

# Neuromodulation

TECHNOLOGY AT THE NEURAL INTERFACE

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### SPINAL CORD STIMULATION FOR CHRONIC PAIN

#### Review Articles



#### Editor's Choice

#### 951 The Neurostimulation Appropriateness Consensus Committee (NACC)<sup>®</sup>: Recommendations for Spinal Cord Stimulation Long-Term Outcome Optimization and Salvage Therapy

Timothy R. Deer, MD; Marc Russo, MBBS; Jay S. Grider, DO, PhD, MBA; Dawood Sayed, MD;  
Tim J. Lamer, MD; David M. Dickerson, MD; Jonathan M. Hagedorn, MD; Erika A. Petersen, MD;  
Michael A. Fishman, MD, PhD; James FitzGerald, PhD; Ganesan Baranidharan, MBBS;  
Dirk De Ridder, MD, PhD; Krishnan V. Chakravarthy, MD, PhD; Adnan Al-Kaisy, MB, ChB; Corey W. Hunter, MD;  
Eric Buchser, MD; Kenneth Chapman, MD; Chris Gilligan, MD, MBA; Salim M. Hayek, MD, PhD;  
Simon Thomson, MBBS; Natalie Strand, MD; Jessica Jameson, MD; Thomas T. Simopoulos, MD, MA;  
Ajax Yang, MD; Olivier De Coster, MD; Fabián Cremaschi, MD, MSc; Paul J. Christo, MD, MBA;  
Vishal Varshney, MD; Stana Bojanic, MBBS; Robert M. Levy, MD, PhD

*The INS nominated faculty for this NACC<sup>®</sup> publication based on expertise, publications and career work on the issue. In addition, the faculty was chosen in consideration of diversity and inclusion of different career paths and demographics. The NACC<sup>®</sup> group established informative and authoritative recommendations on the salvage and optimization of care for those with implanted devices for the treatment of chronic pain. The recommendations are based on evidence and expert opinion and will be expected to evolve as new data are generated for each topic. NACC<sup>®</sup> guidance should be considered for any patient with less-than-optimal effectiveness of these implanted devices. Consideration should be given to these consensus points to salvage a potentially failed device before it is explanted.*

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### Editor's Choice

#### **977** The Neurostimulation Appropriateness Consensus Committee (NACC)<sup>®</sup>: Recommendations for the Mitigation of Complications of Neurostimulation

Timothy R. Deer, MD; Marc A. Russo, MBBS, DA (UK); Dawood Sayed, MD; Jason E. Pope, MD; Jay S. Grider, DO, PhD, MBA; Jonathan M. Hagedorn, MD; Steven M. Falowski, MD; Adnan Al-Kaisy, MB, ChB; Konstantin V. Slavin, MD; Sean Li, MD; Lawrence R. Poree, MD, MPH, PhD; Sam Eldabe, MD; Kaare Meier, MD, PhD; Tim J. Lamer, MD; Julie G. Pilitsis, MD, PhD; Jose De Andrés, MD, PhD; Christophe Perruchoud, PD, Dr. med.; Alexios G. Carayannopoulos, DO, MPH; Susan M. Moeschler, MD; Amir Hadanny, MD; Eric Lee, MD; Vishal P. Varshney, MD; Mehul J. Desai, MD, MPH; Peter Pahapill, MD, PhD; J. Osborn, BSc (PT), PhD, MD; Stana Bojanic, BSc (Hons), MBBS; Ajay Antony, MD; Fabian Piedimonte, MD, PhD; Salim M. Hayek, MD, PhD; Robert M. Levy, MD, PhD

The INS convened a multispecialty group of physicians and included international representation to establish evidence-based guidance on the mitigation of complications of neuromodulation therapies. Authors were chosen based upon their clinical expertise, familiarity with the peer-reviewed literature, research productivity and contributions to the neuromodulation literature. Identified studies were graded using the United States Preventive Services Task Force criteria for evidence and certainty of net benefit. Recommendations are based on the strength of evidence or consensus when evidence was scant. The NACC (put registered as in the blurb above) examined the published literature and established evidence- and consensus-based recommendations to guide best practices. Additional guidance will occur as new evidence is developed in future iterations of this process. The evidence- and consensus-based recommendations should be utilized as a guide to assist decision making when clinically appropriate.

