

## Retrospective Study

# e Factors Associated With Same Day Discharge Post-Spinal Cord Stimulator Placement

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**Background:** Spinal cord stimulator (SCS) surgeries, whether performed using the open or percutaneous approach, are becoming increasingly common for a range of neuropathic pain conditions, including post-laminectomy syndrome and complex regional pain syndrome. However, there is limited knowledge regarding the factors linked to same-day discharge patterns following SCS.

**Objective:** The purpose of this study was to identify factors associated with same-day discharge after SCS placement. The primary outcome was same-day discharge.

**Study Design:** Retrospective, cohort study using a nationwide database.

**Methods:** Inclusion criteria included patients who underwent percutaneous or open SCS from January 1, 2014 through December 31, 2021. Exclusion criteria included patients with missing data ( $n = 178$ ) and those with SCS implants for unlisted indications ( $n = 1,817$ ). A multivariable analysis was conducted on the outcome data and co-variables associated with same-day discharge after SCS.

**Results:** After applying inclusion and exclusion criteria, a total of 18,058 patients remained in the final data set, including 7,339 patients who underwent percutaneous SCS and 10,719 patients who underwent open SCS procedures. After analysis, factors associated with increased rates of same-day discharge after SCS included men (odds ratio [OR] 1.16; 95% CI, 1.09–1.24;  $P < 0.001$ ), patients on Medicaid (OR 1.64; 95% CI, 0.1.34–2.01;  $P < 0.001$ ), and hospitals in the US Midwest (OR 1.66; 95% CI, 1.45–1.90;  $P < 0.001$ ) and hospitals in the US West (OR 1.32; 95% CI, 1.20–1.46;  $P < 0.001$ ). Factors associated with decreased rates of same-day discharge after SCS included the open approach (OR 0.21; 95% CI, 0.19–0.23;  $P < 0.001$ ), Hispanic ethnicity (OR 0.61; 95% CI, 0.54–0.69;  $P < 0.001$ ) and increased age (OR 0.99; 95% CI, 0.98–0.99;  $P < 0.001$ ).

**Limitations:** Since our study is retrospective, the data are subject to various biases, including variable confounding, human error in data entry, and generalizability of the results.

**Conclusion:** These results can be used to help determine hospital bed needs post-SCS surgery. Future research should focus on identifying the specific reasons certain demographic and geographic factors might influence same-day discharge rates. Our study provides important insights into the factors associated with same-day discharge rates post open and percutaneous SCS implant and highlights the need for patient-centered, evidence-based approaches to health care delivery.

**Key words:** Spinal cord stimulator, pain medicine, failed back surgery syndrome, neuromodulation, neuropathic pain

**IRB Statement:** This study was submitted to an institutional review board (IRB) and deemed IRB exempt because patient data were de-identified (redacted).

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**S**pinal cord stimulation (SCS) is a minimally invasive technique used for the treatment of various chronic pain conditions, including failed back surgery syndrome, nonsurgical back pain, complex regional pain syndrome I and II, and diabetic neuropathy(1-3).

With the advent of paresthesia-free and burst SCS, and an expanding list of indications, the number of SCS implants has steadily increased (4). It is crucial to not only identify patients who could potentially benefit from this therapy, but also work to optimize their dispositions and care patterns to ensure favorable patient outcomes (5). This includes postoperative care and discharge patterns related to the trajectory of care after SCS placement (i.e., same day discharge, hospital admission, discharge to facility, etc). Burton, et al (6) suggested that insurance status, in a population of patients from the National Inpatient Sample database, was associated with nonroutine hospital discharge post-SCS. However, no studies have sought to determine factors associated with successful same-day discharge after SCS placement.

Accordingly, the purpose of our study was to examine factors associated with same-day discharge post-SCS placement, broadly inclusive of patient and hospital factors that may play a role. Our hypothesis was twofold: first, that specific patient factors, such as older age, women, and being African American or Hispanic would be associated with same-day discharge (5); second, that insurance status is also associated with same-day discharge (6).

## METHODS

### Data Registry and Inclusion/Exclusion Criteria

Prior to initiating our study, a retrospective data proposal was reviewed by our institution's Institutional Review Board (IRB). Because we used de-identified (redacted) patient data, the study was classified as exempt from patient consent per the IRB 45 Code of Federal Regulation 46.101.

