminar and caudal epidural injections of annual rate of 4.7% and overall rate of 34.9%, followed by a decline of 1.1% annually and overall decline of 9.4% from 2009 to 2018 of lumbar and sacral transforaminal epidurals, and finally the smallest decline was noted with cervical and thoracic interlaminar epidural procedures at an annual rate of 0.4% and overall rate of 3.5% from 2009 to 2018. However, when utilizing only primary codes, the data are somewhat different for those codes with add-on codes, namely transforaminal epidural injections. Based on primary codes, cervical and thoracic transforaminal epidurals, CPT 64479, decreased 2.8% per year with a total decrease of 22.8% from 2009 to 2018. In contrast, the decrease was smaller for lumbar/sacral transforaminal epidurals, CPT 64483, with a decline of 0.6% annually and 5.3% from 2009 to 2018. Further, the proportion of utilization of epidural injections declined compared with all other interventional pain management procedures from 2000 to 2018. In 2000, epidural injections constituted 57% of total interventional procedures, whereas the proportion of epidural procedures declined to 39% in 2018.

In addition, of further significance is increase of lumbosacral transforaminal epidural injections from 14.6% of all epidurals in 2000 to 53% in 2018, reversing the trend of lumbosacral interlaminar epidural injections from 73.7% in 2000 to 34.5% in 2018, a substantial change in the utilization patterns for both procedures.

State distribution characteristics also are shown in Appendix Table 3. These are based on the Medicare carrier of 2016 per 100,000 FFS Medicare population. The results showed that despite differences in policies allowing up to 6 procedures per year per region in some jurisdictions, and a maximum of 5 during the first year, and 4 in subsequent years per region in other jurisdictions, yet a total of 6 for whole spine regions, there were no significant differences in utilization patterns.

In addition to the earlier mentioned data, further analysis was shown in Appendix Tables 4 and 5. As described, lumbar interlaminar or caudal epidural injections declined overall 33% with no significant difference noted among the states. Although there was no change in the utilization patterns, as shown in Appendix Table 5, transforaminal epidural injections increased 0.1% at an annual rate in Noridian states, and 1.2% in the states covered by Palmetto. Further, overall declines were 6% total and 0.6% annually in non-Noridian states compared with Noridian states with an overall increase of 1% and increase of 0.1% annually. Very few states showed increases in utilization of transforaminal epidural injections, but only 2 states showed minor increases with interlaminar epidural injections. This assessment also showed no significant differences in utilization patterns based on site of service, indicating lack of significant movement of interventional pain physicians to hospital employment compared with other specialties (72,73). Physician practice benchmark survey (72) showed in 2018, a new milestone was reached – 2018 marked the first year in which there were fewer physician owners (45.9%) than employees (47.4%). Further, 2016 benchmark survey showed for the first time, less than 50% of physicians (47.1%) had an ownership stake in their practice (73,74), yet some of the reports have shown that only 1 in 3 doctors today are independent (74).

The majority of the declines may be attributed to the FFS Medicare population price changes (75,76). Those data reflected the significant reduction in reimbursement patterns starting in 2015, coupled with bundling of fluoroscopy into physician payments in 2016 (75-78). Multiple regulations were initiated to control the utilization of medical procedures starting in early 2009 with the passage of the Stimulus Act (79), which was followed by the passage of ACA and related regulations (1-3,5-10). Multiple LCDs, spearheaded by Noridian Medicare Administrative Contractors (MAC), seem to have had no significant effect (80).

Despite the decline in utilization, it is considered that utilization of all medical procedures, including

interventional techniques, is rather escalating. This is in contrast to the increases in elderly and Medicare populations. As described in our previous manuscript, the changes continue in the present manuscript in the population younger than 65 years of age on Medicare with disabilities rather than age as the annual growth rate was 1.6% from 2009 to 2018 in contrast to 4% from 2000 to 2009. This is in the face of complaints of escalating disability in all sectors, specifically in patients with spinal pain (81,82), and this reflects the fact that the majority of individuals, after obtaining disability, have been enrolled in Medicaid instead of Medicare. The only one aspect in which there was a slight increase in transforaminal epidural injections in some of the states, the only one factor with slower decreases of lumbosacral transforaminal epidural injections and rapid decrease of lumbar interlaminar and caudal epidural injections, may be based on differences in price patterns (75-78). Additionally, another epidural procedure that is not included in this analysis, percutaneous epidural adhesiolysis, has shown substantially higher reductions than epidural injections with issuance of noncoverage policy for percutaneous adhesiolysis (34,80,83,84), and this was despite significant evidence of clinical and cost effectiveness (42,54,85-88).

