

Health Policy

COVID-19 Pandemic Reduced Utilization Of Interventional Techniques 18.7% In Managing Chronic Pain In The Medicare Population In 2020: Analysis Of Utilization Data From 2000 To 2020

Laxmaiah Manchikanti, MD¹, Vidyasagar Pampati, MSc¹, Mahendra R. Sanapati, MD¹, Radomir Kosanovic, MD¹, Douglas P. Beall, MD², Sairam Atluri, MD³, Salahadin Abdi, MD, PhD⁴, Shalini Shah, MD⁵, Mark V. Boswell, MD, PhD⁶, Alan D. Kaye, MD, PhD⁷, Amol Sooin, MD⁸, Christopher G. Gharibo, MD⁹, Bradley W. Wargo, DO¹⁰, and Joshua A. Hirsch, MD¹¹

From: ¹Pain Management Centers of America, Paducah, KY & Evansville, IN; ²Comprehensive Specialty Care, Edmond, OK; ³Tri-State Spine Care Institute, Cincinnati, OH; ⁴University of Texas, MD Anderson Cancer Center, Houston, TX; ⁵University of California Irvine, Orange, CA; ⁶University of Toledo College of Medicine and Life Sciences, Toledo, OH; ⁷LSU Health Sciences Center, Shreveport, Ochsner Shreveport Hospital and Interventional Pain Clinic Feist-Wieller Cancer Center, Shreveport, LA, USA; ⁸Ohio Pain Clinic, Centerville, OH, Wright State University, Dayton, OH; ⁹NYU Langone Health and NYU School of Medicine, New York, NY; ¹⁰Mays & Schnapp Neurospine & Pain, Memphis, TN, and Kansas Health Science Center School of Medicine, Wichita, KS; and ¹¹Massachusetts General Hospital and Harvard Medical School, Boston, MA

Address Correspondence:
Laxmaiah Manchikanti, MD
67 Lakeview Drive
Paducah, Kentucky 42001
E-mail: drlm@thepainmd.com

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest:
See page #### for information.

Manuscript received: 01-05-2022
Revised manuscript received:
03-15-2022
Accepted for publication:
03-25-2022

Free full manuscript:
www.painphysicianjournal.com

Background: Multiple publications have shown the significant impact of the COVID-19 pandemic on US healthcare and increasing costs over the recent years in managing low back and neck pain as well as other musculoskeletal disorders. The COVID-19 pandemic has affected many modalities of treatments, including those related to chronic pain management, including both interventional techniques and opioids. While there have not been assessments of utilization of interventional techniques specific to the ongoing COVID-19 pandemic, previous analysis published with data from 2000 to 2018 demonstrated a decline in utilization of interventional techniques from 2009 to 2018 of 6.7%, with an annual decline of 0.8% per 100,000 fee-for-service (FFS) in the Medicare population. During that same time, the Medicare population has grown by 3% annually.

Objectives: The objectives of this analysis include an evaluation of the impact of the COVID-19 pandemic, as well as an updated assessment of the utilization of interventional techniques in managing chronic pain in the Medicare population from 2010 to 2019, 2010 to 2020, and 2019 to 2020 in the FFS Medicare population of the United States.

Study Design: Utilization patterns and variables of interventional techniques with the impact of the COVID-19 pandemic in managing chronic pain were assessed from 2000 to 2020 in the FFS Medicare population of the United States.

Methods: The data for the analysis was obtained from the master database from the Centers for Medicare & Medicaid Services (CMS) physician/supplier procedure summary from 2000 to 2020.

Results: The results of the present investigation revealed an 18.7% decrease in utilization of all interventional techniques per 100,000 Medicare beneficiaries from 2019 to 2020, with a 19% decrease for epidural and adhesiolysis procedures, a 17.5% decrease for facet joint interventions and sacroiliac joint blocks, and a 25.4% decrease for disc procedures and other types of nerve blocks. The results differed from 2000 to 2010 with an annualized increase of 10.2% per 100,000 Medicare population compared to an annualized decrease of 0.4% from 2010 to 2019, and a 2.5% decrease from 2010 to 2020 for all interventional techniques. For epidural and adhesiolysis procedures decreases were more significant and annualized at 3.1% from 2010 to 2019, increasing the decline to 4.8% from 2010 to 2020. For facet joint interventions and sacroiliac joint blocks, the reversal of growth patterns was observed but maintained at an annualized rate increase of 2.1% from 2010 to 2019, which changed to a decrease of 0.01% from 2010 to 2020. Disc procedures and other types of nerve blocks showed similar patterns as epidurals with an 0.8% annualized reduction from 2010 to 2019, which was further reduced to 3.6% from 2010 to 2020 due to COVID-19.

Limitations: Data for the COVID-19 pandemic impact were available only for 2019 and 2020 and only the FFS Medicare population was utilized; utilization patterns in Medicare Advantage Plans, which constitutes almost 40% of the Medicare enrollment in 2020 were not available.

Moreover, this analysis shares the limitations present in all retrospective reviews of claims based datasets.

Conclusion: The decline driven by the COVID-19 pandemic was 18.7% from 2019 to 2020. Overall decline in utilization in interventional techniques from 2010 to 2020 was 22.0% per 100,000 Medicare population, with an annual diminution of 2.5%, despite an increase in the population rate of 3.3% annualized (38.9% overall) and Medicare enrollees of 33.4% and 2.9% annually.

Key words: Interventional pain management, chronic spinal pain, interventional techniques, epidural injections, adhesiolysis, facet joint interventions, sacroiliac joint injections, disc procedures, other types of nerve blocks

Pain Physician 2022: 25:223-238

National health care spending in the United States increased 9.7% to reach \$4.1 trillion in 2020 (1). This was an even faster rate than the 4.3% increase seen in 2019 (2). The acceleration in 2020 was related to a 36% increase in federal expenditures for health care that occurred largely in response to the COVID-19 pandemic. At the same time, gross domestic product (GDP) declined 2.2% and the GDP proportion for health care increased 2%, reaching 19.7% compared to 17.7% in 2009. Further, in 2020, there have been significant shifts in the types of coverage, along with a decline in the number of uninsured (2). At the same time, related to the COVID-19 pandemic, there has been a significant decline in services and an increase in provider expenses in 2020 (3-5). In contrast, in 2019, national health care spending increased 4.6%, reaching \$3.8 trillion.

The global pandemic caused major disruptions to the overall economy and to health care with economic shutdowns, increased pandemic-related hospitalizations, resulting in shortages of available medical professionals and personal protective equipment (PPE). In addition, increased disease surveillance, testing and decreasing physician salaries all contributed to major changes in the way health care is being delivered. In the pain world, patients have faced challenges with decreased access and escalating deaths related to the opioid drug epidemic (6-21).

Similar to national health care expenditures increasing to \$4.1 trillion in 2020 (1), US spending on personal and public health care from 1996 to 2016 (22,23) showed the highest spending outlay of \$134.5 billion in 2016 for back and neck pain, with a 53.5% increase from 2013 to \$87.6 billion. Multiple changes have also been made in the delivery of health care with increasing regulations and oversight in the United States. These changes ultimately resulted in declining utilization and curtailed access to medically necessary treatments including interventional techniques (24-32).

The COVID-19 pandemic has exacerbated these issues (9,21). Recent studies have shown a significant deceleration of prescription opioid deaths until 2019, with escalation in 2020 (6,7), creating an opioid paradox with decreasing dosages dispensed (6). Similarly, the majority of the utilization of interventional techniques has been decreasing (24-31), except for a few interventions (32) which showed significant increases.

The utilization patterns of interventional techniques have been well studied with overall increases until 2009 and subsequently, a deceleration of utilization patterns since 2009 (24-31). Spinal cord stimulation techniques, however, have bucked the trend with increasing utilization (32). In fact, the analysis from 2009 to 2018 of utilization patterns showed a decline in utilization of interventional techniques of 6.7%, with an annual decline of 0.8% per 100,000 fee-for-service (FFS) Medicare population. Further, this data also showed a 2.6% annual decrease in the rate of utilization of epidural and adhesiolysis procedures per 100,000 population, and a 1% decrease for disc procedures and other types of nerve blocks, while there was an increase of 0.9% annually for facet joint interventions and sacroiliac joint intraarticular injections. There were also significant decreases in utilization of epidural adhesiolysis procedures, interlaminar epidural injections, and vertebral augmentation procedures (24-31). As an example, utilization patterns of percutaneous adhesiolysis procedures (28) showed a decrease of 69.2%, or an annual decrease of 12 Medicare/100,000 Medicare population from 2009 to 2018.

There is literature demonstrating the clinical and cost utility of various interventional techniques in the form of randomized controlled trials, systematic reviews, cost utility analysis, and evidence for real-world scenarios (33-65). However, there are discordant opinions and conclusions, with lack of agreement between proponents and opponents of the effectiveness and appropriateness of multiple interventional techniques and that contin-

ues (37-40,42,51,52). While the opponents cite lack of effectiveness, proponents emphasize inappropriate conclusions as the basis of discordant results. In fact, some authors describe this as an era of inappropriate evidence synthesis and application of these standards to the public in general, based in part on challenges related to confluence of interest (40,51,52).

