Washington State Health Care Authority

February 16, 2024 Meeting Materials
Health Technology Clinical Committee

Spinal Cord Stimulation

Contents

- ☐ HTCC clinical expert information
- ☐ SCS evidence recap presentation
- ☐ Agency Medical Director draft coverage criteria
- ☐ HTCC decision aid
- ☐ SCS final key questions

Joseph D. Strunk, MD

[redacted]

EDUCATION

Years	Degree	Institution (Area of Study)
2006 - 2010	BS	Northwest Nazarene University (Physics) Nampa, ID
2010 - 2014	MD	University of Utah (Medicine) Salt Lake City, UT

GRADUATE MEDICAL EDUCATION

Years	Degree	Institution (Area of Study)
2014 - 2015	Intern	Providence Sacred Heart Medical Center (Transitional Medicine) Spokane, WA
2015 - 2018	Resident	Virginia Mason Medical Center (Anesthesiology) Seattle, WA
2018 - 2019	Fellow	Virginia Mason Medical Center (Pain Management) Seattle, WA

LICENSURE AND CERTIFICATION

MEDICAL LICENSURE

2018 - present	State of Washington Medical License
2015 - 2018	State of Washington Medical License (Training)

BOARD CERTIFICATION

06/2019-12/2029	American Board of Anesthesiology
09/2019-12/2029	American Board of Anesthesiology Pain Medicine

OTHER CERTIFICATIONS

2012 - present	Advanced Cardiovascular Life Support (ACLS) Certification
2012 - present	Basic Life Support (BLS) Certification
2020 – present	Neonatal Resuscitation Program Certification

PROFESSIONAL EMPLOYMENT

08/2018 – 12/2020	Clinical Anesthesiologist Virginia Mason Medical Center, Seattle, WA
01/2021 – present	Academic Anesthesiologist Virginia Mason Medical Center, Seattle, WA

PROFESSIONAL ORGANIZATIONS

American Society of Regional Anesthesia and Pain Medicine

American Society of Anesthesiologists

Washington State Society of Anesthesiologists

PROFESSIONAL ACTIVITIES

2016 – 2018	Virginia Mason Perioperative Services Steering Committee, Member
05/2017	Washington State Delegation to ASA Legislative Conference, Member
2018 – 2021	Comparison of TAP vs IV Lidocaine After Kidney Transplant Surgery Principle Investigator
2019 – present	The Effect of an Opioid Free Anesthetic on Post-Operative Opioid Consumption after Laparoscopic Bariatric Surgery Sub-Investigator
2020 – present	Virginia Mason Department of Anesthesiology, Complex Spine Team, Member
2021 – present	Virginia Mason Department of Anesthesiology, Scheduling Consultant
2021 – present	ASA Summaries of Emerging Evidence, Question Writer
2021 – present	Virginia Mason Pain Medicine Fellowship Program, Associate Program Director

PUBLICATIONS AND PRESENTATIONS

Peer Reviewed Publications

Velagapudi M, Nair AA, Strodtbeck W, Flynn DN, Howell K, Liberman JS, **Strunk JD**, Horibe M, Harika R, Alamdari A, Hembrador S, Kantamneni S, Nair BG. Evaluation of machine learning models as decision aids for anesthesiologists. *J Clin Monit Comput.* 2022 Jun 9. doi: 10.1007/s10877-022-00872-8. Online ahead of print. PMID: 35680771

Hanson, N. A., **Strunk, J**., Saunders, G., Cowan, N. G., Brandenberger, J., Kuhr, C. S., Oryhan, C., Warren, D. T., Slee, A. E., & Strodtbeck, W. (2021). Comparison of continuous intravenous lidocaine versus transversus abdominis plane block for kidney transplant surgery: a randomized, non-inferiority trial. *Regional anesthesia and pain medicine*, rapm-2021-102973. Advance online publication. https://doi.org/10.1136/rapm-2021-102973. PMID: 34417343.

Davis, J. J., Bankhead, B. R., Eckman, E. J., Wallace, A., & **Strunk, J.** (2012). Three-times-daily subcutaneous unfractionated heparin and neuraxial anesthesia: a retrospective review of 928 cases. *Regional anesthesia and pain medicine*, *37*(6), 623–626. https://doi.org/10.1097/AAP.0b013e31826a8d10

Poster Presentations

Strunk, J., Hanson, N., Oryhan, C., Rouse, J., Strodtbeck, W. (2018) *Thoracic Epidural Catheter Removal in a Patient with Heparin Induced Thrombocytopenia on an Argatroban Infusion.* Submitted for presentation at: American Society of Regional Anesthesia, Pain Medicine Meeting; San Antonio, TX.

Strunk J., Porteous G. (2017) *Blood Product Utilization and Outcomes after Implementation of a Massive Transfusion Protocol in a non-trauma hospital.* Poster presented at: Anesthesiology; Boston, MA.

Washington State Health Care Authority

Conflict of Interest Form

This form must be completed by individuals who are:

- Appointed to, or applying for, the Health Technology Clinical Committee; or
- Are providing certain consultant services.

Depending on the appointment or position, certain interests are permitted, but must be disclosed. In addition to providing disclosure on this form, applicants may be required to affirmatively recuse themselves from discussions or deliberations of a technology topic for which the applicant has an interest. The applicant may not participate in any agenda item for which a conflict of interest is identified and may not vote on any such matter. The applicant's terms of appointment or contract should be consulted for specific dates and limitations.

If a conflict of interest is so great as to make it difficult for an applicant to participate meaningfully in the work to which they have been appointed or contracted for, that member may be asked to resign.

Submission or re-submission of this form is required annually by July 1st. If, during the course of any year, a material change in any of the information occurs, this form should be updated prior to the next public meeting of the committee. It is advised applicants retain a copy of this form for their records.

Definitions

For purposes of this disclosure statement, the following definitions apply:

Business: Any corporation, partnership, proprietorship, firm, enterprise, franchise, association, organization, self-employed individual and any other legal entity operated for economic gain. This does not include income-producing not-for-profit corporations that are tax-exempt under section 501(c) of the Internal Revenue Code with which service is performed in a non-compensated capacity.

Committee: Means the Health Technology Clinical Committee (HTCC) or the consulting service that the person completing this form is applying for, contracting for, or serving on.

Honorarium: A payment or something of economic value given in exchange for services, upon which custom or propriety prevents the setting of a price. Services include, but are not limited to, speeches or other services connected with an event where an appearance is made in an official capacity.

Income: Gross, pre-tax income of any nature, derived from any source, including but not limited to, any salary, wage, advance payment, dividend, interest, rent, honoraria, return of capital, forgiveness of indebtedness, income from government sources (i.e. Social Security, public salary, etc.) retirement income, real estate transactions, inheritance income, or anything of economic value received as income.

Legislative or Administrative Interest: An economic interest, distinct from that of the general public, in one or more bills, resolutions, regulations, proposals or other matters.

Member of Household: Any relative who resides in the household of the person completing this form.

Person: A natural person or a corporation, partnership, joint venture, and any other similar organization or association.

Relative: The spouse of the person completing this form, and any children, siblings or parents whether by birth, adoption or marriage.

Applicant Name	Joseph D. Strunk
Address	[redacted]

1. Business Activities

(a) If you or a member of your household was ***an officer or director of a business*** during the immediately preceding calendar year and the current year to date, provide the following:

Title	Business Name & Address	Business Type
None	None	None

(b) If you or a member of your household ***did business under an assumed business name*** during the immediately preceding calendar year or the current year to date, provide the following information:

Business Name	Business Address	Business Type
None	None	None

2. Honorarium

If you ***received an honorarium of more than $100*** during the immediately preceding calendar year and the current year to date, list all such honoraria:

Received From	Organization Address	Service Performed
American Society of Anesthesiologists: Summaries of Emerging Evidence	1061 American Lane, Schaumburg, IL 60173	Question Writer

3. Sources of Income

(a) Identify ***income source(s) that contributed 10% or more of the combined total gross household income*** received by you or a member of your household during the immediately preceding calendar year and the current year to date.

Source Name & Address	Received By	Source Type
Virginia Mason Franciscan Health 1100 9th Ave, Seattle WA, 98101	Joseph Strunk	Salary

(b) Does any income source listed above relate to, or could it reasonably be expected to relate to, business that has, or may, come before the Committee?

☐ Yes ☒ No

If "yes", describe: Click here to enter text.

(c) Does an income source listed above have a legislative or administrative interest in the business of the Committee?

☐ Yes ☒ No

If "yes", describe: Click here to enter text.

4. Business Shared With a Lobbyist

If you or a member of your household ***shared a partnership, joint venture, or similar substantial economic relationship with a paid lobbyist***, were employed by, or employed, a paid lobbyist during please list the following:

(Owning stock in a publicly traded company in which the lobbyist also owns stock is not a relationship which requires disclosure.)

Lobbyist Name	Business Name	Type Business Shared
None	None	None

Provide the information requested in items 5, 6, and 7 below only if:
(a) Your response involves an individual or business if you or a member of your household did business with, or reasonably could be expected to relate to business that has or may come before the Health Technology Clinical Committee.
(b) The information requested involves an individual or business with a legislative or administrative interest in the Committee.

5. Income of More Than $1,000

List each source (***not amounts***) of income over $1,000, other than a source listed under question 3 above, which you or a member of your household received during the immediately preceding calendar year and the current year to date:

Income Source	Address	Description of Income Source
None	None	None

6. Business Investments of More Than $1,000

(Do not list the amount of the investment or include individual items held in a mutual fund or blind trust, a time or demand deposit in a financial institution, shares in a credit union, or the cash surrender value of life insurance.)

If you or a member of your household had a personal, beneficial interest or investment in a business during the immediate preceding calendar year of more than $1,000, list the following:

Business Name	Business Address	Description of Business
None	None	None

7. Service Fee of More Than $1,000

(Do not list fees if you are prohibited from doing so by law or professional ethics.)

List each ***person for whom you performed a service for a fee of more than $1,000*** in the immediate preceding calendar year or the current year to date.

Name	Description of Service
None	None

I certify that I have read and understand this Conflict of Interest Form and the information I have provided is true and correct as of this date.

Print Name Joseph D. Strunk

Check One: ☒ Committee Member ☐ Subgroup Member ☐ Contractor

[redacted] 09/03/23

Signature Date

Health Technology Clinical Committee Application for Membership

Washington State Health Care Authority

1 Contact information

First name: Joseph

Middle initial:

Last name: Strunk

Address:

Phone number:

Best method, time to reach you:

Email:

Today's date: August 31, 2023

2 Personal information (optional)

Gender:

- [x] Male
- [ ] Female
- [ ] X/non-binary[1]

Pronouns (select all that apply)

- [ ] She/her
- [x] He/him
- [ ] They/them
- [ ] Other (subj./obj.):

Race or Ethnicity

- [ ] American Indian or Alaska Native
- [ ] Asian or Pacific Islander American
- [ ] Black/ African American
- [ ] Latino, Hispanic, Spanish
- [x] White/ Caucasian
- [ ] Other:

3 Professional training

Education (list degrees): Bachelors of Science (BS), Doctor of Medicine (MD)

Health care practitioner licenses: Washington State Medical License, MD

Professional affiliations: American Society of Anesthesiologists, American Society of Regional and Pain Medicine

Board certifications, formal training, or other designations: American Board of Anesthesiology; Anesthesiology and Subspecialty Pain Medicine

Current position (title and employer): Anesthesiologist and Pain Physician, Pain Medicine Fellowship Associate Program Director, Virginia Mas

Current practice type and years in practice: Anesthesiology & Pain Medicine; 4 years

Total years as an active practitioner: 4 years

Location of practice (city): Seattle, WA

1 *Non-binary (X) is an umbrella term used to describe those who do not identify as exclusively male or female. This includes but is not limited to people who identify as genderqueer, gender fluid, agender, or bigender.*

4 Experience

Provide a brief explanation (up to 150 words each) addressing the following:

1) Why you would like to serve on the clinical committee;

My motivation stems from a desire to contribute to the betterment of healthcare systems and patient outcomes. My clinical experience provides me insights into the real-world implications of coverage decisions. I have witnessed firsthand the impact of coverage determinations on patient access to vital treatments and the financial burden it can impose. Additionally, this is an opportunity to engage with fellow experts, and enhance my understanding of healthcare economics and policy. This continuous learning process aligns with my commitment to providing the best possible care to my patients. Lastly, active participation in evidence review is crucial for maintaining the highest standards of care. I am dedicated to the critical evaluation of medical evidence and appropriateness surrounding treatments like spinal cord stimulation.

2) The value of informing health policy decisions with scientific evidence, including any examples incorporating new evidence into your practice;

Evidence based medicine is a cornerstone of our practice at Virginia Mason Franciscan Health. We strive to educate our Pain Medicine fellows in the process of scholarly peer review with the goal to implement the most updated practice guidelines. One example includes the recent review and adoption of the evidence-based consensus guidelines on patient selection and trial stimulation for spinal cord stimlation therapy for chronic non-cancer pain by H. Shanthanna et al. published in Regional Anesthesia and Pain Medicine earlier this year. Our practice now uses these guidelines for treatment discussions with patients, trainee education, and multidisciplinary team planning.