Our data set is from the Hospital Corporation of America (HCA) Healthcare national database, consisting of both inpatient and outpatient hospitals and centers nationally under the ownership of HCA Healthcare (i.e., over centers 150 total). This data set is inclusive of demographics as well as pre-, peri- and postoperative variables. An analysis of the data was conducted for all patients who underwent SCS placement via percutaneous or open approach from January 1, 2014 through

December 31, 2021. Inclusion criteria included adults aged 18 or older and patients who underwent SCS for failed back surgery syndrome, complex regional pain syndrome, chronic pain syndrome, mononeuritis of the lower limb, pain in limb, thoracic or lumbosacral neuritis, degeneration lumbar/lumbosacral disc, lumbosacral spondylosis, and spondylolisthesis. Exclusion criteria included incomplete data points, and data points outside of indications of interest (Fig. 1).

### Study Population and Statistical Analysis

All statistical analyses were performed using SAS Version 9.4 (SAS Institute, Inc. SAS). The covariates of interest included demographic factors, including age, gender, race, body mass index, ethnicity, tobacco use, insurance status, and psychiatric comorbidities. Clinical indications were collected as a part of this study, as were case counts (i.e., the absolute number of cases for SCS placement).

Spinal cord stimulator implants were performed using either an open approach, involving laminectomy with paddle placement, or percutaneously, involving electrodes being placed into the epidural space. The primary outcome of interest was same-day hospital discharge, defined as hospital discharge within 24 hours postsurgery.

Analysis of variance (ANOVA) was used to examine the growth rate of SCS cases per year in the data set. Univariate analyses were performed using *t* tests for continuous variables and  $\chi^2$  tests for categorical variables. Multivariable logistic regression was performed for the outcome of same-day discharge and included all the covariates as independent variables (including approach, age, gender, race, and insurance status). The odds ratio (OR) and their associated 95% CI and *P* value were reported. To analyze model performance, receiver operating characteristic curve analysis was used to measure the area under the curve (AUC).

## RESULTS

A total of 18,058 patients were included in our final study population after inclusion and exclusion, in which 7,339 (40.6%) and 10,719 (59.4%) underwent a percutaneous or open approach, respectively. The most common indications for SCS placement included chronic pain ( $n = 11,662$ , 64.6%), post-laminectomy syndrome ( $n = 7,779$ , 43.1%), and neuritis ( $n = 6,503$ , 36.0%). There were no differences in SCS case counts per year (ANOVA,  $P = 0.89$ ), (Fig. 2), although the open approach had higher case totals by year compared to the percutaneous approach (Fig. 3).

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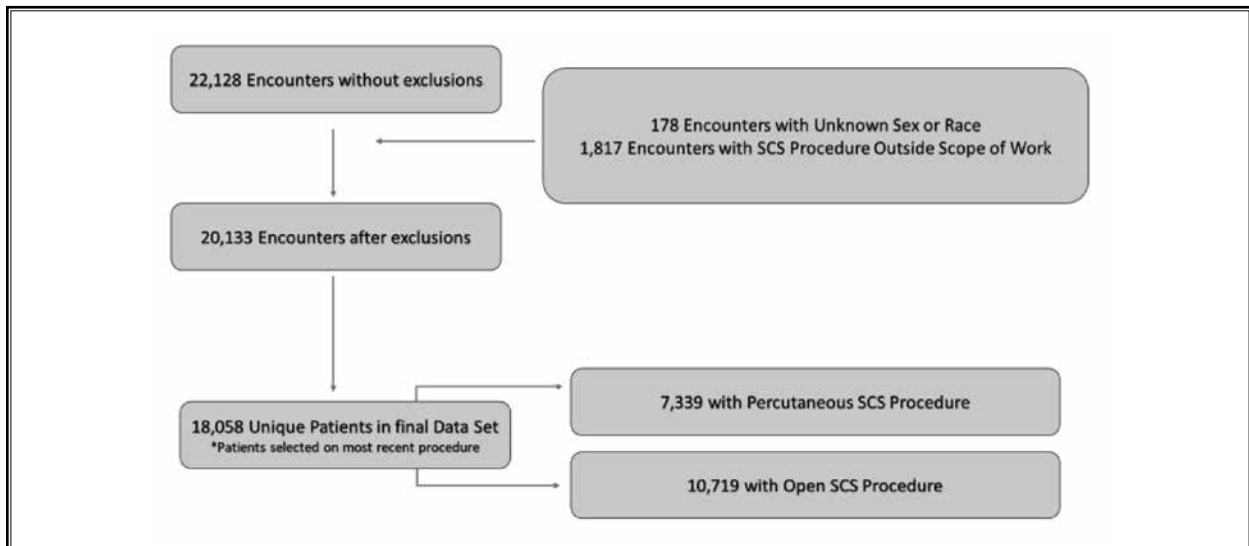