There are a multitude of reasons and unintended consequences of the decreased utilization of interventional techniques in general, and epidural injections in particular, may be considered as a contributing factor to the astronomical increase in opioid deaths (11). A multitude of efforts have been made to curb the opioid epidemic (89-92). Despite a decline in the number of opioid prescriptions and morphine equivalent dosages, opioid deaths have been escalating due to an epidemic of illicit fentanyl and heroin. Consequently, Best Practices in Pain Management recommends a multidisciplinary approach with the inclusion of interventional techniques (4). It should be noted that criticisms of lack of evidence, excessive utilization, and even contribution to increased opioid use remain to be just arguments rather than facts (31). Given the increase in the prevalence of spinal pain and its impact on health together with the escalating opioid epidemic and astronomical increase in death, and the discordant opinions from both proponents and opponents despite multiple favorable systematic reviews, numerous RCTs, and cost utility analysis (40-48,51,53,54,56,58-60), it appears that interventional techniques and epidural injections are over scrutinized. Thus, on the basis of the present analysis, utilization continues to be lower for epidural injections compared with other modalities of treatments in managing spinal pain.

Conclusions

The declining utilization of epidural injections in all categories with an annual total of 2.5% and from 2009 to 2018 of 20.7% compared with an annual increases of 7.3% and overall increase of 89.2% from 2000 to 2009 shows a slow decline of utilization of all epidural injections. However, the utilization patterns, even though declining, may still be considered as high. Further, this analysis showed a decline in utilization with reduction in health care expenditure despite an increase in the Medicare population and proven effectiveness in the literature, based on LCDs, stricter regulations, and potentially biased synthesis of literature, leading to reduced access and increased contribution to the opioid epidemic.

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Author Contributions

The study was designed by LM, VP, and JAH.

Statistical analysis was performed by VP.

All authors contributed to the preparation of the manuscript, reviewed, and approved the content with the final version.

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Appendix Fig. 1. *Frequency of utilization of epidural injections (change in the rate) by procedures from 2000 to 2018, in Medicare recipients.*

Appendix Fig. 2. *Frequency of utilization of epidural injections by procedures from 2000 to 2018 in Medicare recipients by specialty groups.*

Appendix Table 1. *Utilizations of epidural injections in the FFS Medicare population from 2000 to 2018 (only primary codes).*

Appendix Table 2. *Utilization patterns of epidural injections by various specialty groups from 2000 to 2018 in Medicare recipients.*

Appendix Table 3. *Utilizations of epidural injections (rates per 100,000) in the Medicare population from 2009 to 2018 based on Medicare carrier of 2016.*

Appendix Table 4. *Utilizations of caudal and interlaminar epidural injections (CPT 62311 - rates per 100,000) in the FFS Medicare population from 2009 to 2018 based on Medicare carrier of 2016.*

Appendix Table 5. *Utilizations of lumbar/sacral transforaminal epidural injections (CPT 64483 - rates per 100,000) in the FFS Medicare population from 2009 to 2018 based on Medicare carrier of 2016.*

Appendix Table 6. *Utilizations of epidural injections (rates per 100,000) in the Medicare population from 2009 to 2018 (percentage of change in decreasing order).*

Appendix Table 7. *Utilizations of epidural injections services in the Medicare population from 2009 to 2018.*