3) How your training and experience will inform your role on the committee

I trained at Virginia Mason Franciscan Health in Seattle and have continued to practice as clinical faculty of our Pain Medicine training program. Our practice serves a broad mixture of patients with disease processes spanning complex regional pain syndrome, degenerative spine disease, chronic abdominal pain, and cancer pain. Our clinic emphasizes appropriate procedural interventions and coordinations with non-pharmacologic and pharmacologic treatment modalities through our multidisicplinary conferences.

4) Treating populations that may be underrepresented in clinical trials: women, children, elderly, or people with diverse ethnic and racial backgrounds, including recipients of Medicaid or other social safety net programs?

I am dedicated to providing equitable and compassionate healthcare to underserved and vulnerable patient populations. The evidence underscores the pressing need for improved equity in healthcare, particularly in the field of pain medicine, where disparities persist among women, BIPOC individuals, and those with low socioeconomic status. I firmly uphold the fundamental right to quality healthcare for everyone. To achieve this, we must first acknowledge our implicit biases. It is imperative that we give deliberate attention to these patient populations. This entails recognizing and addressing disparities in access and treatment, ensuring that our healthcare systems are inclusive, and working collectively to bridge the existing gaps. Achieving better outcomes for all enrollees hinges on our commitment to equity and a proactive approach to overcoming biases in healthcare.

5 Ability to serve

Are you able to participate in all-day meetings, an estimated six times per year? ✔ Yes ☐ No

Are you willing to commit to the responsibilities of a committee member, including:

- Attending meetings prepared for the topics of the day;
- Actively participating in discussions;
- Making decisions based on the evidence presented and the public interest1? ✔ Yes ☐ No

Could you, or any relative, benefit financially from the decisions made by the HTCC? ☐ Yes ✔ No

6 References

Provide three professional references:

1.
First name: Christine
Last name: Oryhan
Relationship: Colleague
Title: Anesthesiologist & Pain Physician, Pain Medicine
Contact email:
Phone number:

2.
First name: Daniel
Last name: Warren
Relationship: Colleague
Title: Anesthesiologist & Pain Physician,
Contact email:
Phone number:

3.
First name: Wyndam
Last name: Strodtbeck
Relationship: Colleague
Title: Anesthesiologist and Pain Physician,
Contact email:
Phone number:

For your application to be reviewed, please include:

✔ Completed application ✔ curriculum vitae ✔ **conflict of interest disclosure**

Download this form and send the completed version to **shtap@hca.wa.gov**

OR mail to:
Health Technology Assessment Program
Washington State Health Care Authority
P.O. Box 42712
Olympia, WA 98504-2712

1 *Detailed in Washington Administrative Code (WAC) and committee bylaws*

Spinal Cord Stimulators for Chronic Pain: Re-review

Presentation to

Washington State Health Care Authority

Health Technology Clinical Committee

Andrea C. Skelly, PhD, MPH

Erika D. Brodt, BS

February 16, 2024

HTCC Meeting Continuation

Aggregate Analytics

Brief Review:

Questions and Scope
Methods

Aggregate Analytics

Key Questions

When used in adult patients who have failed other treatment options for pain related to FBSS, chronic back pain, CRPS, or peripheral neuropathy (phantom limb or stump pain, diabetic neuropathy or postherpetic neuralgia):

1. What is the evidence of short and long-term **effectiveness** of SCS **compared with** medical and/or surgical treatment (appropriate to condition) that does not include neuromodulation devices?
2. What is the evidence of the **safety** of SCS compared with medical and/or surgical treatment (appropriate to condition) that does not include neuromodulation devices?
3. What is the evidence that SCS has **differential efficacy or safety** issues in sub-populations of interest
4. What is the evidence of **cost-effectiveness** of SCS compared with other medical or surgical options that do not include neuromodulation?

Aggregate Analytics

PICO Scope: Inclusion Criteria

- **Population**
  - Adults who had not been previously treated with SCS with one of the following conditions: chronic low back pain, failed back surgery syndrome with low back pain and significant radicular pain, complex regional pain syndrome, peripheral neuropathy (phantom limb or stump pain, diabetic neuropathy or postherpetic neuralgia
- **Intervention**
  - FDA-approved SCS system (permanently implanted pulse generator systems and radiofrequency receiver systems)
- **Comparator**
  - Medical and/or surgical treatment (appropriate to condition) that does not include comparison of SCS methods/devices or other neuromodulation devices
- **Outcomes**
  - Primary: Function, pain, opioid use, AEs or harms (***SOE on these only***)
  - Economic: Cost-effectiveness (e.g., cost per improved outcome), cost-utility (e.g., cost per quality adjusted life year (QALY), incremental cost effectiveness ratio (ICER) outcome)

Public comments on evidence inclusion

"Evidence not reviewed but available from peer-reviewed publications"	Disposition*
Petersen EA, Stauss TG, Scowcroft JA, et al. Effect of High-frequency (10-kHz) Spinal Cord Stimulation in Patients With Painful Diabetic Neuropathy: A Randomized Clinical Trial. JAMA neurology 2021;78:687-98.	**INCLUDED:** PDN, HF (10 kHz)-SCS vs. CMM; Fair-quality trial
Petersen EA, Stauss TG, Scowcroft JA, et al. Durability of High-Frequency 10-kHz Spinal Cord Stimulation for Patients With Painful Diabetic Neuropathy Refractory to Conventional Treatments: 12-Month Results From a Randomized Controlled Trial. Diabetes care 2022;45:e3-e6.	**INCLUDED** (f/u to Petersen 2021): PDN, HF (10 kHz)-SCS vs. CMM; Fair-quality trial
Canós-Verdecho A, Abejón D, Robledo R, et al. Randomized Prospective Study in Patients With Complex Regional Pain Syndrome of the Upper Limb With High-Frequency Spinal Cord Stimulation (10-kHz) and Low-Frequency Spinal Cord Stimulation. Neuromodulation : journal of the International Neuromodulation Society 2021;24:448-58.	**INCLUDED:** CRPS, HF (10 kHz)-SCS vs. CMM; Small (n=29), Poor-quality trial
Kapural L, Yu C, Doust MW, et al. Novel 10-kHz High-frequency Therapy (HF10 Therapy) Is Superior to Traditional Low-frequency Spinal Cord Stimulation for the Treatment of Chronic Back and Leg Pain: The SENZA-RCT Randomized Controlled Trial. Anesthesiology 2015;123:851-60.	**EXCLUDED:** Ineligible comparator (two SCS types, no control group)
Mekhail N, Levy RM, Deer TR, Kapural L, et al.; Evoke Study Group. Long-term safety and efficacy of closed-loop spinal cord stimulation to treat chronic back and leg pain (Evoke): a double-blind, randomised, controlled trial. Lancet Neurol. 2020 Feb;19(2):123-134.	**EXCLUDED:** Ineligible comparator (two SCS types, no control group)
Mekhail N, Levy RM, Deer TR, Kapural L, et al. Durability of Clinical and Quality-of-Life Outcomes of Closed-Loop Spinal Cord Stimulation for Chronic Back and Leg Pain: A Secondary Analysis of the Evoke Randomized Clinical Trial. JAMA Neurol. 2022 Mar 1;79(3):251-260.	**EXCLUDED:** Ineligible comparator (two SCS types, no control group)

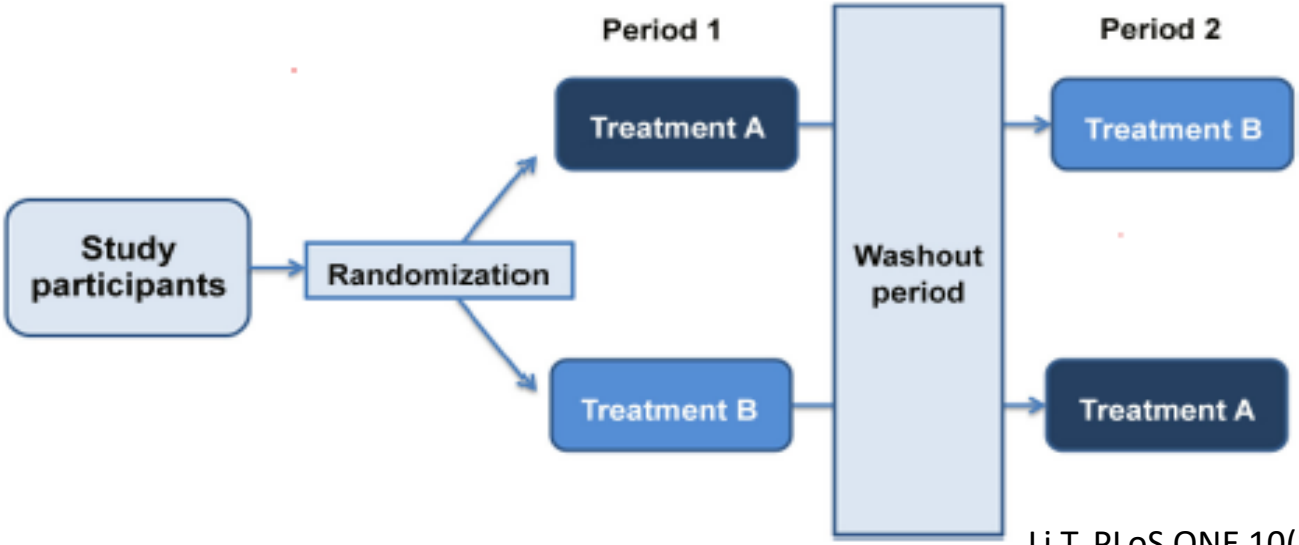
Aggregate Analytics

Two RCT Types Reported

Cross-over and Parallel Group RCTs

Parallel group trials (usual RCT): Groups as randomized followed across time; intentional cross-over to another treatment breaks randomization

Cross-over trials: Groups intentionally cross over to another treatment in a random sequence; additional ROB considerations



Li T, PLoS ONE 10(8): e0133023

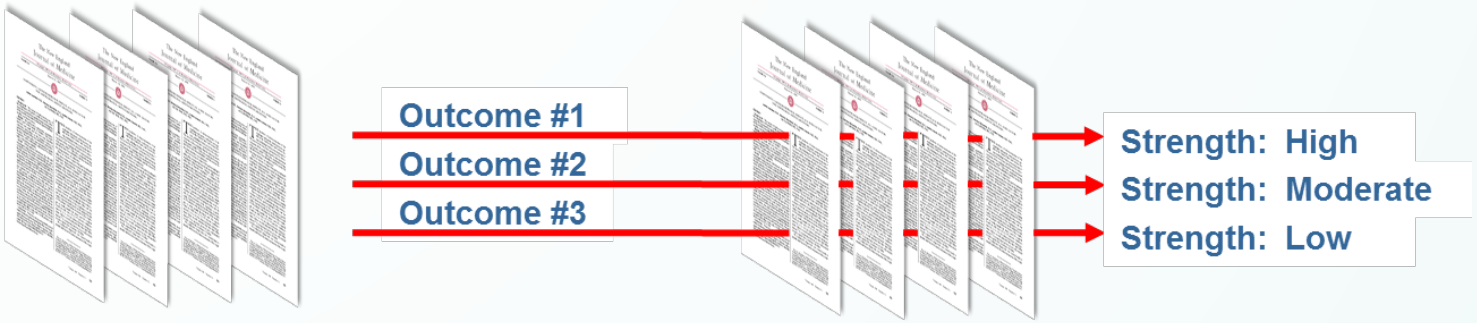
Aggregate Analytics

Systematic Review Process

Studies meeting eligibility criteria
- Efficacy: RCTs
- Harms: RCTs, observational studies
- Economic studies (SOE not done)

Risk of Bias Appraisal (Study)
Good, Fair, or Poor
Synthesis/analysis

Overall Strength of Evidence Determination (GRADE/AHRQ)



Strength of Evidence Ratings	
High	Very confident that effect is true.
Moderate	Moderately confident.
Low	Limited confidence.
Insufficient	No evidence or no confidence in effect.

Aggregate Analytics

Brief Review:

Summary of Findings

Aggregate Analytics

Magnitude of Effects (Appendix J)

Slight/Small	Moderate	Large/Substantial
Pain		
5–10 points on a 0-to 100-point VAS or the equivalent	>10–20 points on a 0-to 100-point VAS or the equivalent	>20 points on a 0-to 100-point VAS or the equivalent
0.5–1.0 points on a 0-to 10-point numerical rating scale or the equivalent	>1–2 points on a 0-to 10-point numerical rating scale or the equivalent	>2 points on a 0-to 10-point numerical rating scale or the equivalent
Function		
5–10 points on the ODI	>10–20 points on the ODI	>20 points on the ODI
Pain or function		
1.2 to 1.4 RR/OR	1.5 to 1.9 RR/OR	≥2.0 RR/OR

Based on mean between-group differences for continuous scores

Small effects may be below published thresholds for clinically meaningful effects. However, for some patients, a small improvement in pain or function may be important.