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#### **1008** The Effect of Various Spinal Neurostimulation Paradigms on the Supraspinal Somatosensory Evoked Response: A Systematic Review

Laurien J. Reinders, MSc; Janne A.M. Luijten, MSc; Sander P.G. Frankema, MD, PhD;  
Frank J.P.M. Huygen, MD, PhD; Cecile C. de Vos, PhD

#### **1020** A Visual and Narrative Timeline Review of Spinal Cord Stimulation Technology and US Food and Drug Administration Milestones

Johnson S. Ho, MD; Cynthia Poon, MS; Richard North, MD; William Grubb, MD; Scott Lempka, PhD;  
Marom Bikson, PhD

#### **1026** Quantitative Sensory Testing in Spinal Cord Stimulation: A Narrative Review

Turo Nurmikko, MD, PhD; Dave Mughan, BSc, MBA; Angela Leitner, MS; Frank J.P.M. Huygen, MD, PhD

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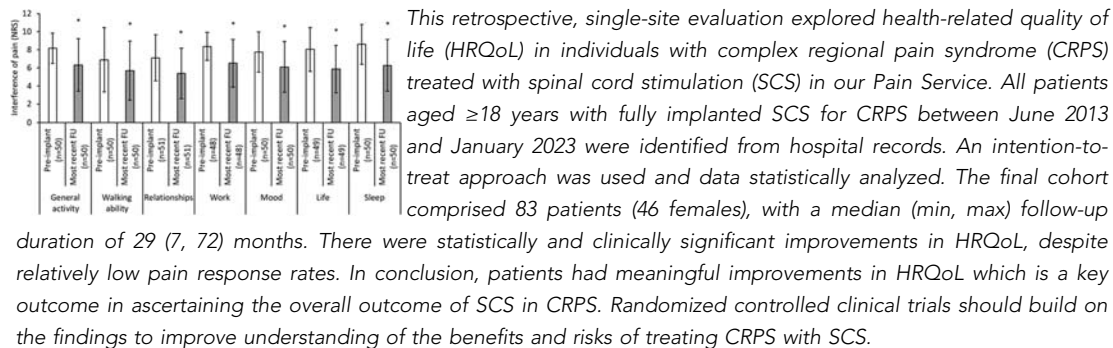
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## Clinical Science

### ★ Editor's Choice

#### 1035 Improvement in Health-Related Quality of Life With Spinal Cord Stimulation in Complex Regional Pain Syndrome: A Single-Center, Retrospective Study

Mazen Khabbass, MBChB, BSc; Mohammad Saleki, MBChB, BSc; Beatrice Bretherton, Bsc (Hons), PhD; Ganesan Baranidharan, MBBS



#### 1045 Defining Short- and Long-Term Programming Requirements in Patients Treated With 10-kHz Spinal Cord Stimulation

David A. Provenzano, MD; Jozef E. Leech, BS; Marina Bendersky, PhD; Rose Azalde, MS

#### 1055 Preoperative Counseling in Spinal Cord Stimulation: A Designated Driver in Implantable Pulse Generator-Related Inconveniences?

Erkan Kurt, MD; Linda Kollenburg, BSc; Sisley Joosten, MSc; Robert Van Dongen, MD, PhD; Yvonne Engels, PhD; Dylan Henssen, MD, PhD; Kris Vissers, MD, PhD

#### 1062 Biportal Endoscopic Spinal Cord Stimulation Paddle Lead Implantation: Technical Note and Preliminary Clinical Results

Xi-Zi Miao, MS; Ding-Zhi Gao, MS; Shao-Mei Yang, BD; Xiao-Li Guo, MD; Ya-Feng Wen, MD; Lei Shi, MD; Lei Chu, MD