Fig. 1. Summary of exclusions. Encounter is defined as a patient care episode for the implantation of a spinal cord stimulator, regardless of medical setting (i.e., hospital, outpatient facility, etc). SCS: spinal cord stimulation

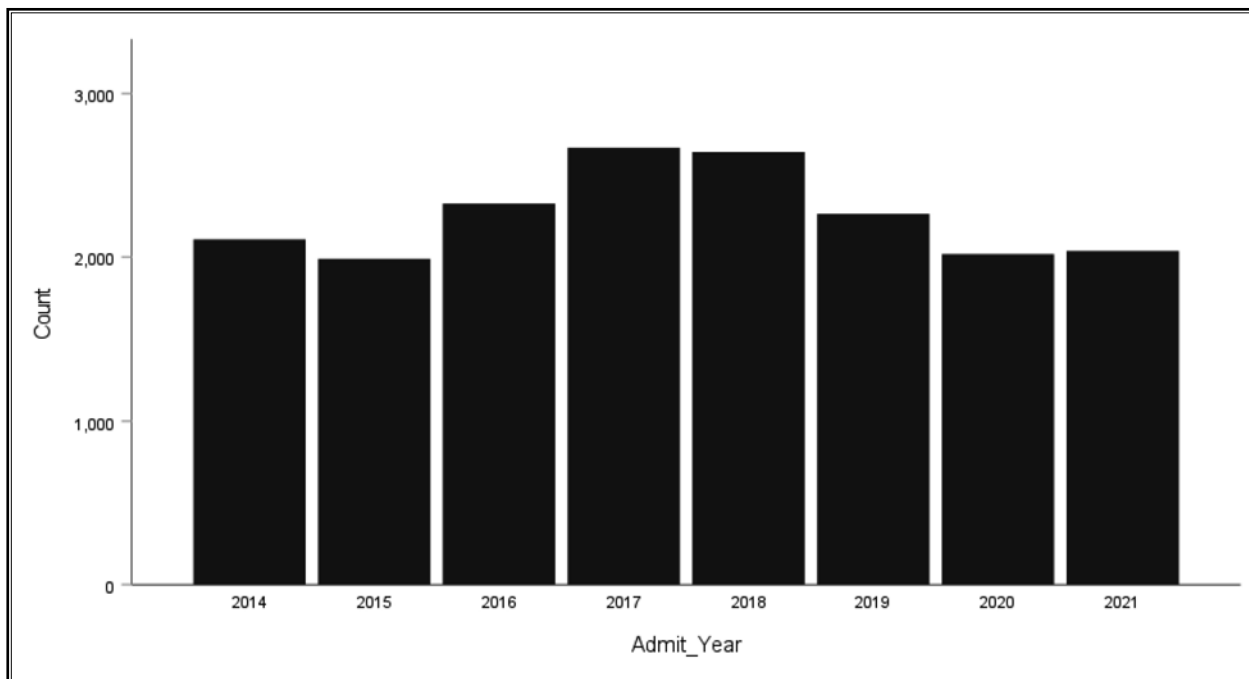
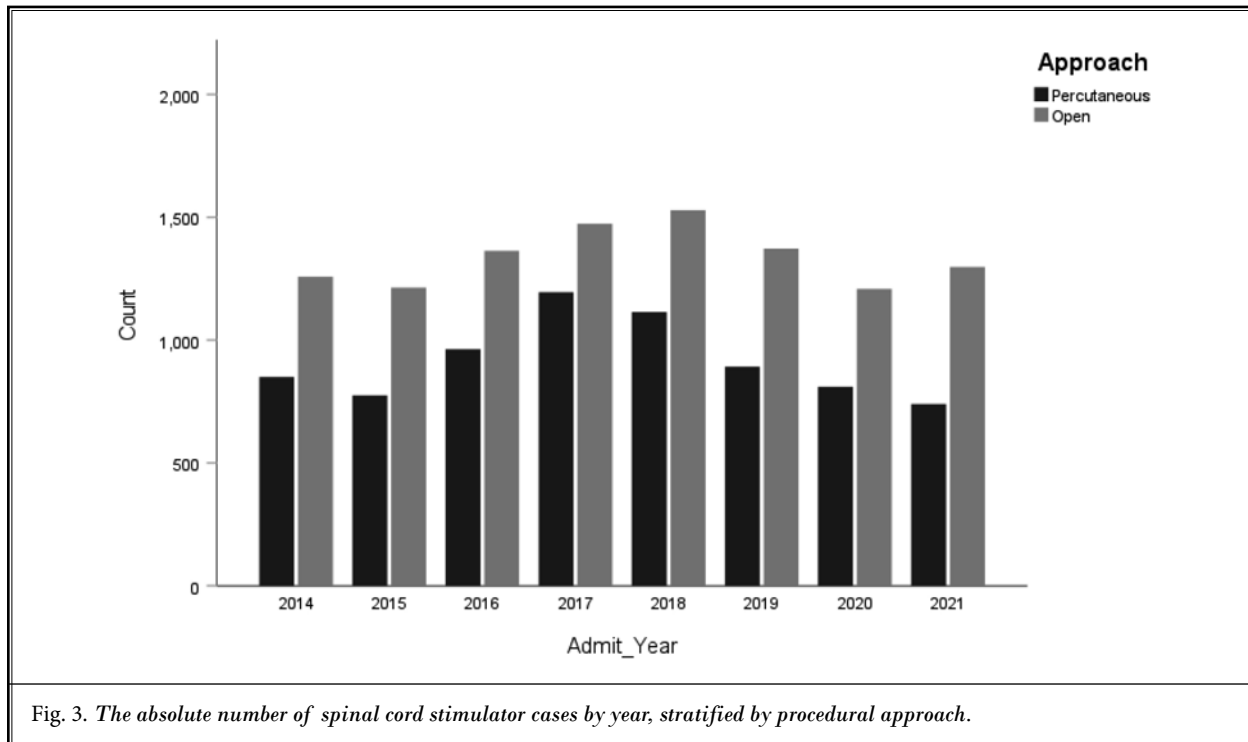