This retrospective cohort study of the impact of COVID-19 on utilization patterns of interventional techniques and overall utilization from 2000 to 2020 updates previous publications examining the US FFS Medicare population.

METHODS

Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidance (66) was utilized in the present investigation. The public use files or non-identifiable data, which is non-attributable and non-confidential, available through the Centers for Medicare & Medicaid Services (CMS) database was utilized (67).

STUDY DESIGN

The study was designed to assess usage or utilization patterns and variables of multiple interventional techniques in managing chronic pain from 2000 to 2020 and assess the impact of the COVID-19 pandemic on utilization in the Medicare FFS population in the United States, with inclusion of the majority of interventional techniques. Excluded procedures included continuous epidurals and neurolytic procedures, trigger point injections, vertebral augmentation procedures, and implantable devices.

OBJECTIVES

Objectives of this assessment are evaluation of the impact of the COVID-19 pandemic on utilization patterns and an updated analysis of utilization patterns of interventional techniques from 2000 to 2020 in the FFS Medicare population.

SETTING

The national database of specialty usage data files from CMS in the FFS Medicare population in the United States (67).

Participants

All the participants 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 2020.

Variables

Variables assessed included the usage patterns of various procedures in the Medicare population from 2019 to 2020 to assess the impact of the COVID-19 pandemic and to analyze usage patterns from 2010 to 2019 and 2010 to 2020. In addition, multiple characteristics in reference to the Medicare population and the growth of the Medicare population were also studied.

Historically, most interventional procedures have been performed by 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). A multitude of other specialties also perform interventional procedures infrequently. Based on Medicare designations, orthopedic surgery (-20), general surgery (-17), and neurosurgery (-14) are grouped as a surgical group; diagnostic radiology (-30), and interventional radiology (-94) as radiological group; all other physicians as a separate group; and all other providers were considered as other providers.

The current procedural terminology procedure codes for interventional techniques utilized were those in effect during 2000 to 2020 as follows:

- Epidural and adhesiolysis procedures (CPT 62280, 62281, 62282, 62310, 62320-new, 62321-new, 62311, 62322-new, 62323-new, 64479, 64480, 64483, 64484, 62263, 62264)
- Facet joint interventions and sacroiliac joint blocks (CPT 64451 (from 2020) , 64470, 64472, 64475, 64476, 64490, 64491- new, 64492-new, 64493-new, 64494-new, 64495- new, 64622, 64623, 64625 (from 2020), 64626, 64627, 64633-new, 64634-new, 64635-new, 64636-new, 27096)
- Discography and disc decompression (CPT 62290, 62291, 62287)
- Other types of nerve blocks (CPT 64400, 64402, 64405, 64408, 64410, 64412, 64413, 64417, 64420, 64421, 64425, 64430, 64445, 64454 (from 2020), 64505, 64510, 64520, 64530, 64600, 64605, 64610, 64613, 64620, 64624 (from 2020), 64630, 64640, 64680).

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

Data Sources

All the analyzed data were obtained from the CMS Physician/Supplier Procedure Summary Master Data from 2000 to 2020 (67). These data included all FFS Medicare participants below the age of 65 and above the age of 65 receiving interventional techniques irrespective of the type of disability.

Measures

The CMS 100% dataset consists of procedure codes (primary procedure, add-on, and bilateral), specialty codes, place of service, total services, and allowed and denied services. The usage pattern analysis included all allowed services configured by taking services submitted minus services denied and any services with zero payments and excluding type of service code equal 8 or F. Allowed services were assessed for each procedure, and rates were calculated based on Medicare beneficiaries for the corresponding year and are reported as procedures per 100,000 Medicare beneficiaries.

Bias

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

Study Size

The study size is large with the inclusion of all patients under Medicare FFS undergoing interventional procedures in all settings for all regions in the United States for chronic spinal pain from 2000 to 2020.

Data Compilation

The data were compiled using Microsoft Access 2020 and Microsoft Excel 2020 (Microsoft Corporation, Redmond, WA).

RESULTS

Participants

Participants in this assessment included all FFS Medicare recipients from 2000, 2010 to 2020.

Descriptive Data of Population Characteristics

As shown in Table 1, from 2010 to 2020, the US population older than 65 years of age increased 38.9% at an annual growth rate of 3.3%, compared to the

total US population of 7.2% at an annual growth rate of 0.7% from 2010 to 2020. The US population grew at an annual rate of 0.9% from 2000 to 2010, compared to 0.7% from 2010 to 2020. In contrast, those aged 65 or older grew at an annual rate of 1.4% from 2000 to 2010, compared to 3.3% from 2010 to 2020. The number of individuals participating in Medicare grew at an annual rate of 2.3%, 1.7%, and 2.9% from 2000 to 2020, 2000 to 2010, and 2010 to 2020 respectively.

The rate of interventional pain management services per 100,000 individuals of the Medicare population declined from 2010 to 2019 at an annual rate of 0.4%, whereas, from 2010 to 2020, the decrease was 2.5%, with a decrease from 2019 to 2020 of 18.7%. In contrast, an annual growth rate of 10.2% was reported from 2000 to 2010. Figure 1 shows a comparative analysis of the annual growth of Medicare participants, utilization of interventional pain management services, and rate (per 100,000 Medicare population).

Utilization Characteristics

Table 2 and Figs. 2 to 6 show the utilization characteristics of interventional techniques in the FFS Medicare population from 2000 to 2020.

Table 2 and Fig. 2 and 3 show a decline of overall interventional techniques at an annual rate of 18.7% per 100,000 Medicare recipients, with epidural and adhesiolysis procedures declining at 19.0% and 17.5% and for facet joint interventions, sacroiliac joint blocks, disc procedures and other types of nerve blocks the decline was 25.4%, from 2019 to 2020.

Further analysis showed rather significant increases from 2000 to 2010 with an annual rate of 8.1% for epidural and adhesiolysis procedures, 14.4% for facet joint interventions and sacroiliac joint blocks, 6.7% for disc procedures and other types of nerve blocks with an overall increase of 10.2% respectively. The data also showed a declining trend from 2010 to 2019 with an annual rate of growth decline of 3.1% for epidural and adhesiolysis procedures, an increase of 2.1% for facet joint interventions and sacroiliac joint blocks, and a decrease of 0.8% for disc procedures and other types of nerve blocks, with an annualized decrease in overall utilization of all interventional techniques included in this analysis of 0.4%. In contrast, with contributions of COVID-19 declines of 17.5% to 20.4%, changes from 2010 to 2020 showed an annualized decrease of 2.5% with epidural and adhesiolysis procedures, facet joint interventions and sacroiliac joint blocks decreasing 0.01%, and disc procedures and other types of nerve blocks decreasing 3.6% annualized. Figure 3 shows

Impact COVID-19 Pandemic and Updated Assessment of Utilization of Interventional Techniques

Table 1. Summary of the frequency of utilization of various categories of interventional procedures in the fee-for-service Medicare population from 2000 to 2020.

Year	U.S. Population		Fee-for-service Medicare Beneficiaries			Utilization of all interventional techniques			
	Total Population (,000)	≥ 65 Years (,000) Percent	Number of individuals participating in Medicare	≥ 65 years (,000) (Percent)	< 65 years (,000) Percent	Allowed Services	PCFPY	Rate Per 100,000 Medicare Beneficiaries	PCFPY
Y2000	282,172	35,077 (12.40%)	39,632 (14.00%)	34,262 (86.50%)	5,370 (13.50%)	1,469,495		3,708	
Y2010	308,746	40,268 (13.00%)	46,914 (15.2%)	38,991 (83.11%)	7,923 (16.89%)	4,578,977	-1.4%	9,760	-3.8%
Y2011	311,583	41,370 (13.28%)	48,300 (15.5%)	40,000 (82.82%)	8,300 (17.18%)	4,815,673	5.2%	9,970	2.2%
Y2012	313,874	43,144 (13.75%)	50,300 (16.0%)	41,900 (83.30%)	8,500 (16.90%)	4,947,974	2.7%	9,837	-1.3%
Y2013	316,129	44,704 (14.14%)	51,900 (16.4%)	43,100 (83.04%)	8,800 (16.96%)	4,932,950	-0.3%	9,505	-3.4%
Y2014	318,892	46,179 (14.48%)	53,500 (16.8%)	44,600 (83.36%)	8,900 (16.64%)	5,025,904	1.9%	9,394	-1.2%
y2015	320,897	47,734 (14.88%)	54,900 (17.1%)	46,000 (83.79%)	9,000 (16.39%)	5,243,036	4.3%	9,550	1.7%
Y2016	323,127	49,244 (15.24%)	56,500 (17.5%)	47,500 (84.07%)	9,000 (15.93%)	5,509,306	5.1%	9,751	2.1%
Y2017	326,625	51,055 (15.63%)	58,000 (17.8%)	49,200 (84.83%)	8,900 (15.34%)	5,558,893	0.9%	9,584	-1.7%
Y2018	327,167	52,423 (16.02%)	59,600 (18.2%)	50,800 (85.23%)	8,800 (14.77%)	5,639,608	1.5%	9,462	-1.3%
Y2019	328,293	54,074 (16.47%)	61,200 (18.6%)	52,600 (85.95%)	8,700 (14.22%)	5,736,488	1.7%	9,373	-0.9%
Y2020	331,002	55,939 (16.90%)	62,600 (18.9%)	54,100 (86.42%)	8,500 (13.58%)	4,767,569	-16.9%	7616	-18.7%
2000-2020 Change	17.3%	59.5%	58.0%	57.9%	58.3%	224.4%		105.4%	
GM	0.8%	2.4%	2.3%	2.3%	2.3%	6.1%		3.7%	
Change 2000-2010	9.4%	14.8%	18.4%	13.8%	47.5%	211.6%		163.2%	
GM	0.9%	1.4%	1.7%	1.3%	4.0%	12.0%		10.2%	
2010-2019 Change	6.3%	34.3%	30.5%	34.9%	9.8%	25.3%		-4.0%	
GM	0.7%	3.3%	3.0%	3.4%	1.0%	2.5%		-0.4%	
2010-2020 Change	7.2%	38.9%	33.4%	38.7%	7.3%	4.1%		-22.0%	
GM	0.7%	3.3%	2.9%	3.3%	0.7%	0.4%		-2.5%	
2019-2020 change	0.8%	3.4%	2.3%	2.9%	-2.3%	-16.9%		-18.7%	