Effects below the threshold for small were categorized as no effect

Summary: KQ1
Chronic Back Pain, SCS vs. Sham, Crossover Trials

Measure	SCS type(s)	≤3 months	>3 to <12 months	≥12 months
Chronic radiculopathy				
Function: ODI (0-100)	Burst	No evidence	Similar, 1 RCT (SOE: Moderate)	No evidence
VAS back pain (0-10)	Burst	No evidence	Similar, 1 RCT (SOE: Moderate)	No evidence
VAS leg pain (0-10)	Burst	No evidence	Similar, 1 RCT (SOE: Low)	No evidence
FBSS				
Function (any measure)	Various frequencies	No evidence	No evidence	No evidence
VAS back pain (0-10)	1200 Hz 3030 Hz 5882 Hz	Insufficient	No evidence	No evidence
VAS leg pain (0-10)	1200 Hz 3030 Hz 5882 Hz	Insufficient	No evidence	No evidence
VAS pain, NOS (0-10)	1000 Hz LF tonic Cluster tonic	Insufficient	No evidence	No evidence

Aggregate Analytics

Favors SCS unless otherwise indicated

Summary: KQ1

FBSS (with radiculopathy*): Conventional SCS vs. CMM – Parallel Trials

Measure	3 months	6 months	≥12 months
FBSS with radiculopathy,* Conventional SCS			
LBP Responders (≥50% on VAS/NPRS)	No evidence	Large increase, 1 RCT (N=218) SOE: Low	No evidence
Leg Pain Responders (≥50% on VAS/NPRS)	Large increase, 1 RCT (N=94) SOE: Low	Large increase, 2 RCTs (N=312) SOE: Low	No evidence
LBP pain scores (VAS/NPRS, 0-10)	Small, 1 RCT (N=94) SOE: Low	Moderate, 2 RCTs (N=312) SOE: Low	No evidence
Leg pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=94) SOE: Low	Moderate, 2 RCTs (N=312) SOE: Low	No evidence
Function Responders (≥10-pt. reduction, ODI)	No evidence	No evidence	No evidence
Function scores (ODI, 0-100)	No evidence	Small, 2 RCTs (N=312) SOE: Low	No evidence
Proportion of patients still using opioids	No evidence	Small decrease, 2 RCTs (N=290) SOE: Low	No evidence
Opioid use: mean MME dose	No evidence	2 RCTs (N=312) SOE: Insufficient	No evidence

Favors SCS unless otherwise noted

*1 RCT enrolled patients with leg pain greater than back pain; the other enrolled patients with back pain greater than leg pain

Summary: KQ1
NSRBP, HF (10 kHz) SCS vs. CMM – Parallel Trials

Measure	3 months	6 months	≥12 months
Nonsurgical Refractory Back Pain (NSRBP), HF (10 kHz) SCS			
LBP Responders (≥50% on VAS/NPRS)	Large increase, 1 RCT (N=159) SOE: Low	Large increase, 1 RCT (N=140) SOE: Low	No evidence
Leg Pain Responders (≥50% on VAS/NPRS)	No evidence	No evidence	No evidence
LBP pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=143) SOE: Low	Large, 1 RCT (N=140) SOE: Low	No evidence
Leg pain scores (VAS/NPRS, 0-10)	No evidence	No evidence	No evidence
Function Responders (≥10-pt. reduction, ODI)	Large, 1 RCT (N=143) SOE: Low	Large, 1 RCT (N=140) SOE: Low	No evidence
Function scores (ODI, 0-100)	No evidence	Large, 1 RCT (N=140) SOE: Low	No evidence
Proportion of patients who stopped or decreased opioids	No evidence	Large increase, 1 RCT (N=140) SOE: Low	No evidence
Opioid use: mean MME dose	No evidence	1 RCT (N=74) SOE: Insufficient	No evidence

Aggregate Analytics

Favors SCS unless otherwise noted

Summary: KQ1
FBSS, SCS vs. Reoperation – Parallel Trials

Evidence from one poor quality RCT (N=60) was **INSUFFICIENT** to draw conclusions

Measure	Mean 2.9 years
Treatment success (≥50% pain improvement and patient satisfaction)	Large, 1 RCT (N=45)
Opioid use: % taking a stable or decrease dose	Moderate, 1 RCT (N=45)

Aggregate Analytics

Summary: KQ1, Back Pain Trials

- Heterogeneity: Enrolled populations, design, SCS, ROB, results, N's
- No comparative follow-up >6 months (benefits)
- Substantial imprecision noted for results
- Mostly low SOE

	Trials (N randomized)	Comparison	Notes
FBSS	Al-Kaisy, 2018 (Crossover) N=24	Various vs. Sham	Insufficient evidence
	Sokal 2020 (Crossover) N=18	Various vs. Sham	Insufficient evidence
	Rigoard, 2019 (Parallel), N=218	Conv vs. CMM	**Function**: small improvement **Back pain:** large improvement **Leg pain:** moderate improvement **Estimates very imprecise**
	Kumar 2007, 2008 (Parallel) N=100	Conv vs. CMM	
	North 2005 (Parallel), N=60	Conv vs. Reop	Insufficient evidence
Radiculopathy after back surgery	Hara, 2022 (Crossover) N=50	Burst vs. Sham	**Function:** Similar **Pain:** Similar
Chronic, refractory axial LBP; not a surgical candidate	Kapural, 2022 (Parallel) N=145 *(only per protocol analysis)*	HF vs. CMM	**Function and pain:** Large improvement **Estimates very imprecise**

Summary: KQ1
PDN, SCS vs. CMM – Parallel Trials

Measure	3 months	6 months	≥12 months
Conventional SCS			
LE Responders (≥50% on VAS/NPRS)	No evidence	Large increase, 2 RCTs (N=96) SOE: Low	No evidence
LE Pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=36) SOE: Low	Large, 2 RCTs (N=96) SOE: Low	No evidence
Opioid use: Proportion of patients still taking opioid; MSQ II scores	No evidence	Similar, 1 RCT (N=60) SOE: Low	No evidence
HF (10 kHz) SCS			
LE Responders (≥50% on VAS/NPRS)	Large increase, 1 RCT (N=184) SOE: Low	Large increase, 1 RCT (N=184) SOE: Low	No evidence
LE Pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=180) SOE: Low	Large, 1 RCT (N=180) SOE: Low	No evidence
Opioid use	No evidence	No evidence	No evidence

*Favors SCS unless otherwise noted

Summary: KQ1
CRPS, SCS vs. CMM or Sham

Parallel Trials: SCS vs. CMM

Measure	3 months	6 months	12-24 months	60 months
Conventional SCS				
Pain scores (VAS/NRS, 0-10)	Large, 2 RCTs (N=85) SOE: Low	Large, 2 RCTs (N=85) SOE: Low	Moderate, 2 RCTs (N=82) SOE: Low	1 RCT (N=44) SOE: Insufficient
Function scores (ODI, 0-100)	Moderate, 1 RCT (N=31) SOE: Low	Small, 1 RCT (N=31) SOE: Low	Small, 1 RCT (N=31) SOE: Low	No evidence
HF (10 kHz) SCS				
Pain scores (VAS/NRS, 0-10)	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	No evidence
Function scores (ODI, 0-100)	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	No evidence

Crossover Trial: SCS vs. Sham

Measure	SCS type(s)	≤3 months	>3 to <12 months	≥12 months
VAS pain (NOS) (0-10)	40 Hz 500 Hz 1200 Hz Burst SCS	Insufficient	No evidence	No evidence
McGill NRS average pain (0-10)		Insufficient	No evidence	No evidence

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*Favors SCS unless otherwise indicated

Summary: KQ 1b
Harms and Safety of SCS

- Substantial heterogeneity in classification, reporting, lack of consistency in definitions and severity description
- **SCS-related AEs common, substantial range of event frequencies**
- RCTs (SOE Low)
  - Any SCS-related AE: 12.4% to 17.6% (6 months), 24.1% to 32.1% (12-24 months)
  - SCS-related, requiring surgery: 11.8% to 16.7% (6 months), 23.8% to 37.5% (12-24 months)
  - Withdrawal due to AE: similar within 6 months
- Across designs, most common (SOE: Low)
  - Any IPG device explantation: 1.4% to 25%
  - Any IPT revision or replacement: 0.9% to 22%
  - IPG removal-inadequate relief, loss of efficacy, lack of efficacy, inadequate benefit: 3% to 20%
  - Any lead/electrode replacement or revision: 3.4% to 20.8%
  - Lead fracture or failure: 1.1% to 15.8%

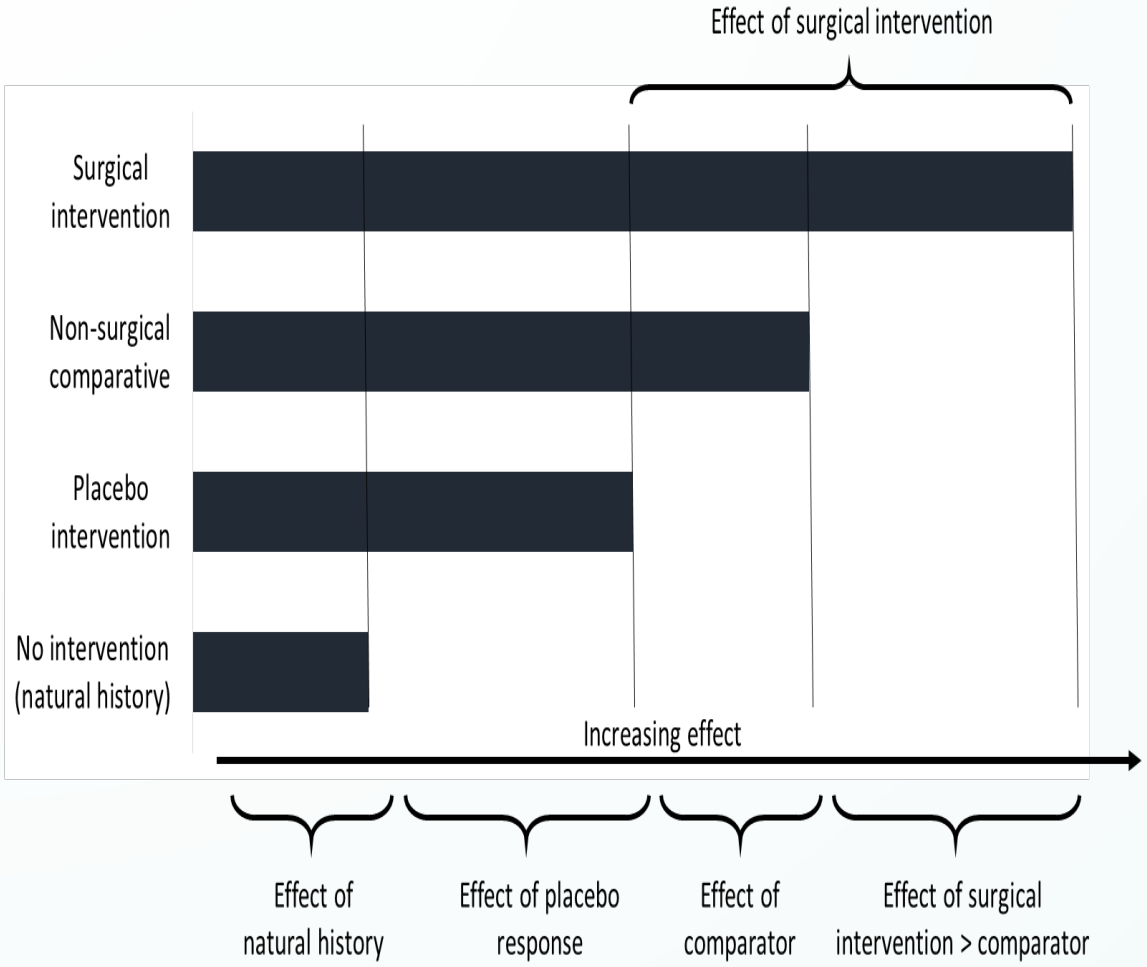
Summary: KQ 1b
Harms and Safety of SCS

- Across designs, less common (SOE Low)
  - Lead failure or migration (surgery not specified): 0.9% to 9.5%
  - IPG removal for infection (1% to 5%) or infect or dehiscence (2.5% to 4.8%)
  - Serious infection (deep, fatal, leading to revision, removal, or hospitalization): 0% to 6%
  - Unintentional durotomy 6% (3/50)
- Across designs, least common (SOE low unless noted)
  - IPG revision, removal for IPG displacement or migration: 0.5% to 1.2%
  - Serious infection reported within 30 days 0.9%
  - CSF leak, dural tear 0.5% to 0.7%
  - Neurologic injury (deficit, paralysis, intraspinal abscess): 0% to 4% (SOE Moderate)

KQ 4: Cost-effectiveness

- Only 2 U.S.-based full economic studies
  - One good quality cost-effectiveness study in Workers Compensation population with FBSS found SCS is not cost effective at common WTP thresholds
  - One poor quality CUA in patients with NSRBP reported that SCS was cost-effective vs. CMM alone in modeling that did not include costs for initial SCS procedure costs for base case and would be cost-effective within 2.1 years when these were included in the model.
- Non-U.S. based full economic studies, mostly good quality
  - In patients with FBSS 4 studies reported SCS+ CMM was cost effective vs. CMM alone; one also reported SCS + CMM was cost-effective versus reoperation.
  - In patients with CRPS, 3 studies reported SCS + CMM was more cost-effective than CMM alone.
  - SCS not cost effective in one study in patients with PDN
- Limitations: time horizon in the absence of long-term data, limited sensitivity analyses, assumptions regarding effectiveness, modeling of AEs; unclear applicability of non-US studies

Conceptual contribution of effects following an intervention



- Treatment response is more than the effect of a given treatment: culture, presentation and ceremony around the treatment and expectation of provider and patient impact outcome
- The placebo response heightens the significance of having a comparative group to evaluate treatment effectiveness; case series should rarely be interpreted as supporting treatment effectiveness

Dettori, JR, et. al. Global Spine Journal Vol. 9(6) 680-683

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Considerations

- Heterogeneity in patient populations, SCS types/delivery/parameters, components of CMM and concurrent medication use across studies is noted.
- Our clinical experts suggest that it is unclear how comparable/applicable the parameters used in the RCTs are to usual clinical practice, that there is likely substantial heterogeneity in what is used clinically, and SCS delivery parameters are tailored to the patient.
- Effect magnitude varied depending on comparator (sham, CMM).
- Effects may at least in part be due to lack of patient blinding, expectation of benefit and other non-specific effects as well as an intervention.
- Substantial lack of precision in effect estimates, particularly when effect sizes were large for some outcomes may call into question the stability of effect size estimates, decreasing confidence in them consistency across single studies is unknown.
- Impact of the following is unclear: Lack of an adequate washout period between SCS modes and sham, potential for carryover effects from prior phases, and potential for breaking of patient blinding for some modes of operation (e.g., switching from high frequency to low frequency conventional).
- Some studies may have been underpowered to detect uncommon or rare AEs or differences in effectiveness; heterogeneity in classification, description of severity and reporting of AEs is noted.
- Applicability: Patients w/ positive response to trial SCS, most reportedly failed CMM, were selected following multidisciplinary assessment including psychological evaluation, but specific thresholds or standards are not described.
- Definitions/diagnostic criteria related to FBSS and NSRBP not well described.
- Economic study limitations: Time horizons modeled, limited sensitivity analyses, inconsistent modeling of SCS procedure costs and AEs, support for assumptions regarding effectiveness and harms especially long term are unclear

Questions?

