



# Lack of Neuromodulation Knowledge Among Rural Family Medicine Residents: A Call for Implementation Research

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**Objective:** Spinal cord stimulation is a proven, evidence-based therapy for persistent spinal pain syndrome. While some patients with this disease are managed by chronic pain physicians, many are managed in primary care offices. Despite mounting evidence, dissemination of this research outside of neuromodulation related fields and implementation of this treatment in common practice has not yet occurred. We hypothesize that family medicine residents in rural training programs will have little knowledge of neuromodulation despite it being an evidence-based and common treatment of post-laminectomy syndrome.

**Materials and Methods:** Online surveys were sent to family medicine residents in six rural family medicine training programs at the University of Arkansas for Medical Sciences Regional Programs to characterize knowledge of neuromodulation as a treatment for post-laminectomy syndrome.

**Results:** Forty-one percent of responding rural, Arkansas family medicine residents reported treating post-laminectomy syndrome during their training, yet only 10% have referred a patient for neuromodulation consultation. Residents rated their knowledge of neuromodulation/spinal cord stimulation at 19 on a scale of 0 (no knowledge) to 100 (extensive knowledge).

**Conclusion:** Despite proof that neuromodulation is an evidence-based treatment for post-laminectomy/failed back syndrome, rural family medicine residents have limited knowledge about the therapy and many do not consider a referral for neuromodulation. Further research to ascertain effective implementation strategies to increase the uptake of neuromodulation for patients with post-laminectomy syndrome is desperately needed.

**Keywords:** spinal cord stimulation, neuromodulation, rural, implementation science, dissemination

## Introduction

The economic impact of chronic pain in the United States, including both medical care and loss of productivity, is approximately \$635 billion dollars.<sup>1</sup> While back pain composes the majority of these patients, 14.8% of patients with chronic back pain have a diagnosis of post-laminectomy syndrome.<sup>2</sup> Post-laminectomy Syndrome (now referred to as persistent spine pain syndrome) is a disease of persistent and/or intermittent back pain with or without sciatica continuing for more than six months after a spine surgery.<sup>3-6</sup> It is estimated to occur after 10% to 40% of lumbar spine operations and unfortunately, surgical success rate declines after each operative attempt.<sup>3,4,7</sup>

Spinal cord stimulation for the treatment of chronic back and leg pain has been discussed in the literature since 1965 after the groundbreaking report of the gate control theory of pain by Melzack and Wall.<sup>8</sup> After the clinical introduction of this therapy by Shealy in 1967, extensive work has been conducted to not only refine and improve this technology but also to demonstrate its efficacious use in the treatment of challenging pain states.<sup>9</sup> The evidence behind the use of spinal cord stimulation over medical management or spine reoperation for the treatment of neuropathic back and leg pain caused by post-laminectomy syndrome is

well established.<sup>10–13</sup> With recent improvements to technology including the introduction of high frequency, novel waveforms, and closed loop feedback mechanisms, outcomes are continuing to improve.<sup>13–15</sup>

Despite demonstrated superiority over medical management for the treatment of neuropathic back and leg pain, many believe that spinal cord stimulation is under-utilized in the treatment of post-laminectomy syndrome. Many factors contribute to the lack of use including access, payer status, lack of available providers, and lack of dissemination of knowledge of the technology. In rural states like Arkansas, these factors are most likely prominent. Despite evidence demonstrating a lack of efficacy and increase morbidity with the use of opioids for the treatment of most chronic pain disease states, opioids are routinely used.<sup>16,17</sup> Per the CDC, Arkansas physicians prescribed 93.5 prescriptions per 100 persons in 2018, well above the national average of 51.4 for the same year.

To increase the availability of health care in the community, provide consultation and education for area health care professionals, and offer health education to individuals across Arkansas, The University of Arkansas for Medical Sciences has strategically placed family medicine residency programs in rural areas within seven of these eight regions of Arkansas to increase the number of primary care providers in rural areas of Arkansas as well as provide evidence-based healthcare for rural Arkansas. Due to this mission, the authors felt that the residents in these programs would be a good surrogate for knowledge among health providers in these rural communities.

With mounting evidence demonstrating benefit with spinal cord stimulation for the treatment of post-laminectomy syndrome, the purpose of this study is to assess the knowledge on this evidence among rural Arkansas family medicine residents and whether referrals for this treatment have been implemented into their practice. Our hypothesis is that rural Arkansas family medicine residents will have poor knowledge about spinal cord stimulation for the treatment of post-laminectomy syndrome and poor implementation of referrals for this treatment in their practice.