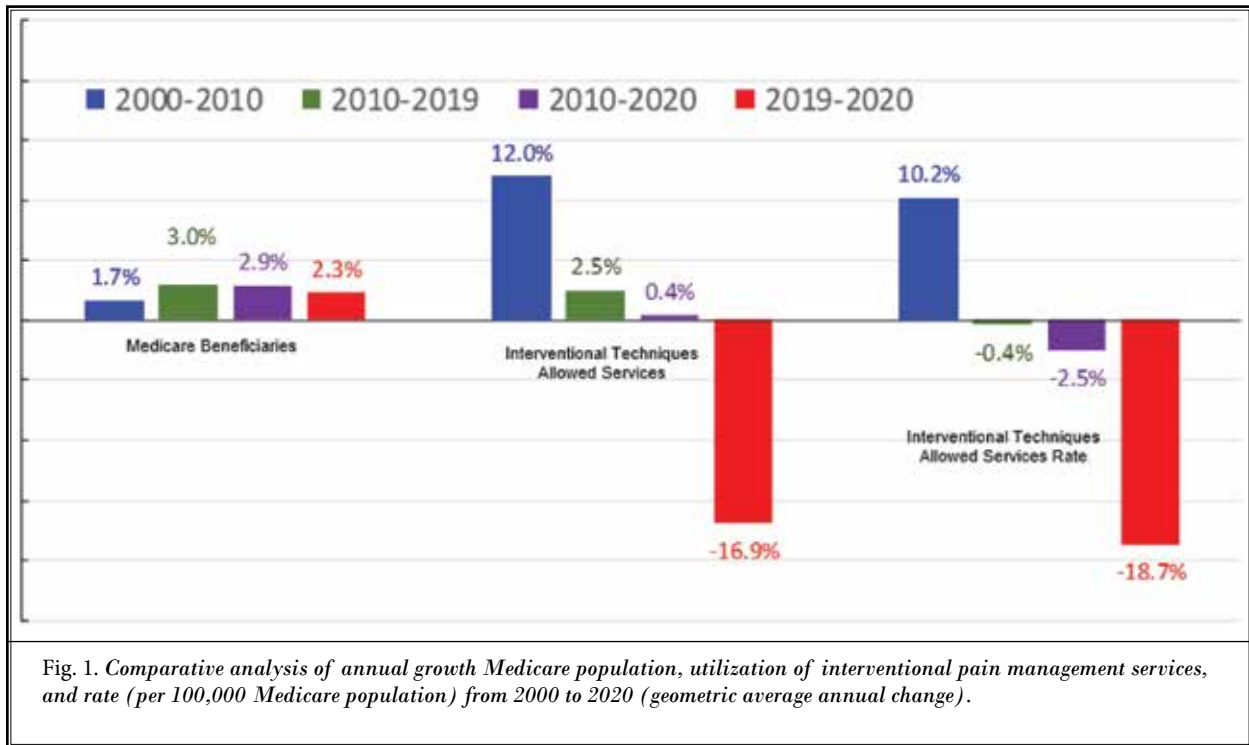
GM – Geometric average annual change

(Excluding continuous epidurals, intraarticular injections, trigger point and ligament injections, peripheral nerve blocks, vertebral augmentation procedures, and implantables)

PCFPY – Percentage of change from previous year

the distribution of procedural characteristics rates by type of procedures from 2000 to 2020 with changing patterns.

In 2000, epidural and adhesiolysis procedures constituted 58.9% of all procedures, whereas in 2010 they constituted



48.6% of all procedures, significantly declining to 38.2% of all procedures in 2020. Facet joint interventions and sacroiliac joint blocks showed reversing patterns with an increasing share over the years from 28.9% in 2000 to 54.5% in 2020.

Specialty Characteristics

Table 3 and Fig. 4 show frequency of utilization of interventional pain management techniques based on specialty designation.

Site-of Service Characteristics

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

Services Compared to Rate

This analysis provides both total number of services and rate per 100,000 population from 2000 to 2020 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.

DISCUSSION

This assessment of utilization data of interventional techniques for chronic pain in the Medicare FFS population was performed from 2000 to 2020, with special emphasis on changes from 2019 to 2020 related to the COVID-19 pandemic. This article provides data from 2000 onwards, with calculation of the utilization patterns from 2000 to 2010, 2010 to 2019, and 2010 to 2020 with an assessment of the devastating effect of COVID-19 on utilization patterns of interventional techniques. This analysis included the majority of interventional techniques except for vertebral augmentation procedures and neuromodulation procedures including spinal cord stimulation and intrathecal infusion systems. The data from 2010 to 2019 showed a 0.4% annualized decrease in utilization patterns of all interventional techniques. Further, the results showed a decline of interventional techniques at an annual rate of 2.5% with an overall reduction in services of 22% per 100,000 FFS Medicare recipients from 2010 to 2020. This analysis showed from 2019 to 2020 there was a prominent decrease of overall interventional techniques of 18.7% per 100,000 Medicare beneficiaries as shown in Table 1 and Fig. 1. Thus, the effect of COVID-19 influenced significant reductions in overall utilization patterns from 2010 to 2020.

Analysis of various groups of procedures which

Impact COVID-19 Pandemic and Updated Assessment of Utilization of Interventional Techniques

Table 2. Frequency of utilization interventional techniques in the fee-for-service Medicare population from 2000 to 2020.

	Epidural and adhesiolysis procedures			Facet joint interventions and Sacroiliac joint blocks			Disc Procedures and other types of nerve blocks			Utilization of all interventional techniques*		
	Allowed Services (Facility)	PCFPY	Rate	Allowed Services (Facility)	PCFPY	Rate	Allowed Services (Facility)	PCFPY	Rate	Allowed Services (Facility)	PCFPY	Rate
2000	860,787 (79%)	7.2%	2,172	424,796 (67%)	39.5%	1,072	183,912 (87%)	14.3%	464	1,469,495 (72%)		3,708
2010	2,226,486 (57%)	4.2%	4,746	1,937,582 (48%)	-8.2%	4,130	414,909 (62%)	4.3%	884	4,578,977 (52%)	-1.4%	9,760
2011	2,309,906 (58%)	3.7%	4,782	2,064,227 (50%)	6.5%	4,274	441,540 (61%)	6.4%	914	4,815,673 (48%)	5.2%	9,970
2012	2,324,563 (58%)	0.6%	4,621	2,159,057 (50%)	4.6%	4,292	464,354 (57%)	5.2%	923	4,947,974 (53%)	2.7%	9,837
2013	2,278,790 (58%)	-2.0%	4,391	2,197,766 (51%)	1.8%	4,235	456,394 (51%)	-1.7%	879	4,932,950 (53%)	-0.3%	9,505
2014	2,273,104 (57%)	-0.2%	4,249	2,370,000 (50%)	7.8%	4,430	382,800 (47%)	-16.1%	716	5,025,904 (52%)	1.9%	9,394
2015	2,291,001 (57%)	0.8%	4,173	2,568,428 (50%)	8.4%	4,678	383,607 (44%)	0.2%	699	5,243,036 (53%)	4.3%	9,550
2016	2,329,062 (58%)	1.7%	4,122	2,759,559 (52%)	7.4%	4,884	420,685 (45%)	9.7%	745	5,509,306 (54%)	5.1%	9,751
2017	2,258,726 (54%)	-3.0%	3,894	2,862,876 (49%)	3.7%	4,936	437,289 (43%)	3.9%	754	5,558,893 (51%)	0.9%	9,584
2018	2,196,060 (54%)	-2.8%	3,685	2,970,100 (50%)	3.7%	4,983	473,448 (44%)	8.3%	794	5,639,608 (51%)	1.5%	9,462
2019	2,192,562 (57%)	-0.2%	3,583	3,040,164 (53%)	2.4%	4,968	503,762 (49%)	6.4%	823	5,736,488 (54%)	1.7%	9,373
2020	1,816,786 (55%)	-17.1%	2,902	2,566,014 (52%)	-15.6%	4,099	384,569 (45%)	-23.7%	614	4,767,369 (52%)	-16.9%	7,616
Change 2000-2020	111.1%		33.6%	504.1%		282.4%	109.1%		32.4%	224.4%		105.4%
GM	3.8%		1.5%	9.4%		6.9%	3.8%		1.4%	6.1%		3.7%
Change 2000-2010	158.7%		118.5%	356.1%		285.3%	125.6%		90.6%	211.6%		163.2%
GM	10.0%		8.1%	16.4%		14.4%	8.5%		6.7%	12.0%		10.2%
2010-2019	-1.5%		-24.5%	56.9%		20.3%	21.4%		-6.9%	25.3%		-4.0%
GM	-0.2%		-3.1%	5.1%		2.1%	2.2%		-0.8%	2.5%		-0.4%
Change 2010-2020	-18.4%		-38.8%	32.4%		-0.8%	-7.3%		-30.5%	4.1%		-22.0%
GM	-2.0%		-4.8%	2.8%		-0.01%	-0.8%		-3.6%	0.4%		-2.5%
Change 2019-2020	-17.1%		-19.0%	-15.6%		-17.5%	-23.7%		-25.4%	-16.9%		-18.7%