APPENDIX

Full Presentation from November 2023 HTCC Meeting

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Spinal Cord Stimulators for Chronic Pain: Re-review

Presentation to
Washington State Health Care Authority
Health Technology Clinical Committee

Andrea C. Skelly, PhD, MPH
Erika D. Brodt, BS

November 17, 2023

Report prepared by:
Andrea C. Skelly, Erika D. Brodt
Dakota Riopelle, Shay Stabler-Morris,
Mark Junge, Asmaa Khariji Watson

Internal clinical, methods review: Roger Chou
Clinical experts/peer review: Carl Noe, Kim Mauer

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2010 Report

- Evidence base: 3 RCTs (2 FBSS, 1 CRPS-I) across 7 publications, 1 prospective NRSI (FBSS, open Washington state workers' compensation claims), 6 case series (safety)
- Findings:
  - SCS superior to conventional therapies (CMM, physical therapy or reoperation) in the shorter term for pain relief but benefits decreased with time, no difference vs. controls longer term but data were sparse.
  - Evidence on function and QOL was sparse and inconsistent
  - Revision surgery and side effects were not uncommon through 5-year f/u
  - No trials compared SCS with sham/placebo

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Re-Review Rationale and Topic Refinement

- Rationale: Additional evidence and technical advances related to use of SCSs, including use of high frequency and burst stimulation available since the prior report.
- Topic Refinement:
  - Public comment to topic nomination, draft key questions/scope and a petition to HTAP were reviewed, considered, and discussed with HTAP as was input from clinical experts prior to finalization of KQ and PICOTS scope. All suggested citations were evaluated against the final PICOTS for possible inclusion.
- Clinical input on specific clinical questions was obtained throughout report development; internal clinical and methods review was done as was clinical peer review of the draft report.

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Background

Chronic Pain

- **Chronic pain**
  - Pain that persists for several months (typically ≥3 months) or for longer than anticipated
  - Substantially interferes with ADLs (e.g., work, social, personal); can lead to depression, anxiety and trouble sleeping; overall loss in QoL
  - Conditions in this review: Back pain (FBSS, NSRBP), peripheral diabetic neuropathy (PDN), complex regional pain syndrome (CRPS)
- **Approx. 51.6 million U.S. adults (21%) currently affected by chronic pain; 17.1 million (7%) experience high-impact chronic pain**
  - LBP is most common: ~13% of U.S. adults; PDN: 8.7-14.6 million; CRPS: 200,000/yearly
- **Healthcare costs**
  - As high as $635 billion a year, which is more than the yearly costs for cancer, heart disease, and diabetes.

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Included Conditions and SCS

Back pain

- FBSS: generalized disorder usually characterized by chronic pain in the lower back and/or legs that persists or recurs following anatomically successful spinal surgery
- NSRBP: chronic refractory back pain that does not respond to CMM in patients with no history of spine surgery and who are not candidates for spine surgery

CRPS

- The presence of severe prolonged pain of without clear origin that occurs in the arm or leg, usually after injury; Pain is often disproportionate to inciting event

Neuropathy

- Intense and persistent pain caused by nerve damage (e.g., from uncontrolled diabetes)

SCS

- **SCS** considered only after CMM has failed, typically used in addition to other therapies; treats rather than cures
- **SCS** may provide pain relief, improve QoL and function, reduce pain medication use

Spinal Cord Stimulation

- **Uses pulsed electrical energy sent to the spinal cord to manage pain**
- **Mechanisms of action not fully understood; thought to provide relief by modifying and masking pain signals before they reach the brain**
- **FDA approved**
  - A number of currently approved devices, 6 manufacturers (Appendix K)
  - Indications (some device dependent): chronic intractable pain in the trunk and/or limbs, radicular syndromes, FBSS, CRPS, PDN, arachnoiditis, other; refractory to CMM, would not benefit from additional surgery
  - Contraindications: failed trial stimulation (i.e., ineffective pain relief), poor surgical candidates, cardiac pacemaker, uncontrolled bleeding or coagulopathy, untreated mental health issues, psychological comorbidities, SUD
  - CMS/most payers require screening (physical and psychological) and diagnosis by a multidisciplinary team and demonstration of pain relief with a temporarily implanted system (i.e., trial stimulation).

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Spinal Cord Stimulation (cont.)

- **3 main components:** implantable pulse generator (IPG) with a battery, a lead wire with electrodes (8-32) (cylindrical or paddle), remote control that controls device and settings.
- **SCS systems** involve percutaneous implantation of electrode leads into the epidural space above the spine cord; IPG typically implant under the skin the abdominal or buttock region.
- "**Conventional" SCS** devices use a low-frequency current to replace the pain sensation with a mild tingling feeling (i.e., paresthesia); others use **high-frequency (HF)** (e.g., 10 kHz) or **burst** pulses to mask the pain with no tingling feeling.
- Input from our clinical experts suggests there is substantial heterogeneity in devices, modes of operation and parameters used across usual clinical practice.
- **SCS-specific risks described**: undesirable changes in stimulation; epidural hemorrhage, hematoma, infection, spinal cord compression and/or paralysis; CSF leak; seroma; persistent pain at electrode/stimulator site; paralysis, weakness, numbness below level of implantation, battery failure/leakage, lead migration, allergic reaction, IPG migration or local skin erosion.

Image: SSED from PMA P010032/S189

Questions and Scope

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Key Questions

When used in adult patients who have failed other treatment options for pain related to FBSS, chronic back pain, CRPS, or peripheral neuropathy (phantom limb or stump pain, diabetic neuropathy or postherpetic neuralgia):

1. What is the evidence of short and long-term **effectiveness** of SCS **compared with** medical and/or surgical treatment (appropriate to condition) that does not include neuromodulation devices?
2. What is the evidence of the **safety** of SCS compared with medical and/or surgical treatment (appropriate to condition) that does not include neuromodulation devices?
3. What is the evidence that SCS has **differential efficacy or safety** issues in sub-populations of interest
4. What is the evidence of **cost-effectiveness** of SCS compared with other medical or surgical options that do not include neuromodulation?

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PICO Scope: Inclusion Criteria

- **Population**
  - Adults who had not been previously treated with SCS with one of the following conditions: chronic low back pain, failed back surgery syndrome with low back pain and significant radicular pain, complex regional pain syndrome, peripheral neuropathy (phantom limb or stump pain, diabetic neuropathy or postherpetic neuralgia
- **Intervention**
  - FDA-approved SCS system (permanently implanted pulse generator systems and radiofrequency receiver systems)
- **Comparator**
  - Medical and/or surgical treatment (appropriate to condition) that does not include comparison of SCS methods/devices or other neuromodulation devices
- **Outcomes**
  - Primary: Function, pain, opioid use, AEs or harms (***SOE on these only***)
  - Economic: Cost-effectiveness (e.g., cost per improved outcome), cost-utility (e.g., cost per quality adjusted life year (QALY), incremental cost effectiveness ratio (ICER) outcome)

PICO Scope: Inclusion Criteria

- **Study Design**
  - Key Questions 1: RCTs will be the primary focus; prospective high quality **comparative** nonrandomized studies of intervention (NRSI) with concurrent controls that control for confounding will be considered.
  - Key Question 2: RCTs and NRSIs designed specifically to evaluate harms/adverse events that are rare or occur long-term (including case series).
  - Key Question 3: RCTs which present results for both intervention and comparator such that they are stratified on patient or other characteristics of interest and test for interaction.
  - Key Question 4: Formal economic studies (i.e., cost-effectiveness, cost-utility, cost-minimization, and cost-benefit studies).
- **Publication**
  - Studies published in English in peer reviewed journals or publicly available FDA reports, published HTAs; KQ 4 full/formal economic studies published after those in the prior HTA

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Methods

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Systematic Review Process

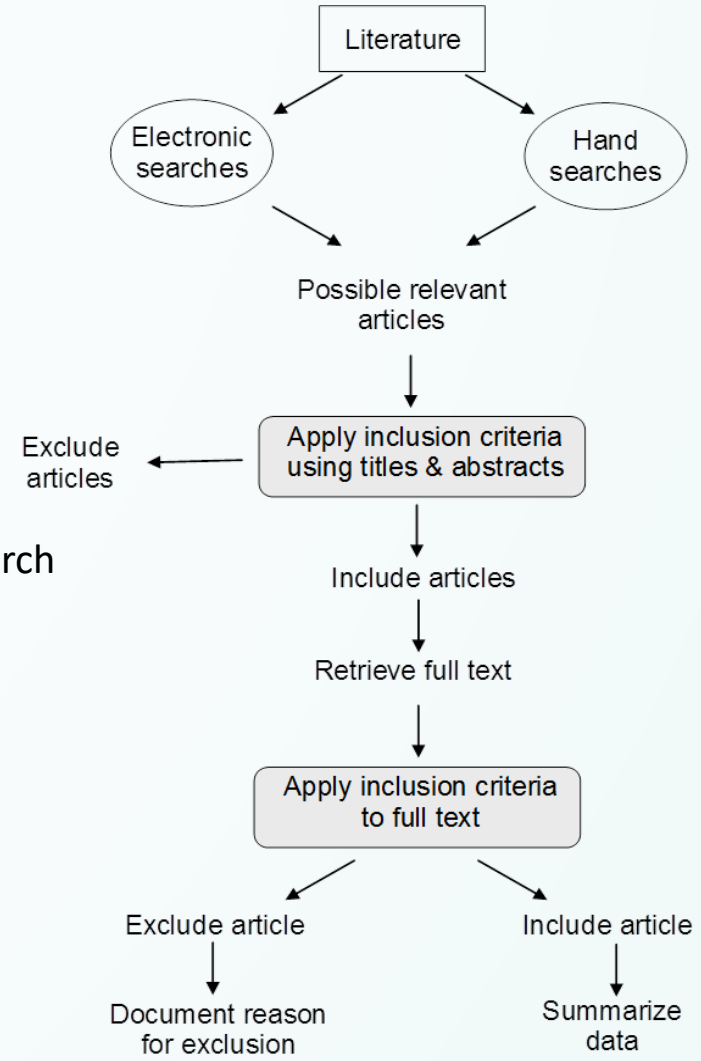
Methodological Standards:
AHRQ, IOM/NASEM, Cochrane

Topic Refinement
- Key questions
- Scope (inclusion/exclusion)
  - Population
  - Intervention
  - Comparators
  - Outcomes
  - Timing
  - Studies
  - Setting
- Preliminary Search

Finalization/Work Plan

Role of Clinical Experts

Formal, Structured Search



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Quality (Risk of Bias) Assessment

Predefined criteria used to assess individual studies based on study design and methods (AHRQ, Cochrane); independent, dual assessment

Rating	Description and Criteria
Good	• **Low ROB, most criteria for methodologic quality are met** and results generally considered valid • Valid methods for selection, inclusion, and treatment allocation; report similar baseline characteristics in different treatment groups; clearly describe attrition and have low attrition; appropriate means for preventing bias and use of appropriate analytic methods
Fair	• **Some study flaws: May not meet all criteria for good quality**, but no flaw is likely to cause major bias that would invalidate results; the study may be missing some information making it difficult to assess limitations and potential problems**. This is a broad category; results from studies may or may not be valid**.
Poor	• **Significant flaws that imply methodologic biases of various kinds that may invalidate results**; most criteria for a good quality study are not met and/or "fatal flaws" in design, analysis or reporting are present; large amounts of missing information; discrepancies in reporting; or serious problems with intervention delivery

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Individual Studies: Risk of Bias –Appendix E

