Specialty-based Variations in Spinal Cord Stimulation Success Rates for Treatment of Chronic Pain

Syed Mohammed Qasim Hussaini BS MS; Kelly Ryan Murphy BS; Jing L. Han BA; Aladine A. Elsamadicy BE; Siyun Yang MS; Alykhan Premji; Beth Parente; Jichun Xie PhD; Shivanand P. Lad MD, PhD

Department of Neurosurgery, Department of Biostatistics, Duke University Medical Center, Durham, NC

INTRODUCTION

Spinal cord stimulation (SCS) has emerged as an appropriate modality of treatment for intractable chronic pain. The present study examines variations in SCS trial-to-permanent conversion rates based on provider types performing the procedure.

HYPOTHESIS

We hypothesize that specialties traditionally trained in surgical implantation of SCS systems will have increased trial-to-permanent conversion rates and will better utilize healthcare resources.

METHODS

A large, retrospective analysis using the Truven MarketScan database analyzing adult SCS patients with provider information available, with or without IPG implantation from the years 2007 to 2012 was designed. Patients were categorized based on provider type performing the implantation including anesthesiologists, neurosurgeons, orthopedic surgeons, and physical medicine and rehabilitation (PM&R). Univariate and multivariate models identified factors associated with successful conversion.

RESULTS

Trial-to-permanent conversion and explant rates

- 7,796 unique instances identified between 2007-2012 identified using the Truven Marketscan national database.
- Anesthesiologists performed majority procedures (64.8%), followed by neurosurgery (20.3%), orthopedic surgery (9.8%) and PM&R (5.1%).
- Higher conversion rates among neurosurgeons (92.0%) and orthopedic surgeons (82.2%), with PM&R having lowest conversion rates (40.3%).
- No significant differences in explant rates across providers.
- No significant differences in Charlson Index score across providers.

Pain diagnoses and healthcare resource utilization

- History of CRPS most common among anesthesiologists
- History of back pain, degenerative spine disease, neuritis/radiculitis and limb pain least common among anesthesiologists
- Overall, no significant differences in HCRU amongst the provider types
- Total cost of pain encounters higher among the neurosurgeons

Predictors of conversion rates

- Neurosurgery and orthopedic surgery had significantly higher conversion rates. PM&R had significantly lower conversion rates
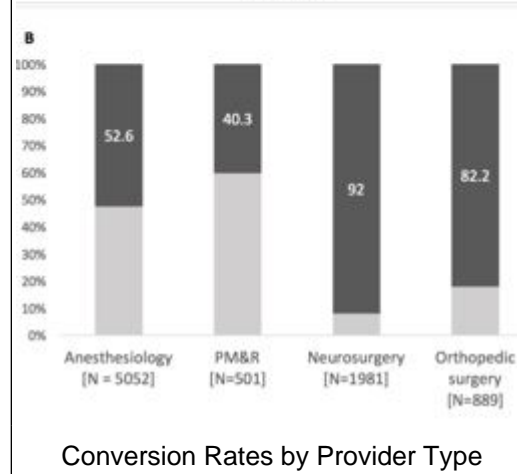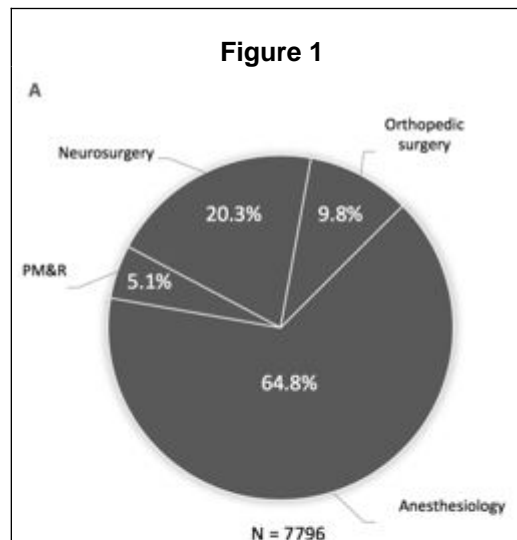- Female gender and Medicaid insurance associated with higher conversion rates.