## Methods

### Study Design

This prospective survey study was approved by the University of Arkansas for Medical Sciences (UAMS) Institutional Review Board (260602). Participants were administered an online survey consisting of 10 questions. The survey contained two question types: polar (yes/no) questions and linear number scale questions to allow rating of knowledge from a 0 (no knowledge) to 100 (extensive knowledge). Surveys were sent to the subjects via email and the survey was closed after fourteen days. A reminder email was sent to the subjects on day ten.

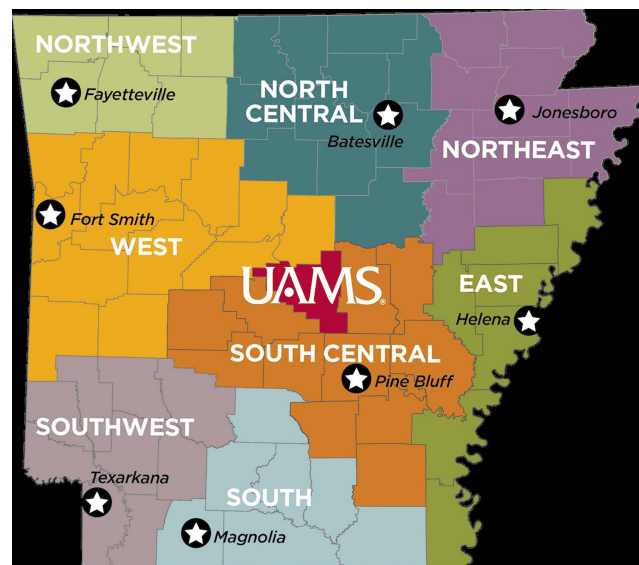
### Subjects

The survey was sent to family medicine residents at UAMS' Regional Programs. UAMS is the only academic health center in Arkansas. To ensure adequate training of family medicine physicians across each of the areas of the state, UAMS divides Arkansas into nine regions. The UAMS Medical Center resides in the region of Central Arkansas in the Little Rock metropolitan area (population 734,622). This is the main population center of the state. The other eight regions contain UAMS Regional Program medical campuses (Figure 1).

Six of the rural Arkansas family medicine residency programs from the UAMS regional programs consented to be a part of this survey study. These sites are located in the following Arkansas cities/towns: Jonesboro, Texarkana, Pine Bluff, Magnolia, Fort Smith, and Batesville. The Northwest Arkansas Regional Center, which resides in the second largest population center in the state (Fayetteville/Bentonville/Springdale, AR metropolitan area – combined population 525,032), was excluded due to its suburban demographics. Table 1 shows the location of each of these programs, with the respective population size each serves, and the number of residents at each location. Family medicine residents at these six regional programs sites were provided with the internet-based, digital survey.

### Survey Development

The survey was developed to ascertain providers' perceived knowledge about commonly prescribed or recommended chronic pain treatments. The survey also evaluated providers' familiarity with post-laminectomy syndrome and other chronic pain therapies and how often they prescribe, recommend, or refer patients for these treatments in patients with



**Figure 1** A map of Arkansas divided by region with location of University of Arkansas for Medical Sciences (UAMS) regional programs.

post-laminectomy syndrome. Two of the authors (JG and CH) iteratively assessed the readability and acceptability of the survey questions. See [Supplemental Document 1](#) for the full survey.

## Analysis

Descriptive statistics were used to characterize the results of the survey. For polar questions, the number and percentage of residents was calculated for each response (yes/no). The mean, median, and standard deviation was calculated for each linear number scale question.

## Results

Of the 115 rural, Arkansas family medicine residents contacted, 39 completed the digital survey, yielding a 34% completion rate. Of respondents, 41% stated they have treated a patient with post-laminectomy syndrome during their training. Only 10% of respondents have treated a patient with or referred a patient for neuromodulation/spinal cord stimulation. However, close to 66% of respondents stated they would refer a patient for neuromodulation in the future ([Table 2](#)). Other chronic pain therapies have wide-spread use among respondents including chronic opioid management (56%), Gabapentinoids/Antidepressants (46%), Epidural Steroid Injections (28%). Acupuncture (0%), Chiropractic Manipulation (5.13%), and Radiofrequency Ablation (7.69%) are recommended even less ([Figure 2](#)).