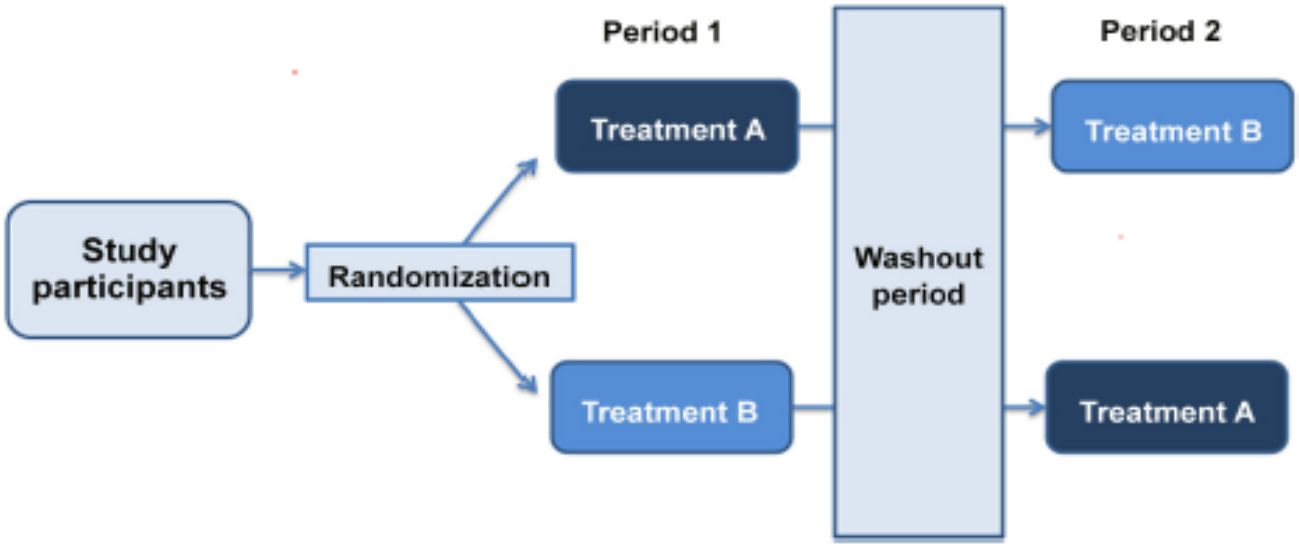
Study Methods Criteria (areas for possible downgrade)

Parallel RCTs

- Random sequence generation
- Statement of allocation concealment
- Intent-to-treat analysis
- Blinding (patients, providers, assessors)
- Groups comparable at baseline
- Complete follow-up of >80% ,
- <10% difference in follow-up between groups
- Reported specified outcomes

Individual Studies: Risk of Bias –Appendix E

Study Methods Criteria (areas for possible downgrade)



Li T, PLoS ONE 10(8): e0133023

Cross-over RCTs (random sequence, concealment, blinding)

- Group comparability baseline/first period
- Washout, mitigation of carryover or carryover effect test
- Completeness of outcome data
- Correlated data analysis

Individual Studies: Risk of Bias

Study Methods Criteria (areas for potential downgrade)

Nonrandomized Studies of Intervention (Observational)

- Patient sampling (random, consecutive) from the same underlying population
- Groups comparable at baseline on key prognostic factors
- Blind, independent assessment of outcomes/analysis
- Follow-up of >80%
- <10% difference in follow-up between groups
- Prespecified outcomes
- Accurate measurement methods
- Follow-up duration reasonable for investigated events
- Controlling for possible confounding
    - Multivariate analysis, matching (including propensity)

*case series are considered at high risk of bias

Strength of Evidence (SoE)- is not the same thing as study risk of bias

SoE for <u>overall body of evidence</u> for primary outcomes is assessed based on:

- **Risk of bias**: the extent to which the individual included studies protect against bias
  - Appropriate randomization
  - Allocation concealment
  - Intention to treat analysis
  - Blind assessment of outcomes
  - Adequate follow-up (≥80%) and <10% follow-up difference between groups
  - Controlling for confounding
- **Consistency**: degree to which estimates across studies of a specific outcome are similar in terms of effect direction, magnitude, range; (Unknown for single study)
- **Directness**: whether the evidence is directly related to patient health outcomes. NOTE: None were considered indirect.
- **Precision**: level of certainty (variability) surrounding the effect estimates.
- **Publication/report bias**: selective reporting or publishing.

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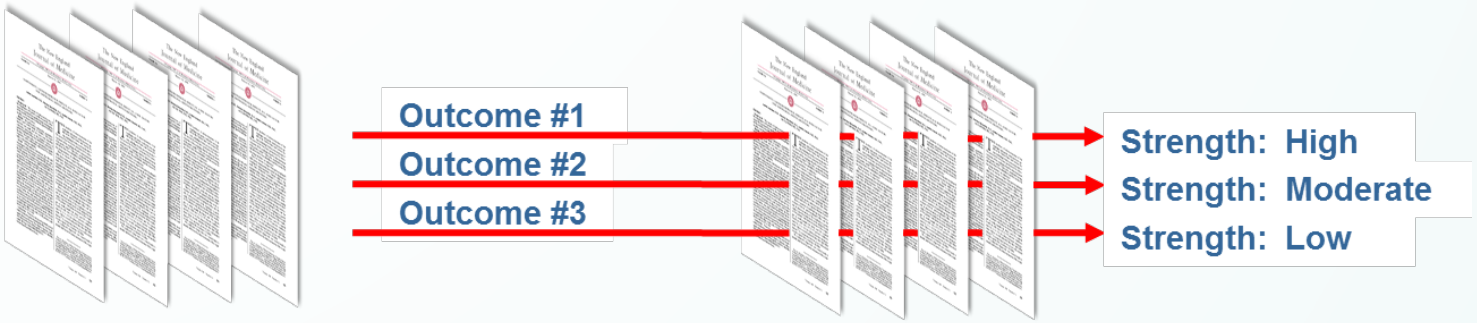
Systematic Review Process

Studies meeting eligibility criteria
- Efficacy: RCTs
- Harms: RCTs, observational studies
- Economic studies (SOE not done)

Risk of Bias Appraisal (Study)
Good, Fair, or Poor
Synthesis/analysis

Overall Strength of Evidence Determination (GRADE/AHRQ)



Strength of Evidence Ratings	
High	Very confident that effect is true.
Moderate	Moderately confident.
Low	Limited confidence.
Insufficient	No evidence or no confidence in effect.

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Magnitude of Effects (Appendix J)

Slight/Small	Moderate	Large/Substantial
Pain		
5–10 points on a 0-to 100-point VAS or the equivalent	>10–20 points on a 0-to 100-point VAS or the equivalent	>20 points on a 0-to 100-point VAS or the equivalent
0.5–1.0 points on a 0-to 10-point numerical rating scale or the equivalent	>1–2 points on a 0-to 10-point numerical rating scale or the equivalent	>2 points on a 0-to 10-point numerical rating scale or the equivalent
Function		
5–10 points on the ODI	>10–20 points on the ODI	>20 points on the ODI
Pain or function		
1.2 to 1.4 RR/OR	1.5 to 1.9 RR/OR	≥2.0 RR/OR

Based on mean between-group differences for continuous scores

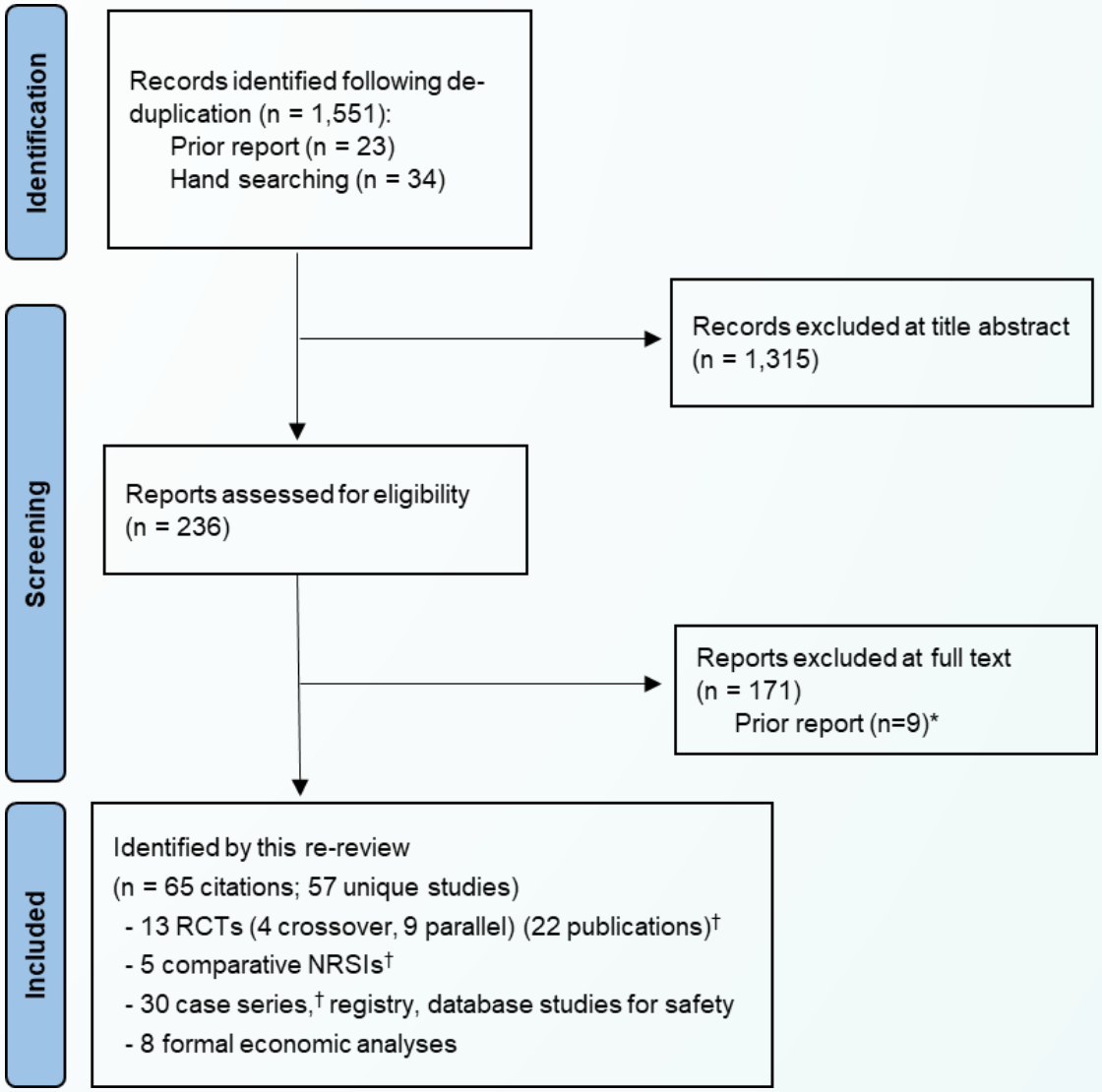
Small effects may be below published thresholds for clinically meaningful effects. However, for some patients, a small improvement in pain or function may be important.

Effects below the threshold for small were categorized as no effect (similar between groups)

Results

Included Literature

- **Literature search**
  - PubMed, Embase, Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews searched 2010 to June 6, 2023
  - Dual abstract review
  - Dual full text review
  - Conference abstracts, non-English-language articles, duplicate publications that did not report different data or follow-up times, white papers, editorials, narrative reviews, preliminary reports, and incomplete economic evaluations excluded



†3 parallel RCT (in 7 publications), 1 prospective comparative NRSI, 6 case series carried over from prior report.