PCFPY – Percentage of change from previous year

federal assistance, both Medicare and Medicaid expenditures for physician and clinical services slowed in 2020.

Medicare spending increased 0.5%, down from 8.9% in 2019 with the deceleration driven by a decline in FFS

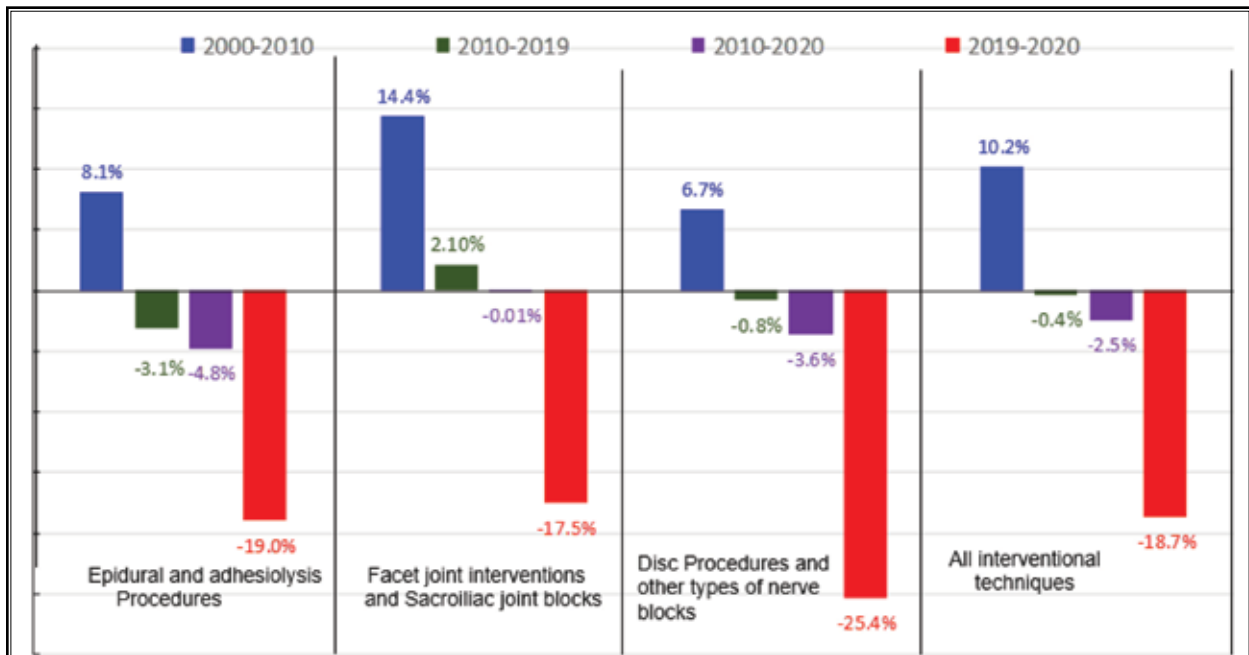


Fig. 2. Comparative analysis of rate (per 100,000 Medicare recipients) of usage patterns for epidural and adhesiolysis procedures, facet joint interventions and sacroiliac joint blocks, disc procedures and other types of nerve blocks, all interventional techniques (geometric average annual change in rates).

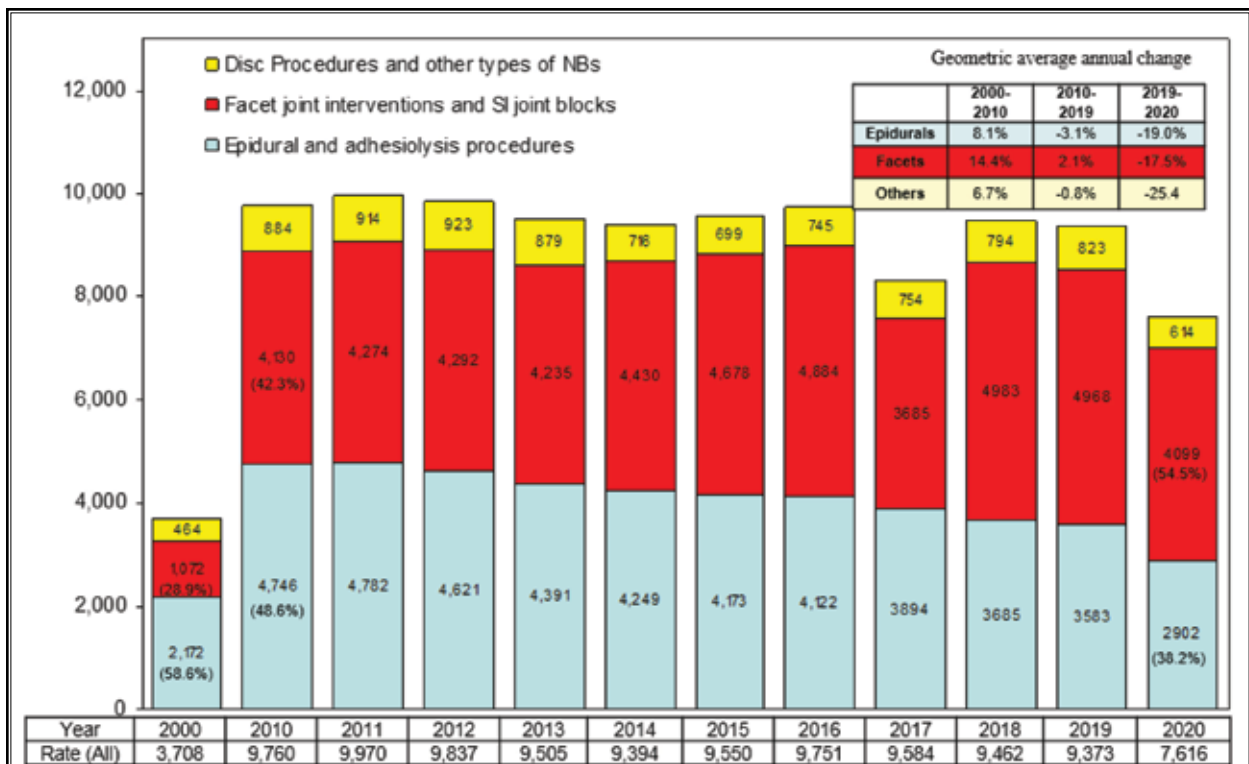


Fig. 3. Distribution of procedural characteristics (rates) by type of procedures from 2000 to 2020.