References

1. Centers for Medicare & Medicaid Services NHE Fact Sheet. https://www.cms.gov/research-statistics-data-and-systems/statistics-trendsand-reports/nationalhealthexpenddata/ nhe-fact-sheet.html
2. Sisko AM, Truffer CJ, Keehan SP, Poisal JA, Clemens MK, Madison AJ. National health spending projections: the estimated impact of reform through 2019. *Health Aff (Millwood)* 2010; 29:1933-1941.
3. Manchikanti L, Helm S 2nd, Benyamin RM, Hirsch JA. A critical analysis of Obamacare: Affordable care or insurance for many and coverage for few? *Pain Physician* 2017; 20:111-138.
4. U.S. Department of Health and Human Services. Pain Management Best Practices Inter-Agency Task Force. Final Report on Pain Management Best Practices: Updates, Gaps, Inconsistencies, and Recommendations. May 9, 2019.
   https://www.hhs.gov/ash/advisory-committees/pain/reports/index.html
5. Manchikanti L, Singh V, Benyamin RM, Kaye AD, Pampati V, Hirsch JA. Reframing Medicare physician payment policy for 2019: A look at proposed policy. *Pain Physician* 2018; 21:415-432.
6. Hirsch JA. The pincer movement of cost and quality in neurointerventional care: resource management as an imperative. *J Neurointerv Surg* 2019; 11:323-325.
7. Hirsch JA, Leslie-Mazwi T, Nicola GN, et al. Storm rising! The Obamacare exchanges will catalyze change: why physicians need to pay attention to the weather. *J Neurointerv Surg* 2019; 11:101-106.
8. Spilberg G, Nicola GN, Rosenkrantz AB, et al. Understanding the impact of 'cost' under MACRA: A neurointerventional imperative! *J Neurointerv Surg* 2018; 10:1005-1011.
9. Golding LP, Nicola GN, Ansari SA, et al. MACRA 2.5: The legislation moves forward. *J Neurointerv Surg* 2018; 10:1224-1228.
10. Chen MM, Rosenkrantz AB, Nicola GN, et al. The Qualified Clinical Data Registry: A Pathway to Success within MACRA. *AJNR Am J Neuroradiol* 2017; 38:1292-1296.
11. Manchikanti L, Sanapati J, Benyamin RM, Atluri S, Kaye AD, Hirsch JA. Reframing the prevention strategies of the opioid crisis: Focusing on prescription opioids, fentanyl, and heroin epidemic. Pain Physician 2018; 21:309-326.
12. Meyer H. Growth in medical prices inched healthcare spending higher in 2018. *Modern Healthcare*, December 9, 2019.
13. Dieleman JL, Cao J, Chapin A, Chen C, Li Z, Liu A, Horst C, Kaldjian A, Matyasz T, Scott KW, Bui AL, Campbell M, Duber HC, Dunn AC, Flaxman AD, Fitzmaurice C, Naghavi M, Sadat N, Shieh P, Squires E, Yeung K, Murray CJL. US Health Care Spending by Payer and Health Condition, 1996–2016. *JAMA*. 3 March 2020. doi:10.1001/jama.2020.0734.
14. U.S. Burden of Disease Collaborators. The state of US health, 1990–2010: Burden of diseases, injuries, and risk factors. *JAMA* 2013; 310:591-608.
15. Manchikanti L, Kaye AM, Knezevic NN, et al. Responsible, safe, and effective prescription of opioids for chronic non-cancer pain: American Society of Interventional Pain Physicians (ASIPP) guidelines. *Pain Physician* 2017; 20: S3-S92.
16. Navani A, Manchikanti L, Albers SL, et al. Responsible, safe, and effective use of biologics in the management of low back pain: American Society of Interventional Pain Physicians (ASIPP) guidelines. *Pain Physician* 2019; 22:S1-S74.
17. Zadro JR, Shirley D, Ferreira M, et al. Is Vitamin D supplementation effective for low back pain? A systematic review and meta-analysis. *Pain Physician* 2018; 21:121-145.
18. U.S. Food and Drug Administration. FDA warms about serious breathing problems with seizure and nerve pain medications gabapentin (Neurontin, Gralise, Horizant) and pregabalin (Lyrica, Lyrica CR) when used with CNS depressants or in patients with lung problems. December 19, 2019.
   https://www.fda.gov/drugs/drug-safety-and-availability/fda-warns-about-serious-breathing-problems-seizure-and-nerve-pain-medicines-gabapentin-neurontin
19. Leavitt SB. NSAID dangers may limit pain-relief options. Pain-Topics News/ Research UPDATES, March 14, 2010.
   http://updates.pain-topics.org/2010/03/nsaid-dangers-may-limit-pain-relief.html
20. Moore A, Wiffen P, Kalso E. Antiepileptic drugs for neuropathic pain and fibromyalgia. *JAMA* 2014; 312:182-183.
21. Gingras MA, Lieu A, Papillon-Ferland L, Lee TC, McDonald EG. Retrospective cohort study of the prevalence of off-label gabapentinoid prescriptions in hospitalized medical patients. *J Hosp Med* 2019; 14:547-550.
22. Harirforoosh S, Asghar W, Jamali F. Adverse effects of nonsteroidal antiinflammatory drugs: an update of gastrointestinal, cardiovascular and renal complications. *J Pharm Pharm Sci* 2013; 16:821-847.
23. Rajaee SS, Bae HW, Kanim LE, Delamarter RB. Spinal fusion in the United States: Analysis of trends from 1998 to 2008. *Spine (Phila Pa 1976)* 2012; 37:67-76.
24. Deyo RA. Fusion surgery for lumbar degenerative disc disease: Still more questions than answers. *Spine J* 2015; 15:272-274.
25. Pannell WC, Savin DD, Scott TP, Wang JC, Daubs MD. Trends in the surgical treatment of lumbar spine disease in the United States. *Spine J* 2015; 15:1719-1727.
26. Jonan AB, Kaye AD, Urman RD. Buprenorphine Formulations: Clinical Best Practice Strategies Recommendations for Perioperative Management of Patients Undergoing Surgical or Interventional Pain Procedures. *Pain Physician* 2018; 21:E1-E12.
27. Shen J, Xu S, Xu S, Ye S, Hao J. Fusion or not for degenerative lumbar spinal stenosis: A Meta-analysis and systematic review. *Pain Physician* 2018; 21:1-8.
28. Fischer B, Jones W, Vojtila L, Kurdyak P. Patterns, changes, and trends in prescription opioid dispensing in Canada, 2005-2016. *Pain Physician* 2018; 21:219-228.
29. US Department of Health and Human Services. Office of Inspector General (OIG). Inappropriate Medicare Payments for Transforaminal Epidural Injection Services (OEI-05-09-00030). August 2010.
   http://oig.hhs.gov/oei/reports/oei-05-09-00030.pdf
30. Manchikanti L, Sanapati MR, Pampati V, Boswell MV, Kaye AD, Hirsch JA.