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Overview of Evidence Base

Condition	No. RCTs (Pubs.)	RCT Industry Funded	No. Comp NRSI	No. Case series for safety
FBSS or Nonsurgical refractory back pain				
TOTAL:	7 (10)	5	5	n/a
PAINFUL DIABETIC NEUROPATHY				
TOTAL:	3 (7)	3	0	n/a
COMPLEX REGIONAL PAIN SYNDROME				
TOTAL:	3 (5)	1	0	n/a
TOTAL OVERALL				
– ***Crossover RCTs***	**4**	**50% (2/4)**		
– ***Parallel RCTs***	**9 (18)**	**78% (7/9)**		
– ***NRSIs***			**5**	**30**

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Key Question (KQ) 1: Effectiveness

Primary outcomes:
Pain, Function, Opioid use

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KQ 1 Overview of Evidence Base: Chronic back pain

Condition Intervention vs. Comparator	No. RCTs (Pubs.)	RCT Industry Funded	No. Comp NRSI	No. Case series for safety
CHRONIC BACK PAIN				
Failed back surgery syndrome				
*Crossover trials**				
SCS (Various)† vs. Sham	3	1	n/a	n/a
Parallel trials				
Conventional SCS vs. CMM	2 (5)	2	4	n/a
Conventional SCS vs. Reoperation	1	1	1	n/a
Nonsurgical refractory back pain				
*Parallel trials**				
HF (10 kHz)-SCS vs. CMM	1	1	0	n/a
TOTAL:	7 (10)	5	5	n/a

Crossover trials: Various frequencies and/or modes of operation(e.g., burst) compared with each other and sham (placebo)

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Patient and Intervention Characteristics:
SCS vs. Placebo
(Crossover trials, back pain)

3 crossover RCTs (1 industry funded), 3 publications, N=84 analyzed

- Mean age 50.4 years (range 48 to 57)
- Female: 37.9% (range 14% to 54%)
- Pain duration at least 6 months
- 2 trials required failed conventional medical management
- Trials did not provide details on multidisciplinary evaluation
- All trials excluded individuals with psychological comorbidities
- All trials excluded individuals with substance use disorders
- All patients were implanted and randomly assigned to phases with different SCS programs including a variety of SCS settings (HF-SCS, LF-SCS, burst SCS, cluster activated SCS, etc.) and a placebo/sham setting
- Heterogeneity across studies: populations studied, SCS methods, reporting

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KQ 1 - Chronic back pain: SCS vs. Sham; Crossover trials

	Al-Kaisy 2018 (FAIR)	Hara 2022 (GOOD)	Sokal 2020 (POOR)
Screening	Yes (NOS)	Yes (NOS)	Yes (NOS)
N enrolled	53	65	23*
N, SCS trial complete	36	61	16*
Trial threshold	≥50% pain reduction	≥2 pt NRS reduction -leg pain	≥50% reduction
Permanent implant	92% (33/36)	82% (50/61)	18*
Same device/mode	Unclear	No†	Unclear
N random, analyzed	30, 24	50, 42	18, 18*
Comorbidities	NR	64%	NR
Condition, diagnosis	FBSS (NOS)	Lumbar surgery, radicular pain	FBSS 78% (NOS)
Prior surgery	Yes, (NOS)	Median: 2 (1-3), diskectomy 76%, Fusion 26%, Decompression 22%	Yes (FBSS, NOS)
Active Treatments	1200 Hz, 3030 Hz, 5882 Hz	Burst- 40 HZ, 50% to 70% paresthesia perception threshold	LF: 40-60 Hz, HF (1000 Hz), cluster tonic
Sham	IPG discharge; no stim	No stimulation	IPG deactivated
N Tx periods/length	4 (3 wks)	2 (12 wks)	4 (2 wks)
Washout period	No	Unclear/No	No
Check period effects	Yes	No	No
1st Phase data	NR	NR	NR
Co-intervention, medications	NR	Daily pain meds (baseline) Overall: 64% Opioids: 36%,	Model estimates, Timing NR: Opioids: 49%, NSAIDS: 72%
Funding	Industry	Non-industry	None

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KQ 1 Chronic back pain – SCS vs. Sham, cross-over trials
FUNCTION

Outcome	Crossover phases, time	Studies N (randomized)	SCS vs. Sham Effect estimate (95% CI) Conclusion	Quality (SoE)
Function: ODI (0-100 scale)	2, 12-week phases per intervention Burst vs. Sham SCS	1 RCT (N=50) Hara	M**ean, 95%CI** 34.0 (95% CI 30.0 to 38.1) vs. 35.4 (95% CI 31.3 to 39.4) **MD in change scores:** -1.3 (95% CI -3.9 to 1.3, p=0.32) **Conclusion**: Similar functional improvement between burst SCS and sham	⊕⊕⊕◯ MODERATE (unknown consistency)

Patients: Persistent radicular pain following low back surgery

KQ 1 Chronic back pain, SCS vs. Sham, cross-over trials: Pain

Outcome	Crossover phases, time	Studies N (randomized)	SCS vs. Sham Effect estimate (95% CI) Conclusion	Quality (SoE)
Back pain VAS or NRS (0-10 scale)	2, 12-week phases per intervention	Burst vs. Sham 1 RCT (N=50) Hara 2022 Persistent radicular pain after surgery	**MD**, −0.2 (95% CI −0.7 to 0.2), p=0.32 **<u>Conclusion</u>: Similar back pain improvement between burst SCS and sham**	⊕⊕⊕◯ MODERATE (unknown consistency)
	For 4, 3-week phases (over 12 weeks)	Multiple frequencies (1200 Hz, 3030 Hz, 5882 Hz) vs. sham 1 RCT (N=24) Al-Kaisy 2018 FBSS	**MD (95%CI) from author data** 1200 Hz vs. Sham: MD -0.32 (-1.59 to 0.94) 3030 Hz vs. Sham: MD -0.26 (-1.58 to 1.06) **5882Hz vs. Sham:** **MD-1.61 (-2.67 to -0.55) CI calculated from p-value** MD (95%CI) Calculated by Cochrane* 1200 Hz vs. Sham: MD -0.32 (-2.17 to 1.54) 3030 Hz vs. Sham: MD -0.26 (-2.1 to 1.63) 5882 Hz vs. Sham: MD-1.61 (-3.48 to 0.26) **<u>Conclusion</u>: Insufficient evidence to draw firm conclusions**.	⊕◯◯◯ INSUFFICIENT (ROB, unknown consistency, imprecision)

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KQ 1 Chronic back pain, SCS vs. Sham, cross-over trials: Pain

Outcome	Crossover phases, time	Studies N (randomized)	SCS vs. Sham Effect estimate (95% CI) Conclusion	Quality (SoE)
Leg pain (0-10 scale)	2, 12-week phases per intervention	Burst vs. Sham 1 RCT (N=50) Hara 2022	MD, −0.2 (95% CI −0.7 to 0.2), p=0.32 **Conclusion:** Similar leg pain improvement between burst SCS and sham	⊕⊕◯◯ LOW (unknown consistency, imprecision)
	For 4, 3-week phases (over 12 weeks)	Multiple frequencies (1200 Hz, 3030 Hz, 5882 Hz) vs. sham 1 RCT (N=24) Al-Kaisy 2018 FBSS	Mean (SD or CI) Sham: 2.51 (NR) 1200 Hz: 2.37 (NR) 3030 Hz: 2.20 (NR) 5882 Hz: 1.81 (NR) P across groups = 0.367 **Conclusion:** Evidence insufficient to draw conclusions	⊕◯◯◯ INSUFFICIENT (ROB, unknown consistency, imprecision)
VAS Pain (NOS, 0-10 scale)	4, 2-week periods per intervention	1 RCT (N=18) Sokal 2020 FBSS	**Adjusted MD (95%CI)*** 1000 Hz: -0.17 (-0.77 to 0.43) LF tonic: -0.99 (-2.25 to 0.27) Cluster tonic: -0.03(-1.06 to 1.0) **Conclusion:** Evidence from this poor-quality trial is insufficient.	⊕◯◯◯ INSUFFICIENT (ROB -2, unknown consistency, imprecision)

Patient and Intervention Characteristics:
SCS vs. CMM/Reoperation (Parallel Trials, FBSS and NSRBP)

4 RCTs (4 industry funded), 6 publications, N=577

- Mean age 47.9 years (range 38 to 54)
- Female: 56.8% (range 48.7% to 60.6%)
- Pain duration ranged from 6.7 years to 8.3 years
- 3 trials used conventional SCS, 1 trial used 10 kHz HF-SCS
- 3 trials compared SCS vs. CMM, 1 trial compared SCS vs. Reoperation
- 2 trials required failed conventional medical management
- 2 trials used multidisciplinary evaluation
- 3 trials excluded individuals with psychological comorbidities
- 2 trials excluded individuals with substance abuse disorders
- Patients randomized to SCS underwent trial; if successful trial patients had permanent implant.
- All trials allowed patients to cross over to SCS after 6 months.
- Heterogeneity in populations studied and SCS devices/methods

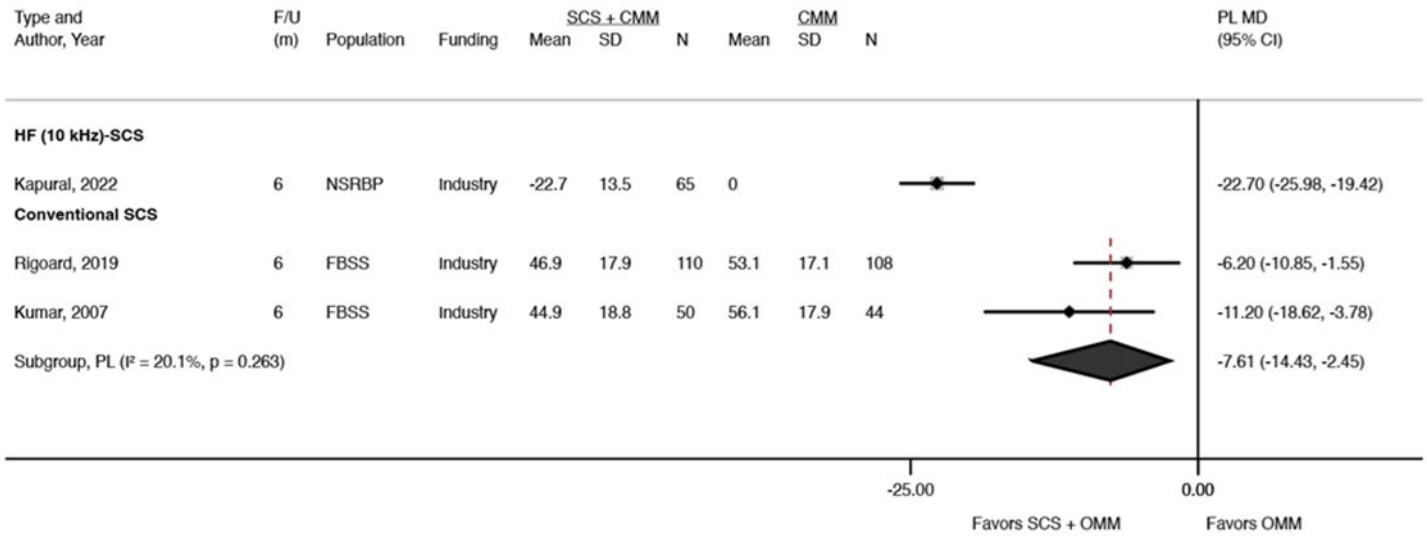
Aggregate Analytics

KQ 1 Chronic back pain – SCS vs. CMM, Parallel Trials
Function – ODI Responders and ODI scores

Function - ODI Responder

Author, year	Definition	Timing	10 kHz SCS % (n/N)	CMM % (n/N)	RR (95% CI)	Conclusion SOE
Kapural, 2022 **NSRBP** **HF (10 kHz) SCS** **PP analysis**	≥10 point reduction in ODI score (0-100)	1 mos.	67.7% (46/68)	8.1% (6/75)	8.45 (3.86, 18.54)	**Large improvement** **SOE: LOW** *Downgrades*: RoB, Imprecision
		3 mos.	80.9% (55/68)	12.0% (9/75)	6.74 (3.61, 12.58)	
		6 mos.	78.5% (51/65)	4.0% (3/75)	18.75 (6.13, 57.31)	

Function - ODI Scores (0-100 scale): Different SCS and population



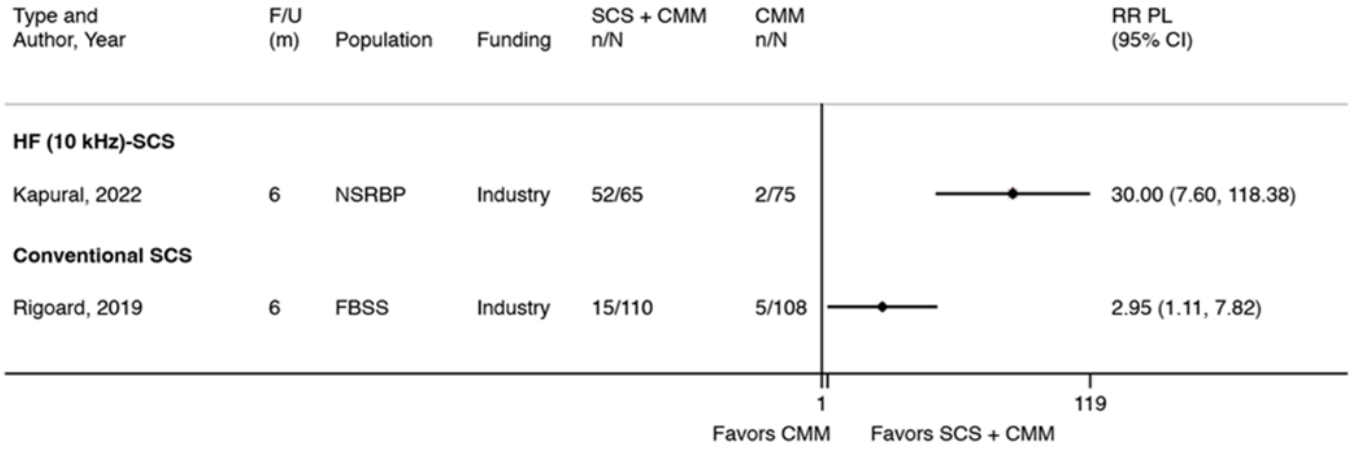
<u>HF SCS</u>:
Large improvement
MD -22.7 (-26.0, -19.4)