Fig. 2. The absolute number of spinal cord stimulator cases (open and percutaneous) stratified by hospital admission year.

When comparing the same-day discharge group with hospital admission cohorts on univariate analysis, the same day discharge group had a higher percentage of patients who underwent the percutaneous ap-

proach (82.2% vs 17.8%;  $P < 0.001$ ), a higher percentage of men (42.9% vs 40.3%;  $P < 0.001$ ), a trend toward increased same-day discharge rates by year (68.1% in 2014 vs 59.6% in 2021,  $P < 0.001$ ), a higher proportion



of those on Medicaid (5.2% vs 2.4%;  $P < 0.001$ ), a higher percentage of younger age groups ( $P < 0.001$ ), and decreased home discharge and increased transfer rates in the groups not discharged on the same day (Table 1).

A multivariable analysis was conducted for same-day discharge. Factors associated with decreased odds of same-day discharge included the open approach (OR: 0.21; 95% CI, 0.19 – 0.23;  $P < 0.001$ ), increasing age (OR: 0.99; 95% CI, 0.98 – 0.99;  $P < 0.001$ ), Hispanic ethnicity (OR: 0.61; 95% CI, 0.54 – 0.69;  $P < 0.001$ ), and the South region (OR: 0.77; 95% CI, 0.70 – 0.85;  $P < 0.0001$ ). Factors associated with increased odds of same-day discharge included male gender (OR: 1.17; 95% CI, 1.09 – 1.25;  $P < 0.001$ ), having Medicaid insurance (OR: 1.67; 95% CI, 1.37 – 2.08;  $P < 0.001$ ), and both the Midwest (OR: 1.25; 95% CI, 1.07 – 1.47;  $P = 0.005$ ) and West regions (OR: 1.32; 95% CI, 1.20 – 1.46;  $P < 0.001$ ) (Table 2). The AUC of the model was 0.697.

## DISCUSSION

The main findings of our study was that the open approach to SCS placement, Hispanic ethnicity, and older age are associated with lower odds of same-day discharge, while being of male gender, having Medicaid insurance, and living in the West and Midwest regions are associated with increased odds of same-day

discharge. Additionally, our study uniquely demonstrates the factors to consider when estimating a patient's odds of same-day discharge post-SCS placement. Findings from this project adds to previous work that demonstrated a longer stay for patients who receive the open approach (5). Therefore, our study, along with previous work, shows that not only does the open approach result in a longer hospital stay, but it also is associated with transfers to acute care facilities (i.e., skilled nursing facility).

Specifically, this study adds to previous work by Burton, et al (6) using the National Inpatient Sample, in which patients with Medicare or Medicaid had a higher likelihood of discharge to a medical facility. In addition to those who have public insurance, we show that those that require hospital admission have a higher propensity to require transfer to another medical facility (i.e., 10.7% vs 0.3%).