Update on reversal and decline of growth of utilization of interventional techniques in managing chronic pain in the Medicare population from 2000 to 2018. *Pain Physician* 2019; 22:521-536.

31. Manchikanti L, Soin A, Mann DP, Bakshi S, Pampati V, Hirsch JA. Comparative analysis of utilization of epidural procedures in managing chronic pain in the Medicare population: Pre and post Affordable Care Act. *Spine (Phila Pa 1976)* 2019; 44:220-232.
32. Secretary Azar Statement on 2018 Provisional Drug Overdose Death Data. July 17, 2019. www.hhs.gov/about/news/2019/07/17/secretary-azar-statement-on-2018-provisional-drug-overdose-death-data.html
33. Manchikanti L, Pampati V, Hirsch JA. Retrospective cohort study of usage patterns of epidural injections for spinal pain in the US fee-for-service Medicare population from 2000 to 2014. *BMJ Open* 2016; 6:e013042.
34. Manchikanti L, Pampati V, Benyamin RM, Hirsch JA. Declining utilization of percutaneous epidural adhesiolysis in Medicare population: Evidence-based or over-regulated? *IPM Reports* 2018; 2:9-18.
35. Manchikanti L, Soin A, Mann DP, et al. Utilization patterns of facet joint interventions in managing spinal pain: A retrospective cohort study in the US fee-for-service Medicare population. *Curr Pain Headache Rep* 2019; 23:73.
36. Manchikanti MV, Manchikanti L, Kaye AD, Pampati V, Hirsch JA. Usage patterns of sacroiliac joint injections - a comparative evaluation of pre and post Affordable Care Act in Medicare population. *IPM Reports* 2018; 2:157-166.
37. Manchikanti L, Sanapati J, Pampati V, Kaye AD, Hirsch JA. Utilization of vertebral augmentation procedures in the United States: A comparative analysis in Medicare fee-for-service population pre- and post-2009 trials. *Curr Pain Headache Rep* 2019; in press.
38. Farber SH, Han JL, Elsamadicy AA, et al. Long-term cost utility of spinal cord stimulation in patients with failed back surgery syndrome. *Pain Physician* 2017; 20:E797-E805.
39. Starr JB, Gold L, McCormick Z, Suri P, Friedly J. Trends in lumbar radiofrequency ablation utilization from 2007 to 2016. *Spine J* 2019; 19:1019-1028.
40. Lee JH, Shin KS, Park SJ, et al. Comparison of clinical efficacy between transforaminal and interlaminar epidural injections in lumbosacral disc herniation: A systematic review and meta-analysis. *Pain Physician* 2018; 21:433-448.
41. Manchikanti L, Pampati V, Kaye AD, Hirsch JA. Cost utility analysis of cervical therapeutic medial branch blocks in managing chronic neck pain. *Int J Med Sci* 2017; 14:1307-1316.
42. Manchikanti L, Helm S 2nd, Pampati V, Racz GB. Cost utility analysis of percutaneous adhesiolysis in managing pain of post-lumbar surgery syndrome and lumbar central spinal stenosis. *Pain Pract* 2015; 15:414-422.
43. Lee JH, Kim DH, Kim DH, et al. Comparison of clinical efficacy of epidural injection with or without steroid in lumbosacral disc herniation: A systematic review and meta-analysis. *Pain Physician* 2018; 21:449-468.
44. Lee JH, Shin KH, Bahk SJ, et al. Comparison of clinical efficacy of transforaminal and caudal epidural steroid injection in lumbar and lumbosacral disc herniation: A systematic review and metaanalysis. Spine J 2018; 18:2343-2353.