Table 1

Table 1: Baseline characteristics by provider type

	Anesthesia (N=5052)	PM&R (N=397)	Neurosurgery (N=1585)	Orthopedic Surgery (N=762)	Total (N=7796)	p value
Successful Trial, N (%)						<0.0001
0	2397 (47.4%)	237 (59.7%)	127 (8.0%)	136 (17.8%)	2897 (37.2%)	
1	2655 (52.6%)	160 (40.3%)	1458 (92.0%)	626 (82.2%)	4899 (62.8%)	
Inpatient, N (%)						0.4119
Inpatient	97 (1.9%)	4 (1.0%)	28 (1.8%)	10 (1.3%)	139 (1.8%)	
Outpatient	4955 (98.1%)	393 (99.0%)	1557 (98.2%)	752 (98.7%)	7657 (98.2%)	
Charlson Index, N (%)						0.7829
Missing	74 (1.5%)	4 (1.0%)	14 (0.9%)	11 (1.4%)	103 (1.3%)	
0	2841 (56.2%)	219 (55.2%)	877 (55.3%)	433 (56.8%)	4370 (56.1%)	
1	1097 (21.7%)	86 (21.7%)	352 (22.2%)	176 (23.1%)	1711 (21.9%)	
2	565 (11.2%)	52 (13.1%)	183 (11.5%)	76 (10.0%)	876 (11.2%)	
>=3	475 (9.4%)	36 (9.1%)	159 (10.0%)	66 (8.7%)	736 (9.4%)	
Gender of Patient, N (%)						0.0584
Male	1996 (39.5%)	148 (37.3%)	675 (42.6%)	289 (37.9%)	3108 (39.9%)	
Female	3056 (60.5%)	249 (62.7%)	910 (57.4%)	473 (62.1%)	4688 (60.1%)	
Age at SCS, N (%)						0.1607
Mean (SD)	53.9 (13.3)	53.4 (13.5)	53.1 (12.2)	53.0 (11.4)	53.6 (12.9)	
Median	53.0	53.0	53.0	53.0	53.0	
Source, N (%)						<0.0001
CCAE	3583 (70.9%)	290 (73.0%)	1210 (76.3%)	634 (83.2%)	5717 (73.3%)	
MAID	508 (10.1%)	26 (6.5%)	154 (9.7%)	29 (3.8%)	717 (9.2%)	
MDCR	961 (19.0%)	81 (20.4%)	221 (13.9%)	99 (13.0%)	1362 (17.5%)	
Explant						0.3904
0	2331 (87.8%)	142 (88.8%)	1306 (89.6%)	551 (88.0%)	4330 (88.4%)	
1	324 (12.2%)	18 (11.3%)	152 (10.4%)	75 (12.0%)	569 (11.6%)	
Explant days after SCS						0.6352
N	324	18	152	75	569	
Mean (SD)	391.5 (386.0)	470.1 (544.8)	362.2 (386.6)	337.3 (306.5)	379.0 (382.4)	
Median	252.0	358.5	209.5	257.0	243.0	

SD, standard deviation
SCS, spinal cord stimulation

Baseline Characteristics

Table 2

Table 2: Pain diagnosis characteristics by provider type

	Anesthesia (N=5052)	PM&R (N=397)	Neurosurgery (N=1585)	Orthopedic Surgery (N=762)	Total (N=7796)	p value
Back Pain						<0.0001
0	1746 (34.6%)	102 (25.7%)	432 (27.3%)	183 (24.0%)	2463 (31.6%)	
1	3306 (65.4%)	295 (74.3%)	1153 (72.7%)	579 (76.0%)	5333 (68.4%)	
Chronic Pain Syndrome						.
0	5052 (100.0%)	397 (100.0%)	1585 (100.0%)	762 (100.0%)	7796 (100.0%)	
CRPS						0.0001
0	4578 (90.6%)	366 (92.2%)	1472 (92.9%)	723 (94.9%)	7139 (91.6%)	
1	474 (9.4%)	31 (7.8%)	113 (7.1%)	39 (5.1%)	657 (8.4%)	
Degenerative Spine Disease						<0.0001
0	1763 (34.9%)	103 (25.9%)	508 (32.1%)	190 (24.9%)	2564 (32.9%)	
1	3289 (65.1%)	294 (74.1%)	1077 (67.9%)	572 (75.1%)	5232 (67.1%)	
Neuritis/Radiculitis						0.0099
0	1400 (27.7%)	85 (21.4%)	393 (24.8%)	208 (27.3%)	2086 (26.8%)	
1	3652 (72.3%)	312 (78.6%)	1192 (75.2%)	554 (72.7%)	5710 (73.2%)	
Limb Pain						0.0081
0	3870 (76.6%)	289 (72.8%)	1152 (72.7%)	571 (74.9%)	5882 (75.4%)	
1	1182 (23.4%)	108 (27.2%)	433 (27.3%)	191 (25.1%)	1914 (24.6%)	
Post-laminectomy Syndrome						0.1280
0	2912 (57.6%)	209 (52.6%)	919 (58.0%)	419 (55.0%)	4459 (57.2%)	
1	2140 (42.4%)	188 (47.4%)	666 (42.0%)	343 (45.0%)	3337 (42.8%)	
Multiple chronic pain dx						<0.0001
Mean (SD)	3.5 (1.2)	3.8 (1.2)	3.6 (1.2)	3.7 (1.1)	3.6 (1.2)	
Median	4.0	4.0	4.0	4.0	4.0	