<u>Conv. SCS</u>:
Small improvement
MD -7.6 (-14.5, -2.5), I^2=20%

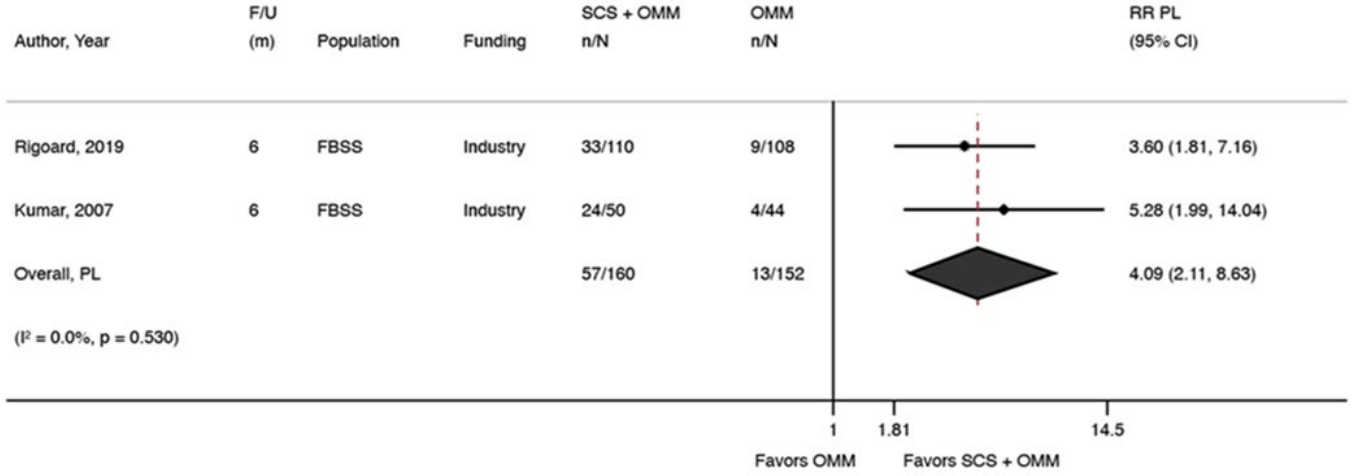
SOE: LOW
(RoB, Imprecision)

KQ 1 Chronic back pain – SCS vs. CMM, Parallel Trials
Pain Responders (≥ 50% decrease, 0-10 VAS)

Back Pain Responders



Leg Pain Responders (Conventional SCS)



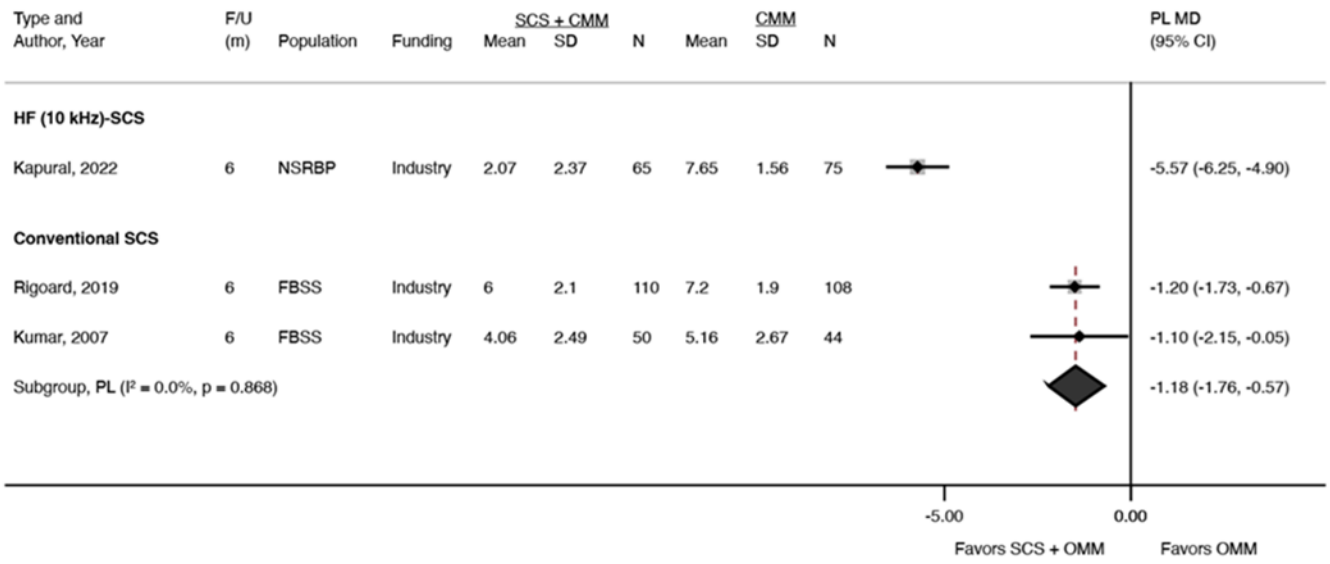
Large improvement (both outcomes) for both HF and Conv.

Same conclusion at 3 months (back pain, 1 RCT, HF SCS; leg pain, 1 RCT, conv. SCS)

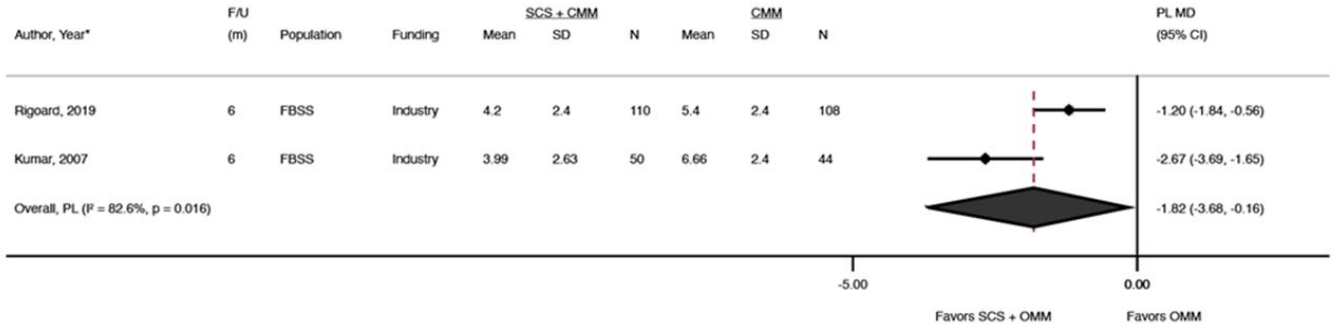
SOE: LOW for all (RoB, Imprecision)

KQ 1 Chronic back pain – SCS vs. CMM, Parallel Trials
Pain Scores (0-10 VAS)

Back Pain



Leg Pain (Conv. SCS)



Back Pain

HF SCS: Large improvement

Conv. SCS: Moderate improvement

3 months: Same conclusion in HF SCS trial; small improvement in 1 Conv. SCS trial

SOE: LOW (RoB, imprecision)

Leg Pain

Pooled MD -1.8 (-3.7, -0.16), I^2=83%, Moderate improvement

Substantial heterogeneity, diff. in patient populations

SOE: LOW (RoB, Imprecision)

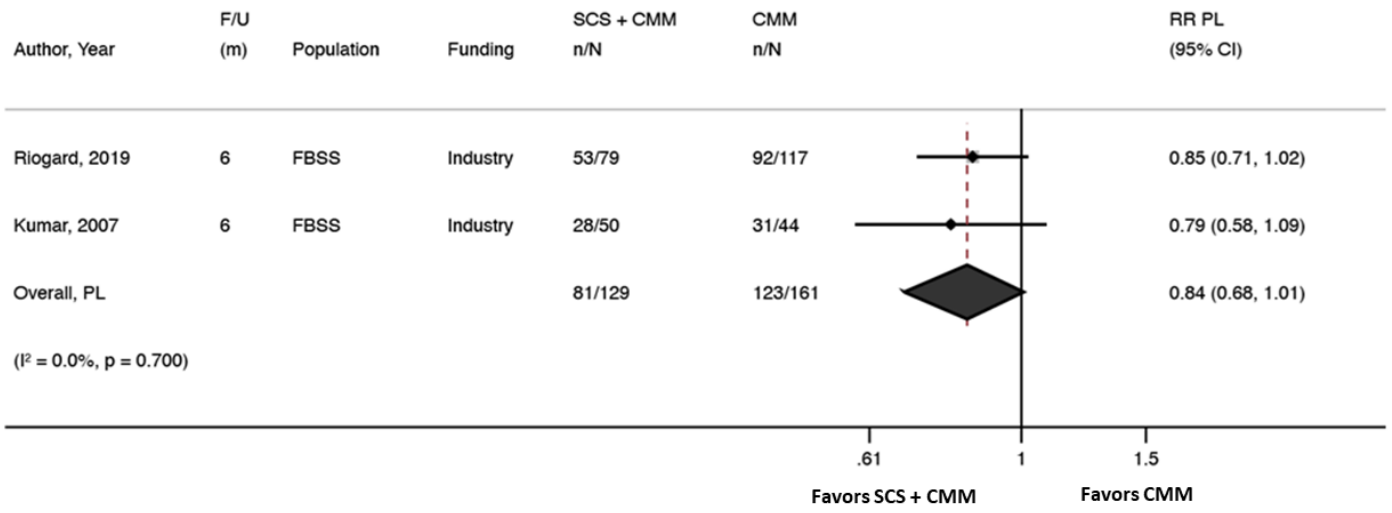
KQ 1 Chronic back pain – SCS vs. CMM, Parallel Trials
Opioid use

Change in Opioid Use (HF 10 kHz SCS)

Author, year	Outcome	10 kHz SCS % (n/N)	CMM % (n/N)	RR (95% CI)
Kapural, 2022 NSRBP 6 months PP analysis	Stopped use	22% (16/65)	0% (0/75)	NC, p<0.05
	Decreased use	44% (27/65)	17% (13/75)	2.40 (1.35 to 4.25)
	Increased use	6% (4/65)	49% (37/75)	0.12 (0.05 to 0.33)

Substantially more **HF SCS** patients decreased or stopped opioid use; substantially fewer increased opioid use

Proportion Using Opioids (Conv. SCS)

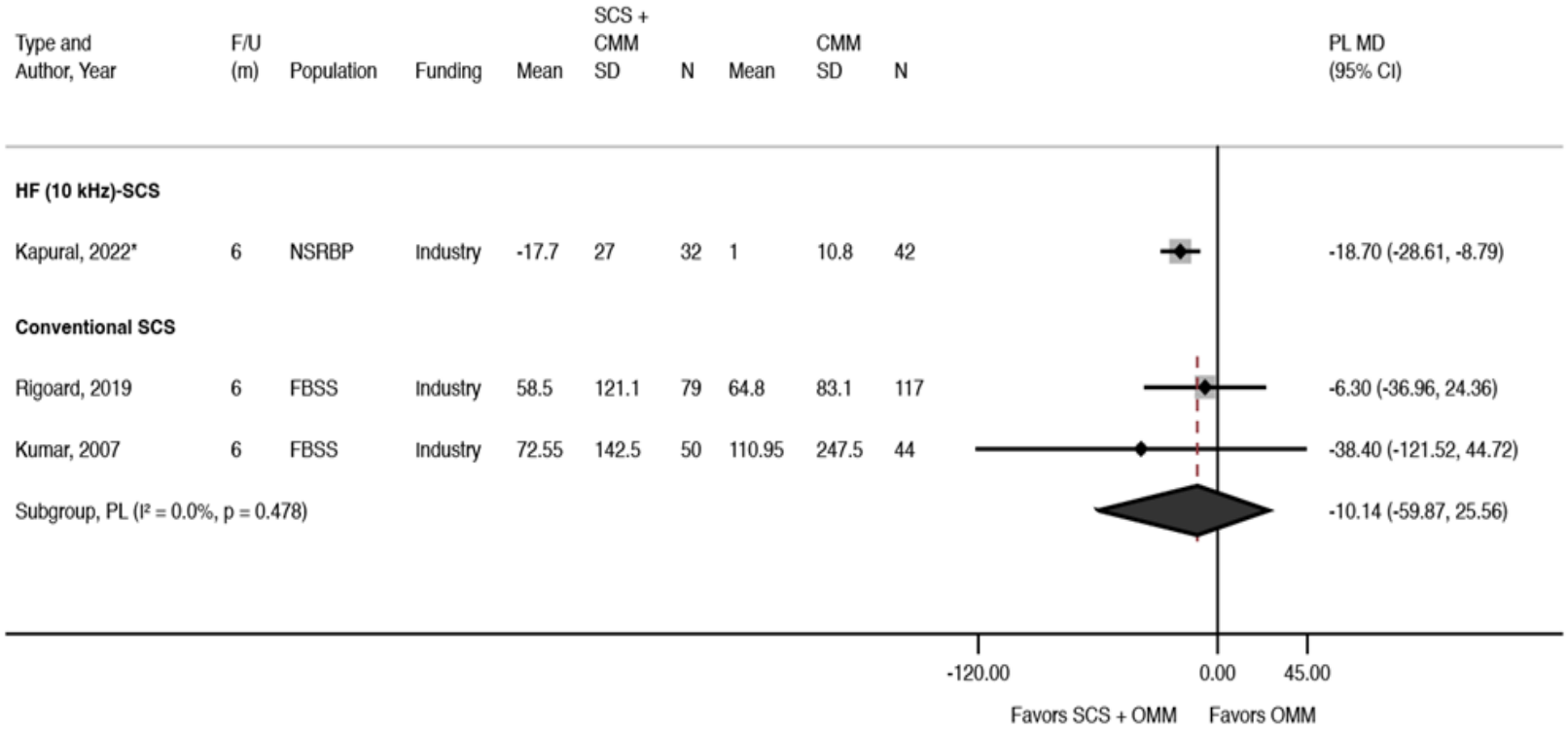


Small decrease in the likelihood of continued opioid use with **Conv. SCS**

SOE: LOW for all (RoB, Imprecision)