We also added findings with respect to gender and race, showing that being male gender is associated with increased odds of same-day discharge, while Hispanic ethnicity is associated with decreased odds of same-day discharge. One possible explanation in the gender-based difference in odds of same-day discharge could be related to differences in pain perception, given that previous studies have reported differences in pain sensitivity

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(7). For example, several studies have demonstrated that women are more likely than men to experience a variety of chronic pain conditions, that is women tend to report increased pain levels at more anatomic locations than

men (8). Our study also adds to the previous literature by suggesting that within the scope of SCS delivery, there exists clinically meaningful differences in discharge rates based on gender (7-11).

Table 1. Univariate analysis of same-day discharge.

		Same Day						$\chi^2$	P value
		No			Yes				
		Count	Row N %	Column N %	Count	Row N %	Column N %		
Approach	Percutaneous	1,309	17.8%	19.4%	6,030	82.2%	53.3%	2006.199	< 0.001
	Open	5,430	50.7%	80.6%	5,289	49.3%	46.7%		
Gender	Women	4,024	38.4%	59.7%	6,463	61.6%	57.1%	11.849	< 0.001
	Men	2,715	35.9%	40.3%	4,856	64.1%	42.9%		
Race	Other	113	35.0%	1.7%	210	65.0%	1.9%	20.886	< 0.001
	African American	437	35.3%	6.5%	802	64.7%	7.1%		
	White	5,615	37.0%	83.3%	9,541	63.0%	84.3%		
	Hispanic	574	42.8%	8.5%	766	57.2%	6.8%		
Ethnicity	Hispanic	563	42.7%	8.4%	756	57.3%	6.7%	17.986	< 0.001
	Non Hisp	5,696	36.8%	84.5%	9,773	63.2%	86.3%		
	Unknown	480	37.8%	7.1%	790	62.2%	7.0%		
Admit Year	2014	852	40.4%	12.6%	1,256	59.6%	11.1%	141.584	< 0.001
	2015	894	44.9%	13.3%	1,095	55.1%	9.7%		
	2016	964	41.4%	14.3%	1,363	58.6%	12.0%		
	2017	980	36.7%	14.5%	1,689	63.3%	14.9%		
	2018	960	36.3%	14.2%	1,683	63.7%	14.9%		
	2019	820	36.2%	12.2%	1,445	63.8%	12.8%		
	2020	619	30.7%	9.2%	1,400	69.3%	12.4%		
Admit Time frame	Jan-June	3,304	38.0%	49.0%	5,396	62.0%	47.7%	3.111	0.078
	July-Dec	3,435	36.7%	51.0%	5,923	63.3%	52.3%		
Insurance	Medicaid	165	22.1%	2.4%	583	77.9%	5.2%	80.701	< 0.001
	Medicare	4,141	38.4%	61.4%	6,654	61.6%	58.8%		
	Other	868	36.6%	12.9%	1,505	63.4%	13.3%		
	Private	1,565	37.8%	23.2%	2,577	62.2%	22.8%		
Discharge	Expired	4	100.0%	0.1%	0	0.0%	0.0%	*	*
	Home	5,981	34.7%	88.8%	11,263	65.3%	99.5%		
	Other	30	62.5%	0.4%	18	37.5%	0.2%		
	Transfer	724	95.0%	10.7%	38	5.0%	0.3%		
Age Group	18-29	86	36.3%	1.3%	151	63.7%	1.3%	37.332	< 0.001
	30-39	414	34.5%	6.1%	786	65.5%	6.9%		
	40-49	920	35.6%	13.7%	1,662	64.4%	14.7%		
	50-59	1,482	35.9%	22.0%	2,648	64.1%	23.4%		
	60-69	1,696	37.2%	25.2%	2,860	62.8%	25.3%		
	70-79	1,560	38.8%	23.1%	2,461	61.2%	21.7%		
	80+	581	43.6%	8.6%	751	56.4%	6.6%		

Table 2. Multivariable regression analysis for same-day discharge.