**Table 1** Demographic Information of the Participating Sites. East Does Not Have a Resident Training Program and Northwest Declined Participation

Region	Location of Program	Population	Number of Family Medicine Residents
North Central	Batesville	10,727	6
Northeast	Jonesboro	75,866	24
South	Magnolia	11,467	8
South Central	Pine Bluff	42,984	27
Southwest	Texarkana	30,259	24
West	Ft. Smith	88,037	26

**Table 2** Selected Yes/No Questions from Survey Presented to Rural Family Medicine Residents. For Ease of Presentation, We Shortened the Items. Full Survey Can Be Viewed in [Supplemental Document 1](#)

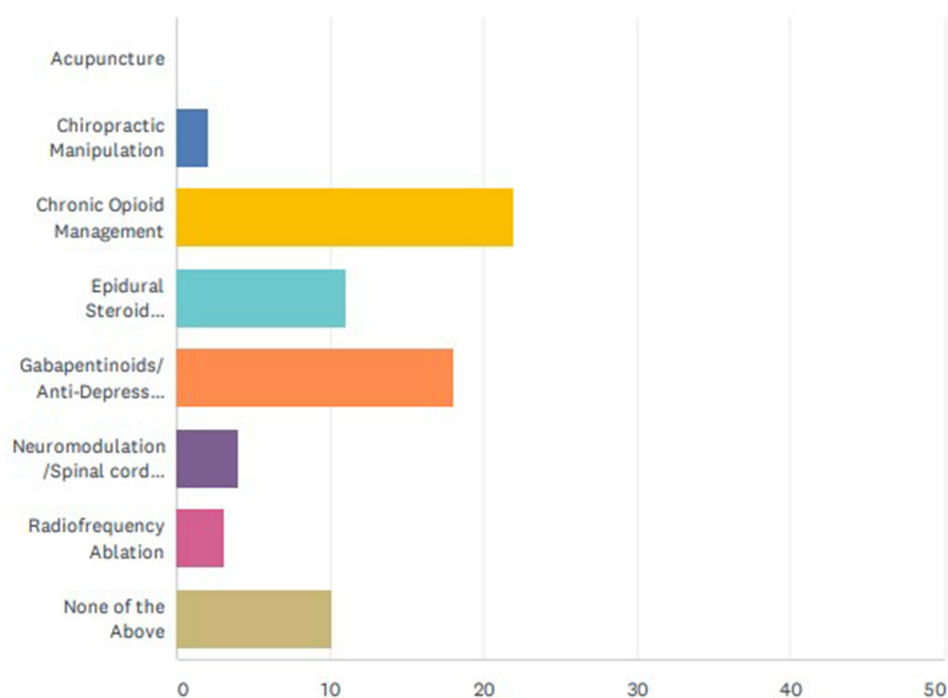
Question	Yes
Have you ever treated a patient with failed back surgery syndrome/post-laminectomy syndrome?	41.03%
Have you prescribed or referred a patient for neuromodulation/spinal cord stimulation who has chronic pain from failed back surgery syndrome/post-laminectomy syndrome?	10.26%
In the future, would you refer a patient for neuromodulation/spinal cord stimulation who has chronic pain from failed back surgery syndrome/post-laminectomy syndrome?	65.79%

Among respondents, the mean rating of knowledge of neuromodulation was low, 18.66 on a scale of 0 to 100 (Table 3). This was only higher than chiropractic manipulation (14.00) and radiofrequency ablation (12.97). Responding rural, Arkansas family medicine residents rate their knowledge of neuromodulation lower than gabapentinoids/antidepressants (48.10), chronic opioid therapy (45.44), epidural steroid injections (29.30), and acupuncture (19.21).

## Discussion

This was the first study to evaluate the knowledge of neuromodulation, an evidence-based therapy for post-laminectomy syndrome, among rural family medicine residents. Through our survey study, we found that slightly less than half of rural family medicine residents have made the diagnosis of post-laminectomy syndrome or failed back syndrome. Despite this, only one quarter of those have referred a patient for neuromodulation. We also noted that these residents rated their knowledge of neuromodulation below acupuncture, chronic opioid management, adjuvant medications, and epidural steroid injections despite mounting evidence of the effectiveness of neuromodulation for the treatment of this condition.

While the efficacy of neuromodulation has been demonstrated, this evidence-based therapy has not been widely adopted, particularly as a referral option for family medicine residents seeing patients with post-laminectomy syndrome.



**Figure 2** Graphic comparison of survey answers to "Which of the following therapies have you prescribed or referred a patient for who has chronic pain from failed back surgery syndrome/post-laminectomy syndrome?"