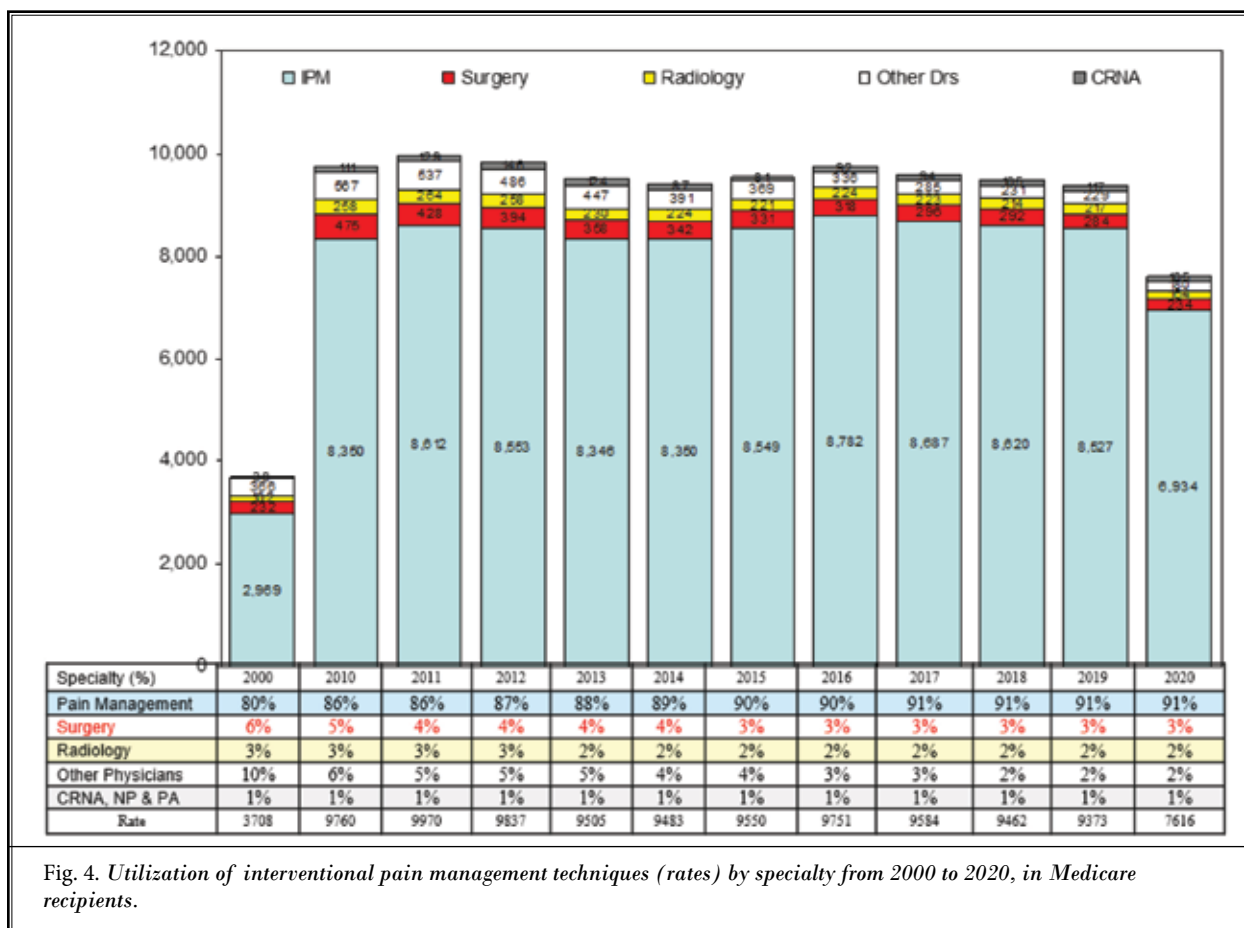


Fig. 4. Utilization of interventional pain management techniques (rates) by specialty from 2000 to 2020, in Medicare recipients.

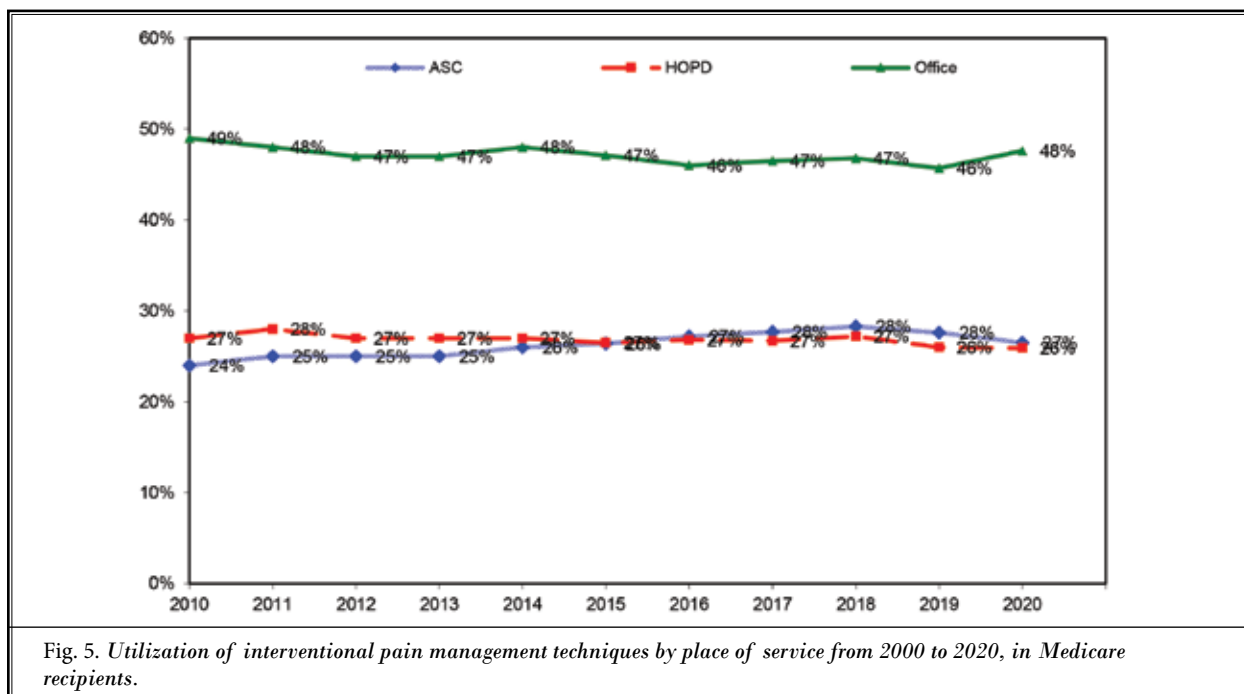


Fig. 5. Utilization of interventional pain management techniques by place of service from 2000 to 2020, in Medicare recipients.

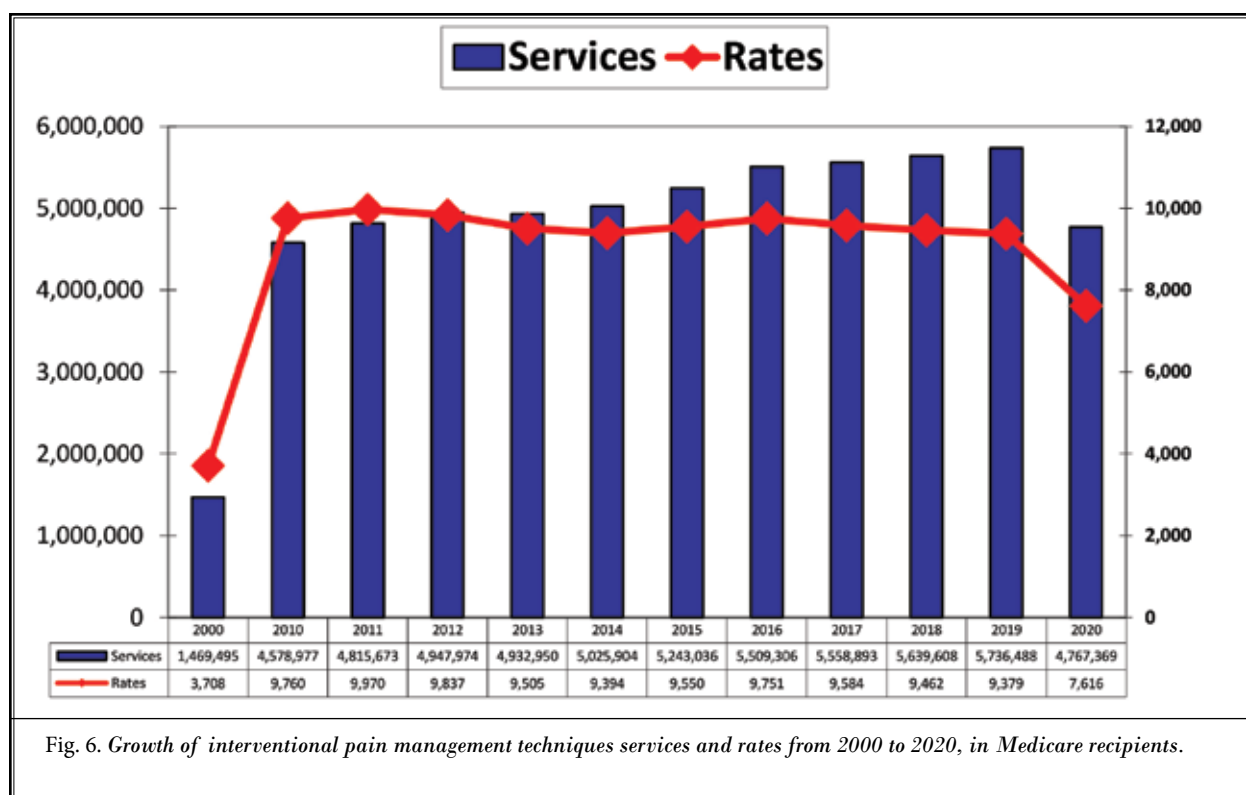


Fig. 6. Growth of interventional pain management techniques services and rates from 2000 to 2020, in Medicare recipients.