Variables	OR & 95% CI	P value
Open Approach	0.21 (0.19, 0.23)	< 0.001
Age	0.99 (0.98, 0.99)	< 0.001
Fender (Men)	1.17 (1.09, 1.25)	< 0.001
Race (Other)	0.97 (0.75, 1.24)	0.83
Race (African American)	1.07 (0.94, 1.22)	0.28
Race (Hispanic)	0.61 (0.54, 0.69)	< 0.001
Insurance (Medicare)	0.97 (0.87, 1.09)	0.64
Insurance (Medicaid)	1.67 (1.37, 2.08)	< 0.001
Insurance (Private)	0.91 (0.81, 1.02)	0.10
Insurance (Other)	1.10 (0.98, 1.17)	0.11
Region (Midwest)	1.25 (1.07, 1.47)	0.005
Region (West)	1.32 (1.20, 1.46)	< 0.001
Region (South)	0.77 (0.70, 0.85)	< 0.001

Reference groups for race was white, insurance was uninsured/charity, and region was Northeast.

Our results also show that Hispanic ethnicity is an indicator for decreased odds of same-day discharge, building on previous work by Ovrom, et al (12), in which they utilized the National Inpatient Sample to examine costs associated with SCS placement (12). That study showed that Hispanic patients had a higher total charge associated with care for inpatient SCS surgery (12). A possible explanation could be that this patient population has a propensity to require longer hospital stays; however, the exact cause of prolonged stay (i.e., pain, complications from SCS placement, etc) remains unknown and future clinical studies exploring this research question should be conducted.

With respect to insurance status, our results demonstrate that those with Medicaid insurance had higher odds of same-day discharge compared to patients who are privately insured. These results add to previous work published by Huang, et al (13). Their results showed a longer length of stay for patients with Medicaid insurance as well as greater health care utilization in terms of medications prescribed and emergency department visits (13). A recent study by Jones, et al (14) adds that patients that were dual eligible for Medicare and Medicaid were less likely to receive SCS compared to those eligible for Medicare alone. Our study adds important data showing that patients with Medicare, compared to privately insured patients, had similar odds of same-day discharge, but that patients with Medicaid had heightened odds of same-day discharge. Variables such as patients with Medicaid being more likely to receive

an SCS implant from a pain physician via the percutaneous approach, or these patients being poor surgical candidates (e.g., increased comorbidity burden), are possible explanations for having heightened rates of same-day discharge.

Our study is a retrospective cohort study with the goal of identifying factors associated with either increased or decreased odds of same-day discharge post-SCS placement. Given that the study is highly powered with  $n > 18,000$ , it is important to consider the topic of clinical vs statistical significance. With this many data points, even small effect sizes become clinically significant. Therefore, a larger emphasis was placed on smaller P values (i.e.,  $< 0.001$ ,  $> 0.01$ ,  $> 0.05$ ) and larger effect sizes, thought to be more suggestive of clinically important differences. Retrospective database studies are subject to a variety of biases, including, but not limited to, biases associated with incorrect data entry, selection bias, the effect of residual confounding, and limitations associated with generalizability.

With respect to the data, a majority of the SCS implants were performed using the open approach (i.e., approximately 60%), likely with the hospital setting facilitating admission when necessary. Nonetheless, this is a disproportionate amount of cases being performed using paddle lead placement. Another important consideration in database studies such as this one is the effect of residual confounding, particularly by factors not coded for in the analysis. For example, medical comorbidities were not coded for or captured in this data set and may have had an influence on discharge patterns. Another limitation in the study is that we were unable to include institutional identification as a covariate, which would be important to control for hospital level differences via a mixed effects regression approach.

## CONCLUSIONS

The study suggests that factors such as gender, race, insurance status, and geographic location can influence a patient's likelihood of same-day discharge post-SCS placement. It can be useful in developing patient-centered care plans and developing health care policies. Providers can use this information to identify patients who are at higher risk for longer hospital stays and develop strategies to reduce their length of stay. In addition, policymakers can use this information to identify areas where health care disparities exist and develop potential interventions to address them.

### Author Contributions

Alexander Beletsky, MD: This author helped interpret the data, draft the initial manuscript, and critically revise the manuscript.

Cherry Liu, MD: This author helped design the study, acquire, analyze, and interpret the data, draft the initial manuscript, and critically revise the manuscript.

Kim Vickery, MS: This author acquired, analyzed, and interpreted the data.

Natalie Hurlock, MPH: This author acquired, analyzed, and interpreted the data.

Nutan Winston, MD: This author helped critically revise the manuscript.

Brittney N. Burton, MD: This author helped critically revise this manuscript.

Ahish Chitneni, DO: This author helped critically revise this manuscript.

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Jeffrey Chen, MD: This author helped interpret the data, draft the manuscript, and critically revise the manuscript.

Munish Loomba, MD: This author helped critically revise the manuscript.

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