**Table 3** Selected Linear Number Scale Questions from Survey Presented to Rural Family Medicine Residents. For Ease of Presentation, We Shortened the Items. Full Survey Can Be Viewed in [Supplemental Document 1](#)

Question	Mean	SD
On a scale of 0 to 100, how would you rate your knowledge of the following treatments for chronic pain syndromes (i.e., post-laminectomy syndrome)		
Gabapentinoids/Antidepressants	48.10	32.79
Chronic Opioid Management	45.44	28.71
Epidural Steroid Injections	29.30	27.86
Acupuncture	19.21	19.22
Neuromodulation/Spinal Cord Stimulation	18.66	20.27
Chiropractic Manipulation	14.00	13.56
Radiofrequency Ablation	12.97	18.32

We feel that this finding is particularly important because many chronic pain patients are treated exclusively by their primary care physicians. This especially holds true in rural America and in rural areas around the globe. While randomized controlled trials are always needed to prove efficacy of novel treatment options, the movement of evidence-based practices (EBP) into routine clinical usage is not spontaneous and often takes focused, dedicated effort.<sup>18</sup> It has been shown that an EBP require an average of seventeen years to be incorporated into routine clinical practice.<sup>19,20</sup> Despite these averages, over half of proven, efficacious treatments never reach widespread clinical usage.<sup>19</sup> This demonstrates that even the best clinical evidence does not guarantee any tangible public health impact, as seems to be the case with neuromodulation in certain contexts.

There are many potential reasons why there is not widespread referrals of patients with post-laminectomy syndrome to neuromodulators. Many primary care providers have historically treated chronic non-malignant pain with opioids.<sup>21</sup> While the CDC guidelines have been effective at reducing average oral morphine equivalents, most academic family medicine physicians (88.4%) report feeling confident in their ability to prescribe opioids for non-malignant chronic pain.<sup>21,22</sup> While the CDC guidelines do state that “nonpharmacologic therapy” is preferred for chronic pain treatment over opioids, the examples used in the manuscript do not include advanced pain procedures like radiofrequency ablation and neuromodulation.<sup>22</sup> This could lead to a lack of inclusion of these therapies in treatment algorithms in primary care education programs not only in the United States but around The World. In addition, since very little neuromodulation literature is published in primary care or family medicine journals, the dissemination of this literature into these fields is unknown. Lastly, these authors have found that there is little crossover between the current fields of implementation science and neuromodulation in the currently published literature. We feel that the basic principles of implementation science would lend themselves to an increased uptake of this EBP.

Implementation science is defined as

“the scientific study of methods to promote the systematic uptake of research findings and other evidence based practices into routine practice, and, hence, to improve the quality and effectiveness of health services.<sup>18</sup>”

This novel research field seeks to solve the lack of acceptance of an EBP by combining implementation interventions into a comprehensive implementation strategy that can be replicated in other institutions, health-care systems, or populations.<sup>23</sup> In the Expert Recommendations for Implementing Change Project (ERIC), Powell et al lists seventy-three defined implementation strategies.<sup>24</sup> Examples of implementation interventions include education/training, audit and feedback, performance incentives, electronic medical record based reminders, and academic detailing. The goal of implementation science research is to propose an implementation strategy would increase the uptake of an EBP like use of neuromodulation in patients with post-laminectomy syndrome with the hopes that this implementation strategy can be widely replicated. While this may represent

a fundamental change in the way that research is conducted in the field of neuromodulation, these authors feel that incorporating these types of strategies could have far-reaching patient care implications. Implementation based neuromodulation research could fuel the universal, world-wide acceptance of neuromodulation as a first line treatment for proven indications-like post-laminectomy syndrome, complex regional pain syndrome, and others.

## Conclusion

Despite high-level evidence that neuromodulation is an effective treatment for post-laminectomy/failed back syndrome, this study demonstrates that there is poor implementation of this practice by rural family medicine residents. While increased dissemination of this data through targeted education, lectures, and conferences may be helpful, we feel that the proven methods of implementation science research could be a large asset to the neuromodulation community. Ongoing discussion of how to better implement EBPs in neuromodulation is needed at practice, institutional, and society levels worldwide.

## Data Sharing Statement

The data that support the findings of this study are available on request from the corresponding author.

## Author Contributions

JG and CH conducted the data analysis and assembly for presentation in the document. JG prepared the manuscript draft with important intellectual input from CH, EP, and GC. JG, CH, EP, and GC provided editorial input. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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