



INTRODUCTION

The efficacy and cost-effectiveness of spinal cord stimulation (SCS) is well-documented, despite initial healthcare acquisition costs. Nevertheless, a subset of patients ultimately require explantation of their permanent SCS system. The ability to predict SCS success involves a variety of factors, including the success of trial implant, judicious patient selection, and post-procedure programming. Understanding the predictors and rates of explantation has important implications for healthcare resource utilization (HCRU) and pain management.

METHODS

We designed a large, retrospective analysis using the Truven MarketScan database. We included all adult patients who underwent a percutaneous or paddle SCS trial from 2007 to 2012. Patients were grouped into cohorts that retained the SCS system or underwent explantation over a 3-year period; they were further divided into high (>25), medium (9-24), and low (3-8) volume providers. Multivariate models were utilized to evaluate differences in HCRU.

RESULTS

Of the total 8,727 unique trial implants identified, 805 patients (9.2%) underwent device explantation. One year prior to SCS implant, the explant cohort had significantly ($p < 0.0001$) higher median:

- baseline costs: \$42,140.3 vs \$27,821.7 non-explant
- associated costs: \$15,446.9 vs \$9,227.9
- total # pain encounters: 180 vs 103
- total # procedures: 19 vs 9

For each month after initial implant, explanted patients had a slower decrease in total costs (4% vs 6% in non-explant; $p < 0.01$). At the month of explant, explant patients were expected to have incurred 2.65x the total cost compared to the non-explant cohort. Each unit increase in Charlson

Healthcare Resource Utilization

	Non-explant (N=7922)	Explant (N=805)
Total cost ($p < 0.0001$)		
Mean (SD)	86740.5 (255259.1)	120449.9 (372441.5)
Median	27821.7	42140.3
Pain encounters ($p < 0.0001$)		
Mean (SD)	329.8 (1054.1)	452.1 (1110.0)
Median	103.0	180.0
Cost of encounters* ($p < 0.0001$)		
Mean (SD)	43764.8 (159662.2)	65441.8 (233042.7)
Median	9227.9	15446.9
Inpatient admissions ($p = 0.0010$)		
Mean (SD)	2.3 (17.0)	3.1 (15.7)
Median	0.0	0.0
Cost of prescriptions* ($p = 0.0905$)		
Mean (SD)	1024.3 (5327.3)	1063.8 (3242.1)
Median	132.1	160.8
Cost of all medication ($p = 0.0319$)		
Mean (SD)	3832.6 (7661.0)	3498.1 (7037.1)
Median	1737.1	1292.1

*pain-associated

Multivariate Analysis of Pain-Related HCRU

	Total cost	Total meds cost	Encounter cost	Prescription cost
Age	1.00 (1.00, 1.01)	0.94 (0.93, 0.95)*	1.00 (0.99, 1.00)	0.96 (0.95, 0.97)*
Charlson	1.51 (1.43, 1.59)*	1.06 (0.99, 1.14)	1.07 (1.00, 1.15)	0.93 (0.87, 1.00) [#]
Gender				
Female	1.50 (1.32, 1.71)*	0.85 (0.71, 1.00)	0.97 (0.81, 1.16)	0.80 (0.67, 0.96) [#]
Male	reference	reference	reference	reference
Month of explant				
Explant	2.65 (1.83, 3.84)*	3.15 (2.20, 4.51)*	7.59 (4.23, 13.64)*	4.25 (2.97, 6.09)*
Non-explant	reference	reference	reference	reference
Month after explant				
Explant	1.19 (0.82, 1.71)	3.88 (2.66, 5.66)*	0.69 (0.38, 1.24)	3.48 (2.38, 5.07)*
Non-explant	reference	reference	reference	reference

Presented as cost ratio (95% confidence interval); * $p < 0.0001$, [#] $p < 0.05$

Medium volume providers had lower rates of explantation at 3 years compared to low volume providers ($p = 0.042$). Increased age was an independent predictor of explantation at 1 and 3 years.

Explant Rates

	At 1-year		At 3-years	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Age	0.99 (0.98, 1.00)	0.001	0.99 (0.98, 1.00)	0.003
Charlson	1.02 (0.96, 1.08)	0.513	1.02 (0.97, 1.08)	0.391
Gender of Patient				
Male	reference		reference	
Female	1.15 (0.98, 1.34)	0.091	1.11 (0.95, 1.28)	0.190
Provider Implant Volume				
Low	reference		reference	
Medium	0.86 (0.71, 1.04)	0.113	0.83 (0.69, 0.99)	0.042
High	0.95 (0.79, 1.14)	0.594	0.96 (0.81, 1.15)	0.680

HR = hazard ratio; CI = confidence interval

CONCLUSION

There is a high cost burden associated with failed SCS systems. Explantation is correlated with higher baseline costs, total cost post-implant, and increased use of procedures to control pain. Medium-volume providers were associated with the lowest explant rates at 3-years post SCS; this may be due to a combination of lower-risk patient populations compared to high-volume providers, and increased experience compared to low-volume providers. This has implications for clinician training, standardization of practice, and construction of meaningful national guidelines. An 'at-risk' patient cohort for increased explantation identifies need for further investigation of alternative treatment options for pain management.

REFERENCES

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- Additional references can be provided as requested.