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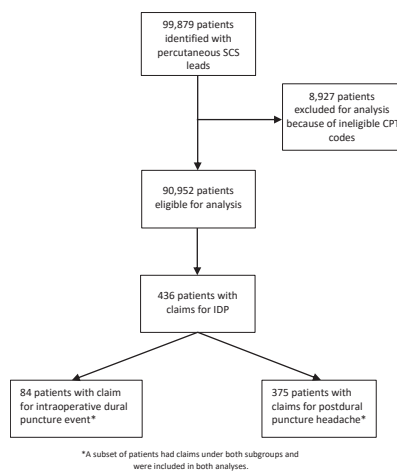
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## ★ Editor's Choice

### 1068 Incidence and Predictors of Inadvertent Dural Puncture After Percutaneous Spinal Cord Stimulation: A Retrospective Database Analysis

Nasir Hussain, MD, MSc; Jay Karri, MD, MPH; Theodore Dimitrov, BS; Ryan S. D'Souza, MD; Steven Zhou, MD; Mahmoud Abdel-Rasoul, MS, MPH; Alaa Abd-Elseyed, MD, MPH; Jatinder Gill, MD; Thomas Simopoulos, MD, MA; Tristan E. Weaver, MD



This retrospective analysis aims to understand the incidence and associated characteristics of patients with inadvertent dural puncture (IDP) after percutaneous spinal cord stimulation (SCS) lead placement. The PearlDiver-Mariner database of national all-payer claims was used to identify patients who received percutaneous SCS leads and had a claim for IDP (intra-operative IDP or post-dural puncture headache [PDPH] claim) within 45-days. The primary outcome was to determine the overall incidence of IDP. A total of 90,952 patients who underwent percutaneous lead SCS placement were included. The incidence of IDP was 0.48% (436/90,952 patients).

Our findings suggest that IDP after percutaneous SCS lead placement is an uncommon event; however, certain factors are associated with its development. Overall, early recognition of IDP following percutaneous SCS lead placement is imperative to facilitate the delivery of targeted treatments and prevent further harmful consequences to the patient.

### 1076 Sonication in Patients With Spinal Cord Stimulation: A New Approach for Infection Diagnostics

Adnan Kasapovic, Dr.Med.; Gunnar Hischebeth, Dr.Med.; Max Jaenisch, Dr.Med.; Thaer Ali, Dr.Med.; Martin Gathen, Dr.Med. Habil.; Mari Babasiz, Dr.Med.; Jessica Bojko, Dr.Med.; Jonas Roos, Dr.Med.; Samir Smajic, Dr.Med.

### 1082 Incidence of Infections, Explantations, and Displacements/Mechanical Complications of Spinal Cord Stimulation During the Past Eight Years

Lisa Goudman, PhD; Maarten Moens, MD, PhD; Sophie Kelly, BS; Christopher Young, BS; Julie G. Pilitsis, MD, PhD

### 1090 Spinal Cord Stimulation Trial Electrodes Rapidly Produce Epidural Scarring, Impeding Surgical Paddle Lead Placement

Randall W. Treffy, MD; Justin Morris, PA-C; Rahul Koshy, DO; Dylan J. Coss, MD; Peter A. Pahapill, MD, PhD

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## Clinical Letter

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**1098** Percutaneously Placed Gasserian Neurostimulation Electrode Migration Into the Quadrigeminal Cistern: Pathophysiological Hypothesis and Report of Successful Repositioning

*Dieter Thijs, MD; Erik Van de Kelft, MD, PhD*

## Letters to the Editor

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**1102** Letter to the Editor Regarding: "Regulatory Framework for Implantable Neurostimulation Devices: Comparison of Systems in the US and European Union"

*Aaron Lawson McLean, MSc, MBChB; Jakob Nemir, MD PhD*

**1104** Response to: "Letter to the Editor Regarding: 'Regulatory Framework for Implantable Neurostimulation Devices: Comparison of Systems in the US and European Union'"

*Andreas Amon, MSc; François Alesch, MD*

## Professional Development

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**1005** Calendar of Events