included epidural and adhesiolysis procedures showed a decline of 4.8% annually from 2010 to 2020, facet joint interventions and sacroiliac joint blocks showed an annual decline of 0.01%, and disc procedures and other types of nerve blocks showed a decline of 3.6% annually. This data reflects the fact that due to the COVID-19 pandemic from 2019 to 2020, overall utilization decreased 18.7%, with a 17.5% decrease for facet joint interventions and sacroiliac joint blocks and a 25.4% decrease for disc procedures and other types of nerve blocks. To eliminate this COVID-19 effect, the data was also assessed from 2000 to 2019, which demonstrated an annual decrease of interventional techniques of 0.4%, 3.1% for epidural and adhesiolysis procedures, increase of 2.1% for facet joint interventions and sacroiliac joint blocks, and a decrease of 0.8% for disc procedures and other types of nerve blocks. Thus, the data from 2000 to 2019, or 2010 to 2019, or 2010 to 2020, are in stark contrast to utilization patterns of 2000 to 2010, which showed an annual increase of 10.2%, with 8.1% for epidural and adhesiolysis procedures, 14.4% for facet joint interventions and sacroiliac joint blocks, and 6.7% annually, for disc procedures and other types of nerve blocks with a 10.2% annual increase in utilization patterns of all interventional techniques. The data

from 2010 to 2018 are in concordance with previously published data illustrating a gradual decline in utilization patterns of interventional techniques.

This study and its overall assessment showed higher population growth as well as Medicare beneficiary growth with no decline in US population or Medicare beneficiaries from 2019 to 2020. However, the data also showed that increases were significant from 2010 to 2020 with the percent of population change total of 38.9% for an annual rate of 3.3% compared to the growth of the Medicare population of 33.4% overall and at an annual rate of 2.9%. In contrast the US population changed 14.8% overall with an annual increase of 1.4% and the Medicare population increased 18.4% with an annual increase of 1.7% from 2000 to 2010. Thus, the growth patterns of interventional techniques are below the Medicare annualized growth of 2.9% and the overall population growth of 3.3%. Surprisingly, the US population growth stayed at 3.4%, whereas the Medicare population growth declined 2.3% from 2019 to 2020 compared to a 2.5% annual decline and an 18.7% overall decrease in interventional techniques from 2019 to 2020.

There was no significant difference in utilization patterns among the various specialties with the major-

Table 3. Frequency of utilization of interventional pain management techniques from 2010 to 2020, in fee-for-service Medicare recipients.

Specialty	Interventional Pain Management #		Surgical (neuro, general, & orthopedic)		Radiology (interventional & diagnostic)		Other Physicians		Other Providers (CRNA, NP & PA)		Total	
	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate
2000	1,176,541 (80.1%)	2,969	92,126 (6.3%)	232	40,491 (2.8%)	102	145,100 (9.9%)	366	15,237 (1.0%)	38	1,469,495	3,708
2010	3,917,426 (85.6%)	8,350	222,784 (4.9%)	475	121,127 (2.6%)	258	265,771 (5.8%)	567	51,869 (1.1%)	111	4,578,977	9,760
2011	4,159,585 (86.4%)	8,612	206,805 (4.3%)	428	127,614 (2.6%)	264	259,177 (5.4%)	537	62,492 (1.3%)	129	4,815,673	9,970
2012	4,302,121 (86.9%)	8,553	197,982 (4.0%)	394	129,823 (2.6%)	258	244,626 (4.9%)	486	73,422 (1.5%)	146	4,947,974	9,837
2013	4,331,789 (87.8%)	8,346	185,630 (3.8%)	358	119,172 (2.4%)	230	231,899 (4.7%)	447	64,460 (1.3%)	124	4,932,950	9,505
2014	4,467,374 (88.9%)	8,350	183,111 (3.6%)	342	119,684 (2.4%)	224	209,379 (4.2%)	391	46,356 (0.9%)	87	5,025,904	9,394
2015	4,693,156 (89.5%)	8,549	181,546 (3.5%)	331	121,344 (2.3%)	221	202,307 (3.9%)	369	44,683 (0.9%)	81	5,243,036	9550
2016	4,961,640 (90.1%)	8,782	179,880 (3.3%)	318	126,493 (2.3%)	224	189,573 (3.4%)	336	51,720 (0.9%)	92	5,509,306	9751
2017	5,038,383 (90.6%)	8,687	171,767 (3.1%)	296	129,098 (2.3%)	223	165,219 (3.0%)	285	54,426 (1.0%)	94	5,558,893	9584
2018	5,137,539 (91.1%)	8,620	174,072 (3.1%)	292	127,612 (2.3%)	214	137,855 (2.4%)	231	62,530 (1.1%)	105	5,639,608	9462
2019	5,218,668 (91.0%)	8,527	173,724 (3.0%)	284	132,762 (2.3%)	217	139,875 (2.4%)	229	71,459 (1.2%)	117	5,736,488	9,373
2020	4,340,386 (91.%)	6,934	146,494 (3.1%)	234	102,369 (2.1%)	164	112,292 (2.4%)	180	65,828 (1.4%)	105	4,767,369	7,616
Change 2000-2010	268.9%	133.6%	59.0%	0.7%	152.8%	60.1%	-22.6%	-50.9%	332.0%	173.5%	224.4%	105.4%
GM change	6.7%	4.3%	2.3%	0.0%	4.7%	2.4%	-1.3%	-3.5%	7.6%	5.2%	6.1%	3.7%
Change 2000-2010	233.0%	181.3%	141.8%	104.3%	199.1%	152.7%	83.2%	54.7%	240.4%	187.6%	211.6%	163.2%
GM	12.8%	10.9%	9.2%	7.4%	11.6%	9.7%	6.2%	4.5%	13.0%	11.1%	12.0%	10.2%
Change 2010-2020	10.8%	-17.0%	-34.2%	-50.7%	-15.5%	-36.7%	-57.7%	-68.3%	26.9%	-4.9%	4.1%	-22.0%
GM	1.0%	-1.8%	-4.1%	-6.8%	-1.7%	-4.5%	-8.2%	-10.8%	2.4%	-0.5%	0.4%	-2.5%

Table 3 (cont.). Frequency of utilization of interventional pain management techniques from 2010 to 2020, in fee-for-service Medicare recipients.

Specialty	Interventional Pain Management #		Surgical (neuro, general, & orthopedic)		Radiology (interventional & diagnostic)		Other Physicians		Other Providers (CRNA, NP & PA)		Total	
	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate	Allowed Services (Facility)	Rate
Change 2019-2020	-16.8%	-18.7%	-15.7%	-17.6%	-22.9%	-24.6%	-19.7%	-21.4%	-7.9%	-9.9%	-16.9%	-18.7%

Rate - IPM services per 100,000 Medicare beneficiaries () percentage of row total. GM - Geometric average annual change

ity of procedures being performed by interventional pain management specialties, accounting for 91% with all other specialties accounting for the remaining 9% (Fig. 4). As shown in Fig. 5, utilization of interventional pain management techniques by place of service also stayed similar to our previous publications but office procedures increased slightly from 46% to 48% in 2019 to 2020, while hospital outpatient services decreased by 1% with ambulatory surgery center procedures remaining the same.

This analysis is similar to our previous publications with appropriate analysis of differentiation of years from 2000 to 2010, 2010 to 2019, 2010 to 2020, and 2019 to 2020. Significant changes prior to COVID-19 may be attributed to changing medical policies and local coverage determinations which ultimately may affect access to these interventions (68-76). In addition, multiple changes in insurance policies with high copays and deductibles, specifically during the 2020 COVID-19 pandemic have contributed to declines in 2019 to 2020.

While health care expenditures increased due to COVID-19, private health insurance spending decreased by 1.2% because of the decline in enrollment and lower utilization related to the COVID-19 pandemic. This accounted for 28% of the total health care expenditures, or \$1.15 trillion in 2020 (1). Further, total private health insurance spending for medical goods and services declined 3.5% in 2020 to \$1 trillion secondary to pandemic-related reductions in health care use. This was particularly true for some elective procedures and was combined with economic shutdowns and moratoria on certain procedures that resulted in a 5.9% decrease in hospital care, 2.6% in physician and clinical services, and 3.8% for dental services (1). Similar to private insurance, Medicare spend-

ing also showed a deceleration to a 3.5% growth rate in 2020, compared to 6.9% in 2019 (21). Thus, Medicare spending accounted for \$829.5 billion in 2020, driven by the slower growth in expenditures for hospital care and physician and clinical services. Similarly, Medicare private plan spending, which accounted for 45% of the total Medicare expenditures in 2020, increased 17.1% in 2020, an acceleration from a growth of 15.3% in 2019. This was related to an increase in enrollment of 9.5% in 2020, representing 40% of the total Medicare enrollment. Finally, as a share of total Medicare spending, FFS expenditures accounted for 55% in 2020, down from a share of 61% in 2019. The decrease was caused by a 5.5% decline in expenditures for health care goods and services – the first such decline in spending since 1999.