45. Manchikanti L, Pampati V, Benyamin RM, Hirsch JA. Cost utility analysis of lumbar interlaminar epidural injections in the treatment of lumbar disc herniation, central spinal stenosis, and axial or discogenic low back pain. *Pain Physician* 2017; 20:219-228.
46. Kumar K, Rizvi S. Cost-effectiveness of spinal cord stimulation therapy in management of chronic pain. *Pain Med* 2013; 14:1631-1649.
47. Taylor RS, Ryan J, O'Donnell R, Eldabe S, Kumar K, North RB. The cost-effectiveness of spinal cord stimulation in the treatment of failed back surgery syndrome. *Clin J Pain* 2010; 26:463-469.
48. Manchikanti L, Pampati V, Kaye AD, Hirsch JA. Therapeutic lumbar facet joint nerve blocks in the treatment of chronic low back pain: Cost utility analysis based on a randomized controlled trial. *Korean J Pain* 2018; 31:27-38.
49. Zheng C, Yitong J, Zipu J, Tao W, Fang L. The long-term outcome of 3-dimensional CT-guided percutaneous radiofrequency thermocoagulation for tumor-related trigeminal neuralgia. *Pain Physician* 2019; 22:E467-E475.
50. Jazini E, Gum JL, Glassman SD, et al. Cost-effectiveness of circumferential fusion for lumbar spondylolisthesis: propensity-matched comparison of transforaminal lumbar interbody fusion with anterior-posterior fusion. *Spine J* 2018; 18:1969-1973.
51. Manchikanti L, Pampati V, Parr III A, et al. Cervical interlaminar epidural injections in the treatment of cervical disc herniation, post surgery syndrome, or discogenic pain: Cost utility analysis from randomized trials. *Pain Physician* 2019; 22:421-431.
52. Chou R, Hashimoto R, Friedly J, et al. Epidural corticosteroid injections for radiculopathy and spinal stenosis: A systematic review and meta-analysis. *Ann Intern Med* 2015; 163:373-381.
53. Manchikanti L, Knezevic NN, Boswell MV, Kaye AD, Hirsch JA. Epidural injections for lumbar radiculopathy and spinal stenosis: A comparative systematic review and meta-analysis. *Pain Physician* 2016; 19:E365-E410.
54. Manchikanti L, Knezevic NN, Sanapati MR, Boswell MV, Kaye AD, Hirsch JA. Effectiveness of percutaneous adhesiolysis in managing chronic central lumbar spinal stenosis: A systematic review and meta-analysis. *Pain Physician* 2019; 22:E523-E550.
55. Sanapati J, Manchikanti L, Atluri S, et al. Do regenerative medicine therapies provide long-term relief in chronic low back pain: A systematic review and metaanalysis. *Pain Physician* 2018; 21:515-540.
56. Manchikanti L, Soin A, Benyamin RM, et al. An update of the systematic appraisal of the accuracy and utility of discography in chronic spinal pain. Pain Physician 2018; 21:91-110.
57. Chen X, Guo W, Li Q, et al. Is unilateral percutaneous kyphoplasty superior to bilateral percutaneous kyphoplasty for osteoporotic vertebral compression fractures? Evidence from a systematic review of discordant meta-analyses. *Pain Physician* 2018; 21:327-336.
58. Manchikanti L, Knezevic NN, Sanapati MR, Boswell MV, Kaye AD, Hirsch JA. Effectiveness of percutaneous adhesiolysis in managing chronic central lumbar spinal stenosis: A systematic review and meta-analysis. *Pain Physician* 2019; 22:E523-E550.
59. Manchikanti L, Soin A, Boswell MV, Kaye AD, Sanapati M, Hirsch JA. Effectiveness of percutaneous adhesiolysis in post lumbar surgery syndrome: A systematic