SD, standard deviation
SCS, spinal cord stimulation

Pain Diagnoses of Patient Cohort

Table 3

Table 3: Healthcare resource utilization by provider type

	Anesthesiology (N=2483)	PM&R (N=397)	Neurosurgery (N=1585)	Orthopedic Surgery (N=762)	Total (N=7796)	p-value
Total Cost						0.5101
Mean (SD)	12871.5 (15244.6)	12539.3 (13513.3)	12506.1 (13764.5)	13026.8 (14008.8)	12795.5 (14749.7)	
Median	8247.7	7983.0	8362.1	9094.7	8347.3	
Pain encounters						0.0020
Mean (SD)	43.1 (44.6)	45.9 (42.3)	43.0 (45.5)	46.3 (43.1)	43.6 (44.5)	
Median	31.0	35.0	30.0	34.5	31.0	
Total cost pain encounters						0.0014
Mean (SD)	6028.0 (7986.0)	6243.6 (8043.0)	6006.2 (8248.7)	6955.7 (8304.0)	6125.2 (8077.6)	
Median	3426.8	3768.3	3443.0	4315.6	3493.1	
IPG implantation post-SCS lead (days)						0.0036
N	2647	159	1457	626	4889	
Mean (SD)	49.7 (90.9)	52.3 (51.6)	52.8 (86.9)	54.4 (86.8)	51.3 (88.2)	
Median	33.0	35.0	36.0	35.0	34.0	

*Total cost, pain encounters, total cost of pain encounters, and inpatient admission data were obtained 1 year prior to match DT
SD, standard deviation; SCS, spinal cord stimulation; IPG, internal pulse generator

Healthcare Resource Utilization

Figure 1

Figure 1

A

- Orthopedic surgery 9.8%
- Neurosurgery 20.3%
- PM&R 5.1%
- Anesthesiology 64.8%

N = 7796

B

Provider	Value
Anesthesiology [N = 5052]	52.6
PM&R [N=501]	40.3
Neurosurgery [N=1981]	92
Orthopedic surgery [N=889]	82.2

Conversion Rates by Provider Type

Table 4

Table 4. Multivariate Logistic Regression

	OR (95% CI)	p-value
Age		
	1.00 (0.99, 1.00)	0.718
Gender		
Female	1.11 (1.00, 1.23)	0.049
Male	reference	.
Year of SCS		
	0.98 (0.95, 1.01)	0.176
Insurance source		
MDCR	0.98 (0.82, 1.17)	0.811
MAID	0.72 (0.52, 0.99)	0.044
CCAE	reference	.
Provider type		
Orthopedic Surgery	4.39 (3.60, 5.35)	<.001
Neurosurgery	10.71 (8.85, 12.97)	<.001
PM&R	0.63 (0.51, 0.78)	<.001
Anesthesiology	reference	.
Charlson Score		
>=3	0.92 (0.77, 1.10)	0.380
2	1.09 (0.92, 1.28)	0.321
1	1.04 (0.92, 1.18)	0.528
0	reference	.

MDCR, Medicare; MAID, Medicaid; CCAE, commercially available insurance
OR, odds ratio; CI, confidence interval

Predictors of Successful Conversion

CONCLUSIONS

Our results suggest that over a recent five-year period, conversion rates are highest when SCS trials are performed by neurosurgeons and orthopedic surgeons. In a separate analysis performed by our group, providers with high volume were found to be independent predictors of successful trial-to-permanent conversion rates. As the number of patients with chronic pain and the number of SCS implantations continues to increase annually, this study has important implications for establishing uniform guidelines for training, patient selection and education of physicians across multiple disciplines.

Please contact Syed Hussaini at syed.m.hussaini@duke.edu for references.