In contrast to private insurance and Medicare, Medicaid spending increased 9.2% in 2020, its fastest rate of growth since 2014 after the expansion of the Affordable Care Act. This represented a rate approximately 3 times faster than the growth of 3% in 2019 and was influenced primarily by the increased enrollment due to the loss of private insurance and multiple other factors.

While overall hospital care increased to \$1.3 trillion, a 31% share of national health spending, the 6.4% growth in 2020 was similar to that of 6.3% in 2019 (1,2). Similarly, spending for physician and clinical services also increased 5.4% in 2020, reaching \$809.5 billion and representing a 20% of total health care expenditures which was higher than the growth rate in 2019 of 4.2% (1,2). The expenditures for hospital care and physician and clinical services are based on federal assistance, including the Paycheck Protection Program (PPP) loans and provider relief fund. Without considering

expenditures. Medicaid spending grew 4% in 2020 after increasing 6.5% in 2019, due to increased enrollment.

Limitations of the current study, as all other similar studies, include its retrospective nature, the lack of differentiation of individual procedures in each category and the lack of inclusion of Medicare Advantage enrollees, which constitute approximately 30% of the Medicare population. Further, this analysis does not identify specific approaches with each modality of treatment in the various categories, such as facet joint nerve blocks versus radiofrequency neurotomy, and interlaminar epidural versus transforaminal epidural injections.

CONCLUSION

The present investigation demonstrated that from 2010 to 2020, not only was there a reversal of growth patterns of interventional pain procedures, but also actual declines in procedures, despite increases in the total US population, elderly population, and the number of Medicare recipients. The data demonstrated an overall decrease of utilization of interventional techniques of 18.7% from 2019 to 2020, whereas from 2010 to 2019, there was a reversal of growth patterns with a decrease of 0.4% annually. The overall COVID-19 pandemic effect resulted in an escalation from 2010 to 2020 with annual decreases of 2.5% and an overall 22% decline per 100,000 Medicare recipients. Further, higher decreases and utilization patterns were shown for disc procedures and other types of nerve blocks, followed by epidural and adhesiolysis procedures, without a decrease in facet joint interventions and sacroiliac joint blocks.

Author Contributions

The study was designed by LM, JH, and VP. Statistical analysis was performed by VP.

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

Conflicts of Interest

Dr. Beall is a consultant for Medtronic, Merit Medical, IZI, Techlamed, Boston Scientific, Stryker, Lenoss Medical, Spine BioPharma, Piramal, ReGelTec, Spinal Simplicity, Smart Soft, Tissue Tech, Vivex, Stratus Medical, Genesys, Abbott, Eliquence, SetBone Medical, Amber Implants, and Cerapedics.

Dr. Shah is a consultant for Masimo Corporation, Allergan Inc., and SPR Therapeutics.

Dr. Soin is the founder and CEO of Soin Neuroscience, which is developing a spinal cord stimulator to treat spinal pain and has a patent for Soin Neuroscience, Jan One, and Avanos and a patent pending for Soin Therapeutics.

Dr. Hirsch is a consultant for Medtronic and Senior Affiliate Research Fellow at the Neiman Policy Institute.

Dr. Abd-Elseyed is a consultant of Medtronic, Avanos, Abott, Sprint, and Averitas.

Acknowledgments

The authors wish to thank Vidyasagar Pampati, MSc, for statistical assistance, and Bert Fellows, MA, Director Emeritus of Psychological Services at Pain Management Centers of America, for manuscript review, and Tonie M. Hatton and Diane E. Neihoff, transcriptionists, for their assistance in preparation of this manuscript. We would like to thank the editorial board of Pain Physician for review and criticism in improving the manuscript.

REFERENCES

- Hartman M, Martin AB, Washington B, Catlin A, The National Health Expenditure Accounts Team. National health care spending in 2020: Growth driven by federal spending in response to the COVID-19 pandemic. *Health Aff (Millwood)* 2022; 41:13-25.
- Martin AB, Hartman M, Lassman D, Catlin A; National Health Expenditure Accounts Team. National Health Care Spending In 2019: Steady growth for the fourth consecutive year. *Health Aff (Millwood)* 2021; 40:14-24.
- Cox C, Amin K, Kamal R. How have health spending and utilization changed during the coronavirus pandemic? *Health System Tracker*, March 22, 2021. Accessed 01/06/2022. www.healthsystemtracker.org/chart-collection/how-have-healthcare-utilization-and-spending-changed-so-far-during-the-coronavirus-pandemic/
- Martin K, Kurowski D, Given P, Kennedy K, Clayton E. The impact of COVID-19 on the use of preventative health care. *Health Care Cost Institute*, April 16, 2021. Accessed 01/06/2022. <https://healthcostinstitute.org/hcci-research/the-impact-of-covid-19-on-the-use-of-preventive-health-care>
- Trends in health care expenditures, American Medical Association. Accessed 01/06/2022. www.ama-assn.org/about/research/trends-health-care-spending
- Manchikanti L, Singh VM, Staats PS, et al. Fourth wave of opioid (illicit drug) overdose deaths and diminishing access to prescription opioids and interventional techniques: Cause and effect. *Pain Physician* 2022; 25:97-124.
- Manchikanti L, Vanaparthi R, Atluri S, Sachdeva H, Kaye AD, Hirsch JA.

- COVID-19 and the opioid epidemic: Two public health emergencies that intersect with chronic pain. *Pain Ther* 2021; 10:269-286.
8. Wahezi SE, Duarte RA, Yerra S, et al. Telemedicine during COVID-19 and beyond: A practical guide and best practices multidisciplinary approach for the orthopedic and neurologic pain physical examination. *Pain Physician* 2020; 23:S205-S238.
 9. Jha SS, Shah S, Calderon MD, Soin A, Manchikanti L. The effect of COVID-19 on interventional pain management practices: A physician burnout survey. *Pain Physician* 2020; 23:S271-S282.
 10. Gharaei H, Diwan S. COVID-19 pandemic: Implications on interventional pain practice-a narrative review. *Pain Physician* 2020; 23:S311-S318.
 11. Eccleston C, Blyth FM, Dear BF, et al. Managing patients with chronic pain during the COVID-19 outbreak: Considerations for the rapid introduction of remotely supported (eHealth) pain management services. *Pain* 2020; 161:889-893.
 12. Shah S, Diwan S, Soin A, et al. Evidence-based risk mitigation and stratification during COVID-19 for return to interventional pain practice: American Society of Interventional Pain Physicians (ASIPP) Guidelines. *Pain Physician* 2020; 23:S161-S182.
 13. Gharibo C, Sharma A, Soin A, et al. Triaging interventional pain procedures during COVID-19 or related elective surgery restrictions: Evidence-informed guidance from the American Society of Interventional Pain Physicians (ASIPP). *Pain Physician* 2020; 23:S183-S204.
 14. Atluri S, Manocha V, Boddu N, et al. Safety and effectiveness of intravascular mesenchymal stem cells to treat organ failure and possible application in COVID-19 complications. *Pain Physician* 2020; 23:S391-S420.
 15. Puntillo F, Giglio M, Brienza N, et al. Impact of COVID-19 pandemic on chronic pain management: Looking for the best way to deliver care. *Best Pract Res Clin Anaesthesiol* 2020; 34:529-537.
 16. Zhang M, Zheng H, Wang J. Considerations when COVID-19 pandemic collides opioid crisis: What we should know? *J Anes Perio Manag* 2020; 4:009.
 17. Heath C, Sommerfield A, von Ungern-Sternberg BS. Resilience strategies to manage psychological distress among healthcare workers during the COVID-19 pandemic: A narrative review. *Anaesthesia* 2020; 10:1364-1371.
 18. Dubey MJ, Ghosh R, Chatterjee S, Biswas P, Chatterjee S, Dubey S. COVID-19 and addiction. *Diabetes Metab Syndr* 2020; 14:817-823.
 19. Alexander GC, Stoller KB, Haffajee RL, Saloner B. An epidemic in the midst of a pandemic: Opioid use disorder and COVID-19. *Ann Intern Med* 2020; 3:57-58.
 20. Dubey S, Biswas P, Ghosh R, et al. Psychosocial impact of COVID-19. *Diabetes Metab Syndr* 2020; 14:779-788.
 21. Manchikanti L, Pampati V, Jha S, et al. The impact of COVID-19 on interventional pain management practices is significant and long-lasting: An interventional pain management physician survey. *Pain Physician* 2022; 25:131-144.
 22. Dieleman JL, Baral R, Birger M, et al. US spending on personal health care and public health, 1996-2013. *JAMA* 2016; 316:2627-2646.
 23. Dieleman JL, Cao J, Chapin A, et al. US health care spending by payer and health condition, 1996-2016. *JAMA* 2020; 323:863-884.
 24. 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.
 25. Manchikanti L, Sanapati MR, Soin A, et al. An updated analysis of utilization of epidural procedures in managing chronic pain in the Medicare population from 2000 to 2018. *Pain Physician* 2020; 23:111-126.
 26. Manchikanti L, Sanapati MR, Pampati V, et al. Update of utilization patterns of facet joint interventions in managing spinal pain from 2000 to 2018 in the US fee-for-service Medicare population. *Pain Physician* 2020; 23:E133-E149.
 27. Manchikanti L, Manchikanti MV, Vanaparthi R, Kosanovic R, Pampati V. Utilization patterns of sacroiliac joint injections from 2000 to 2018 in fee-for-service Medicare population. *Pain Physician* 2020; 23:439-450.
 28. Manchikanti L, Kosanovic R, Pampati V, Kaye AD. Declining utilization patterns of percutaneous adhesiolysis procedures in the fee-for-service (FFS) Medicare population. *Pain Physician* 2021; 24:17-29.
 29. Manchikanti L, Pampati V, Soin A, Sanapati MR, Kaye AD, Hirsch JA. Declining utilization and inflation-adjusted expenditures for epidural procedures in chronic spinal pain in the Medicare population. *Pain Physician* 2021; 24:1-15.
 30. Manchikanti L, Pampati V, Soin A, et al. Trends of expenditures and utilization of facet joint interventions in fee-for-service (FFS) Medicare population from 2009-2018. *Pain Physician* 2020; 23:S129-S147.
 31. Manchikanti L, Senapathi SHV, Milburn JM, et al. Utilization and expenditures of vertebral augmentation continue to decline: An analysis in fee-for-service (FFS) Recipients from 2009 to 2018. *Pain Physician* 2021; 24:401-415.
 32. Manchikanti L, Pampati V, Vangala BP, et al. Spinal cord stimulation trends of utilization and expenditures in fee-for-service (FFS) Medicare population from 2009 to 2018. *Pain Physician* 2021; 24:293-308.
 33. Cho JH, Lee JH, Song KS, et al. Treatment outcomes for patients with failed back surgery. *Pain Physician* 2017; 20:E29-E43.
 34. 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.
 35. 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.
 36. 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 meta-analysis. *Spine J* 2018; 18:2343-2353.
 37. Oliveira CB, Maher CG, Ferreira ML, et al. Epidural corticosteroid injections for lumbosacral radicular pain. *Cochrane Database Syst Rev* 2020; 4:CD013577.
 38. Manchikanti L, Knezevic E, Knezevic NN, et al. Epidural injections for lumbar radiculopathy or sciatica: A comparative systematic review and meta-analysis of Cochrane review. *Pain Physician* 2021; 24:E539-E554.