analysis of findings of systematic reviews. *Pain Physician* 2019; 22:307-322.

60. Manchikanti L, Falco FJE, Pampati V, Cash KA, Benyamin RM, Hirsch JA. Cost utility analysis of caudal epidural injections in the treatment of lumbar disc herniation, axial or discogenic low back pain, central spinal stenosis, and post lumbar surgery syndrome. *Pain Physician* 2013; 16:E129-E143.
61. Artemiadis AK, Zis P. Neuropathic pain in acute and subacute neuropathies: A systematic review. *Pain Physician* 2018; 21:111-120.
62. Xiang GH, Tong MJ, Lou C, Zhu SP, Guo WJ, Ke CR. The role of unilateral balloon kyphoplasty for the treatment of patients with OVCFS: A systematic review and meta-analysis. *Pain Physician* 2018; 21:209-218.
63. Chakravarthy K, Manchikanti L, Kaye AD, Christo PJ. Reframing the role of neuromodulation therapy in the chronic pain treatment paradigm. *Pain Physician* 2018; 21:507-513.
64. Zhao L, Kaye AD, Abd-Elsayed A. Stem cells for the treatment of knee osteoarthritis: A comprehensive review. *Pain Physician* 2018; 21:229-242.
65. Centers for Medicare and Medicaid Services.
https://www.cms.gov/
66. Vandenbroucke JP, von Elm E, Altman DG, et al; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and elaboration. *Epidemiology* 2007; 18:805-835.
67. Friedly J, Chan L, Deyo R. Increases in lumbosacral injections in the Medicare population: 1994 to 2001. *Spine (Phila Pa 1976)* 2007; 32:1754-1760.
68. Friedly J, Chan L, Deyo R. Geographic variation in epidural steroid injection use in Medicare patients. *J Bone Joint Surg Am* 2008; 90:1730-1737.
69. Manchikanti L, Singh V, Pampati V, Smith HS, Hirsch JA. Analysis of growth of interventional techniques in managing chronic pain in Medicare population: A 10-year evaluation from 1997 to 2006. *Pain Physician* 2009; 12:9-34.
70. Manchikanti L, Pampati V, Falco FJE, Hirsch JA. Growth of spinal interventional pain management techniques: Analysis of utilization trends and Medicare expenditures 2000 to 2008. *Spine (Phila Pa 1976)* 2013; 38:157-168.
71. 2017 Annual Report of the Boards of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds, July 13, 2017.
www.cms.gov/Research-Statistics-Dataand-Systems/Statistics-Trends-and-Reports/ReportsTrustFunds/Downloads/ TR2017.pdf.
72. Kane CK. Policy Research Perspectives: Updated data on physician practice arrangements: For the first time, fewer physicians are owners than employees. *AMA Economic and Health Policy Research*, May 2019.
https://www.ama-assn.org/system/files/2019-07/prp-fewer-owners-benchmark-survey-2018.pdf
73. Kane CK. Policy Research Perspectives: Updated data on physician practice arrangements: Physician ownership drops below 50 percent. *AMA Economic and Health Policy Research*, May 2017.
https://www.ama-assn.org/sites/ama-assn.org/files/corp/media-browser/public/health-policy/PRP-2016-physician-benchmark-survey.pdf
74. Carey MJ. Employed vs independent doctors: Numbers don't tell the whole story. *Medical Economics*, June 5, 2019.
https://www.medicaleconomics.com/med-ec-blog/employed-vs-independent-doctors-numbers-dont-tell-whole-story
75. Manchikanti L, Kaye AD, Hirsch JA. Proposed Medicare physician payment schedule for 2017: impact on interventional pain management practices. *Pain Physician* 2016; 19:E935-E955.
76. Manchikanti L, Singh V, Hirsch JA. Facility payments for interventional pain management procedures: impact of proposed rules. *Pain Physician* 2016; 19:E957-E984.