39. 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.
40. 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.
41. Manchikanti L, Kosanovic R, Vanaparthi R, et al. Steroid distancing in interventional pain management during COVID-19 and beyond: Safe, effective and practical approach. *Pain Physician* 2020; 23:S319-S352.
42. 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.
43. 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.
44. Manchikanti L, Knezevic NN, Sanapati SP, Sanapati MR, Kaye AD, Hirsch JA. Is percutaneous adhesiolysis effective in managing chronic low back and lower extremity pain in post-surgery syndrome: A systematic review and meta-analysis. *Curr Pain Headache Rep* 2020; 24:30.
45. Knezevic N, Manchikanti L, Urits I, et al. Lack of superiority of epidural injections with lidocaine with steroids compared to without steroids in spinal pain: A systematic review and meta-analysis. *Pain Physician* 2020; 23:S239-S270.
46. Starr JB, Gold LS, McCormick Z, Suri P, Friedly JL. Repeat procedures and prescription opioid use after lumbar medial branch nerve radiofrequency ablation in commercially insured patients. *Spine J* 2019; S1529-9430:31041-1.
47. Janapala RN, Manchikanti L, Sanapati MR, Thota S, Abd-Elsayed A, Kaye AD, Hirsch JA. Efficacy of radiofrequency neurotomy in chronic low back pain: A systematic review and meta-analysis. *J Pain Res* 2021; 14:2859-2891.
48. Engel A, King W, Schneider BJ, Duszynski B, Bogduk N. The effectiveness of cervical medial branch thermal radiofrequency neurotomy stratified by selection criteria: A systematic review of the literature. *Pain Med* 2020; 21:2726-2737.
49. Manchikanti L, Pampati V, Sanapati MR, Hirsch JA. Outcomes of cervical therapeutic medial branch blocks and radiofrequency neurotomy: Clinical outcomes and cost utility are equivalent. *Pain Physician* 2022; 25:35-47.
50. Hambræus J, Pulkki-Brannstrom AM, Lindholm L. Cost-effectiveness of radiofrequency denervation for zygapophyseal joint pain. *Pain Physician* 2021; 24:E1205-E1218.
51. Manchikanti L, Kaye AD, Soin A, et al. Comprehensive evidence-based guidelines for facet joint interventions in the management of chronic spinal pain: American Society of Interventional Pain Physicians (ASIPP) guidelines. *Pain Physician* 2020; 23:S1-S127.
52. Manchikanti L, Knezevic NN, Navani A, et al. Epidural interventions in the management of chronic spinal pain: American Society of Interventional Pain Physicians (ASIPP) comprehensive evidence-based guidelines. *Pain Physician* 2021; 24:S27-S208.
53. Manchikanti L, Knezevic NN, Sanapati J, Kaye AD, Sanapati MR, Hirsch JA. Is epidural injection of sodium chloride solution a true placebo or an active control agent? A systematic review and meta-analysis. *Pain Physician* 2021; 24:41-59.
54. Manchikanti L, Knezevic NN, Parr A, Kaye AD, Sanapati M, Hirsch JA. Does epidural bupivacaine with or without steroids provide long-term relief? A systematic review and meta-analysis. *Curr Pain Headache Rep* 2020; 24:26.
55. Manchikanti L, Kosanovic R, Cash KA, et al. Assessment of prevalence of cervical facet joint pain with diagnostic cervical medial branch blocks: Analysis based on chronic pain model. *Pain Physician* 2020; 23:531-540.
56. Manchikanti L, Kosanovic R, Pampati V, et al. Low back pain and diagnostic lumbar facet joint nerve blocks: Assessment of prevalence, false-positive rates, and a philosophical paradigm shift from an acute to a chronic pain model. *Pain Physician* 2020; 23:519-530.
57. 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.
58. 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.
59. 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.
60. 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.
61. 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.
62. Mohamed OS, Omar SM, Gaber AF, Hassanien MM, Mohamed AM. Three needles approach-a new technique of genicular nerves radiofrequency ablation for pain relief in advanced chronic knee osteoarthritis: A randomized trial. *Pain Physician* 2021; 24:E1067-E1074.
63. 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.
64. 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.
65. Simon JJ, Gehret J, Larsen ES, Hummerston KS, Koehler III PJ, Kitei PM. Caudal epidural steroid injections in the setting of remaining on antithrombotics: A retrospective study. *Pain Physician* 2021; 24:E821-E828.
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. Centers for Medicare and Medicaid

- Services. Accessed 01/07/2022. www.cms.gov/
68. CGS Administrators, LLC. Local Coverage Determination (LCD). Epidural Steroid Injections for Pain Management (L39015). Original Effective Date: 12/05/2021.
 69. CGS Administrators, LLC. Billing and Coding: Epidural Steroid Injections for Pain Management (A58731). Original Effective Date: 12/05/2021.
 70. CGS Administrators, LLC. Response to Comments: Epidural Steroid Procedures Injections for Pain Management (A58899). Original Effective Date: 10/21/2021.
 71. CGS Administrators, LLC. Local Coverage Determination (LCD). Facet Joint Interventions for Pain Management (L38773). Original Effective Date 5/02/2021.
 72. CGS Administrators, LLC. Billing and Coding: Facet Joint Interventions for Pain Management (A58364). Original Effective Date 5/02/2021.
 73. CGS Administrators, LLC. Response to Comments: Facet Joint Interventions for Pain Management (A58613). Original Effective Date 5/02/2021.
 74. AIM Specialty Health. Appropriate Use Criteria: Interventional Pain Management (MSK01-1121.3). Effective November 7, 2021. Accessed 11/28/2021. <https://aimguidelines.wpengine.com/interventional-pain-management-11-07-21/?highlight=epidural+steroid>
 75. United Healthcare Commercial Medical Policy. Epidural steroid injections for spinal pain. Policy Number: 2021To616C. Effective Date: November 1, 2021. Accessed 11/28/2021. www.uhcprovider.com/content/dam/provider/docs/public/policies/comm-medical-drug/epidural-steroid-injections-spinal-pain.pdf
 76. eviCORE Clinical Guidelines. CMM-200: Epidural steroid injections (ESI). Effective July 1, 2021. Accessed 11/28/2021. www.evicore.com/-/media/files/evicore/clinical-guidelines/solution/msk--advance/2021/cmm-200-epidural-steroid-injections_effo70121_pubo30521.pdf