77. Department of Health and Human Services, Centers for Medicare & Medicaid Services. 42 CFR Parts 403, 405, 410, 414, 425, and 498. Medicare Program; Revisions to Payment Policies under the Physician Fee Schedule, Clinical Laboratory Fee Schedule, Access to Identifiable Data for the Center for Medicare and Medicaid Innovation Models & Other Revisions to Part B for CY 2015. Final Rule. November 13, 2014.
78. Department of Health and Human Services, Centers for Medicare & Medicaid Services. 42 CFR Parts 405, 410, 411, 414, 425, and 495. Medicare Program; Revisions to Payment Policies under the Physician Fee Schedule and Other Revisions to Part B for CY 2016 (CMS-1631-FC). Final Rule. November 16, 2015.
79. American Recovery and Reinvestment Act of 2009 (AARA), P.L. 111-5, February 17, 2009.
80. Noridian Healthcare Solutions, LLC. Local Coverage Determination (LCD). Lumbar Epidural Injections (L34980). October 1, 2015.
81. Hoy D, March L, Brooks P, et al. The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014; 73:968-974.
82. Hoy D, March L, Woolf A, et al. The global burden of neck pain: Estimates from the global burden of disease 2010 study. *Ann Rheum Dis* 2014; 73:1309-1315.
83. Manchikanti L, Pampati V, Helm S 2nd, et al. Declining utilization of percutaneous epidural adhesiolysis in Medicare population: evidence-based or over-regulated. IPM Rep 2018; 2:9-18.
84. Noridian Healthcare Solutions, LLC. Local Coverage Determination (LCD). Non-covered Services (L35008). Revision January 1, 2018. Available at: https://www.cms.gov/medicare-coverage-database/details/lcd-details.aspx?LCDId=35008&DocID=L35008
85. Helm IIS, Racz GB, Gerdesmeyer L, et al. Percutaneous and endoscopic adhesiolysis in managing low back and lower extremity pain: A systematic review and meta-analysis. *Pain Physician* 2016; 19:E245-E282.
86. Manchikanti L, Manchikanti KN, Gharibo CG, et al. Efficacy of percutaneous adhesiolysis in the treatment of lumbar post surgery syndrome. *Anesth Pain Med* 2016; 6:e26172.
87. Choi SS, Lee JH, Kim D, et al. Effectiveness and factors associated with epidural decompression and adhesiolysis using a balloon-inflatable catheter in chronic lumbar spinal stenosis: 1-year follow-up. *Pain Med* 2016; 17:476-487.
88. Park CH, Lee SH. Effectiveness of percutaneous transforaminal adhesiolysis in patients with lumbar neuroforaminal spinal stenosis. *Pain Physician* 2013; 16:E37-E43.
89. Singer JA. Stop calling it an opioid crisis – it's a heroin and fentanyl crisis. *Cato Institute*, January 9, 2018.
https://www.cato.org/blog/stop-calling-

it-opioid-crisisits-heroin-fentanyl-crisis

90. Ahmad FB, Escobedo LA, Rossen LM, Spencer MR, Warner M, Sutton P. Provisional drug overdose death counts. National Center for Health Statistics. 2019.
https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm

91. Singh VM, Browne T, Montgomery J. The emerging role of toxic adulterants in street drugs in the US illicit opioid crisis. *Public Health Rep* 2019:333549198877741.

92. National Institute on Drug Abuse. Overdose death rates. https://www.drugabuse.gov/related-topics/trends-statistics/overdose-death-rates

93. Centers for Disease Control and Prevention. CDC estimates preventable deaths from 5 leading causes. November 17, 2016.
https://www.cdc.gov/media/releases/2016/p1117-preventable-deaths.html