KQ 1 Chronic back pain – SCS vs. CMM, Parallel Trials
Opioid use

Mean daily MME dose (mg)



HF SCS: Stat. significant reduction in mean MME dose, clinical significance unclear (**SOE: Low**, ROB, imprecision)

Conv. SCS: Similar between groups (**SOE: Insufficient,** RoB, Inconsistency, Imprecision)

KQ 1 Chronic back pain – SCS vs. Reoperation

All evidence considered **INSUFFICIENT** to draw conclusions (ROB, unknown consistency, imprecision)

1 small (N=45), fair-quality RCT, FBSS
SCS associated with a:

- Large increase in the likelihood of achieving treatment success (pain relief ≥ 50% and patient satisfied)
- Moderate increase in likelihood of being on a stable or decreased dose of opioids versus reoperation

Aggregate Analytics

KQ 1 Overview of Evidence Base: Painful Diabetic Neuropathy

Condition Intervention vs. Comparator	No. RCTs (Pubs.)	RCT Industry Funded	No. Comp NRSI	No. Case series for safety
PAINFUL DIABETIC NEUROPATHY				
*Parallel trials**				
HF (10 kHz)-SCS vs. CMM	1 (3)	1	0	n/a
Conventional SCS vs. CMM	2 (4)	2	0	n/a
TOTAL:	3 (7)	3	0	n/a

Aggregate Analytics

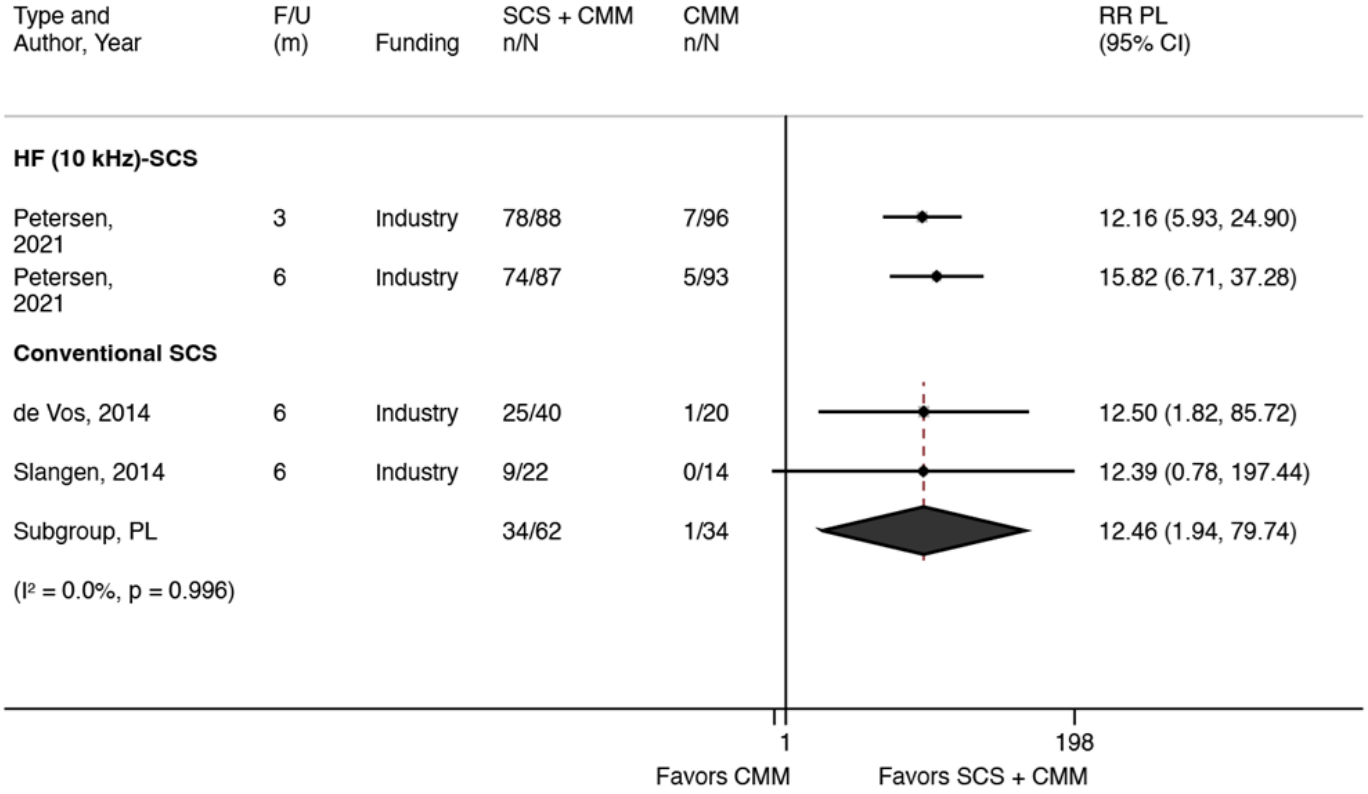
Patient and Intervention Characteristics:
SCS vs. CMM (PDN)

3 RCTs (3 industry funded), 7 publications, N=312

- Mean age 60.2 years (range 57 to 61)
- Female: 54.5% (range 33% to 63%)
- Pain duration ranged from 5.5 years to 7 years
- 2 trials used conventional SCS
- All trials required failed conventional medical management
- 1 trials used multidisciplinary evaluation
- All trials excluded individuals with psychological comorbidities
- All trials excluded individuals with substance abuse disorders
- Patients randomized to SCS underwent trial; if successful trial patients had permanent implant.
- All trials allowed patients to cross over to SCS after 6 months.

Aggregate Analytics

KQ 1 PDN – SCS vs. CMM, Parallel RCTs
Pain responders (≥50% reduction in LE pain on VAS/NRS, 0-10)



Large increase in the likelihood of achieving LE pain response for all:

HF SCS:
3 and 6 months

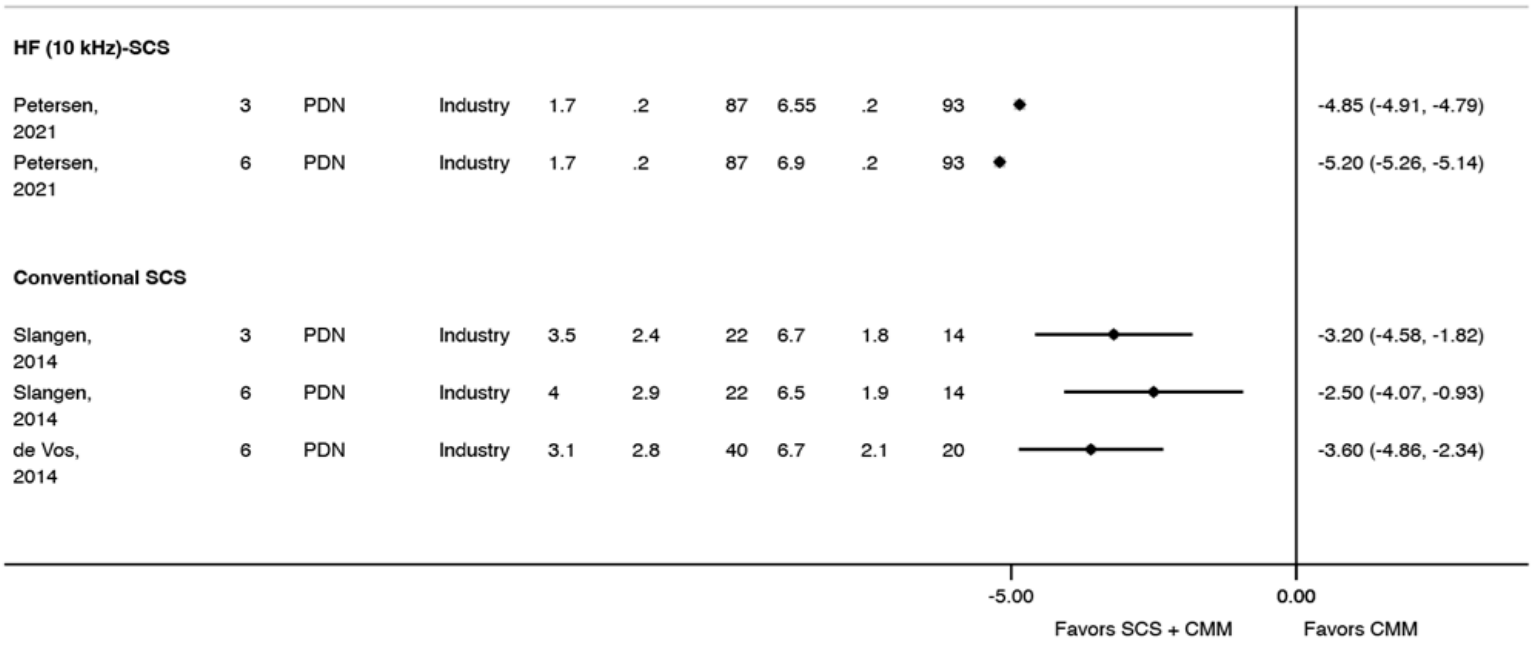
Conv. SCS:
6 months, pooled RR 12.5 (1.9, 79.7), I^2=0%

SOE LOW for all
(RoB, Imprecision)

Aggregate Analytics SOE

KQ 1 PDN – SCS vs. CMM, Parallel RCTs
LE pain scores (VAS/NRS 0-10)

Type and Author, Year	F/U (m)	Population	Funding	SCS + CMM Mean	SCS + CMM SD	SCS + CMM N	CMM Mean	CMM SD	CMM N	PL MD (95% CI)
HF (10 kHz)-SCS										
Petersen, 2021	3	PDN	Industry	1.7	.2	87	6.55	.2	93	-4.85 (-4.91, -4.79)
Petersen, 2021	6	PDN	Industry	1.7	.2	87	6.9	.2	93	-5.20 (-5.26, -5.14)
Conventional SCS										
Slangen, 2014	3	PDN	Industry	3.5	2.4	22	6.7	1.8	14	-3.20 (-4.58, -1.82)
Slangen, 2014	6	PDN	Industry	4	2.9	22	6.5	1.9	14	-2.50 (-4.07, -0.93)
de Vos, 2014	6	PDN	Industry	3.1	2.8	40	6.7	2.1	20	-3.60 (-4.86, -2.34)



6 months: pooled MD -3.2 (-4.5 to -1.7), I^2=12.7%

- Both types of SCS associated with a large improvement in LE pain scores at 3 months (1 RCT each) and 6 months (1 RCT, HF SCS; 2 RCTs, Conv. SCS)
- **SOE: LOW for all** (RoB, Imprecision)

Aggregate Analytics

KQ 1 PDN – SCS vs. CMM, Parallel RCTs
Opioid Use

1 RCT (N=60), Conventional SCS (+ CMM) vs. CMM, 6 months

Similar between groups:

- Proportion taking opioids:
  37.5% (15/40) vs. 55.0% (11/20); RR 0.68 (95% CI 0.39 to 1.20)
- Medication Quantification Scale III scores
  MD -2.4 (95% CI -7.08 to 2.28)

SOE: LOW for both outcomes (RoB, Imprecision)

Aggregate Analytics

KQ 1 Overview of Evidence Base: Complex Regional Pain Syndrome (CRPS)

Condition Intervention vs. Comparator	No. RCTs (Pubs.)	RCT Industry Funded	No. Comp NRSI	No. Case series for safety
COMPLEX REGIONAL PAIN SYNDROME				
Crossover trials[*]				
SCS[‡] vs. Sham	1	1	n/a	n/a
Parallel trials[*]				
HF (10 kHz)-SCS vs. CMM	1	0	0	n/a
Conventional SCS vs. CMM	1	0	0	n/a
Conventional SCS vs. PT	1 (3)	0	0	n/a
TOTAL:	3 (5)	1	0	n/a

Aggregate Analytics

Patient and Intervention Characteristics: SCS vs. PT/CMM (CRPS, Parallel); SCS vs. Sham (CRPS, Crossover)

2 RCTs (0 industry funded), 4 publications; 1 crossover RCT (industry), N=95

- Mean age 42.5 years (range 38 to 49)
- Female: 54.5% (range 14% to 78%)
- Pain duration ranged from at least 12 months to 38 months
- 1 trial used conventional SCS+PT vs. PT alone, 1 trial used LF-SCS vs. CMM, crossover trial used LF-SCS, HF-SCS, burst SCS, and placebo
- All trials required failed conventional medical management
- All trials used multidisciplinary evaluation
- 1 trials excluded individuals with psychological comorbidities
- 2 trials excluded individuals with substance abuse disorders
- **Parallel RCTs**, patients implanted with SCS devices after successful trial. One trial allowed patients to cross over to PT at trial failure; the other allowed cross-over at 6 months.
- **Crossover RCT**, patients randomly assigned to different SCS settings (HF-SCS, LF-SCS, burst SCS) and a sham/placebo setting; Trial included a 2-day washout between settings.

Aggregate Analytics

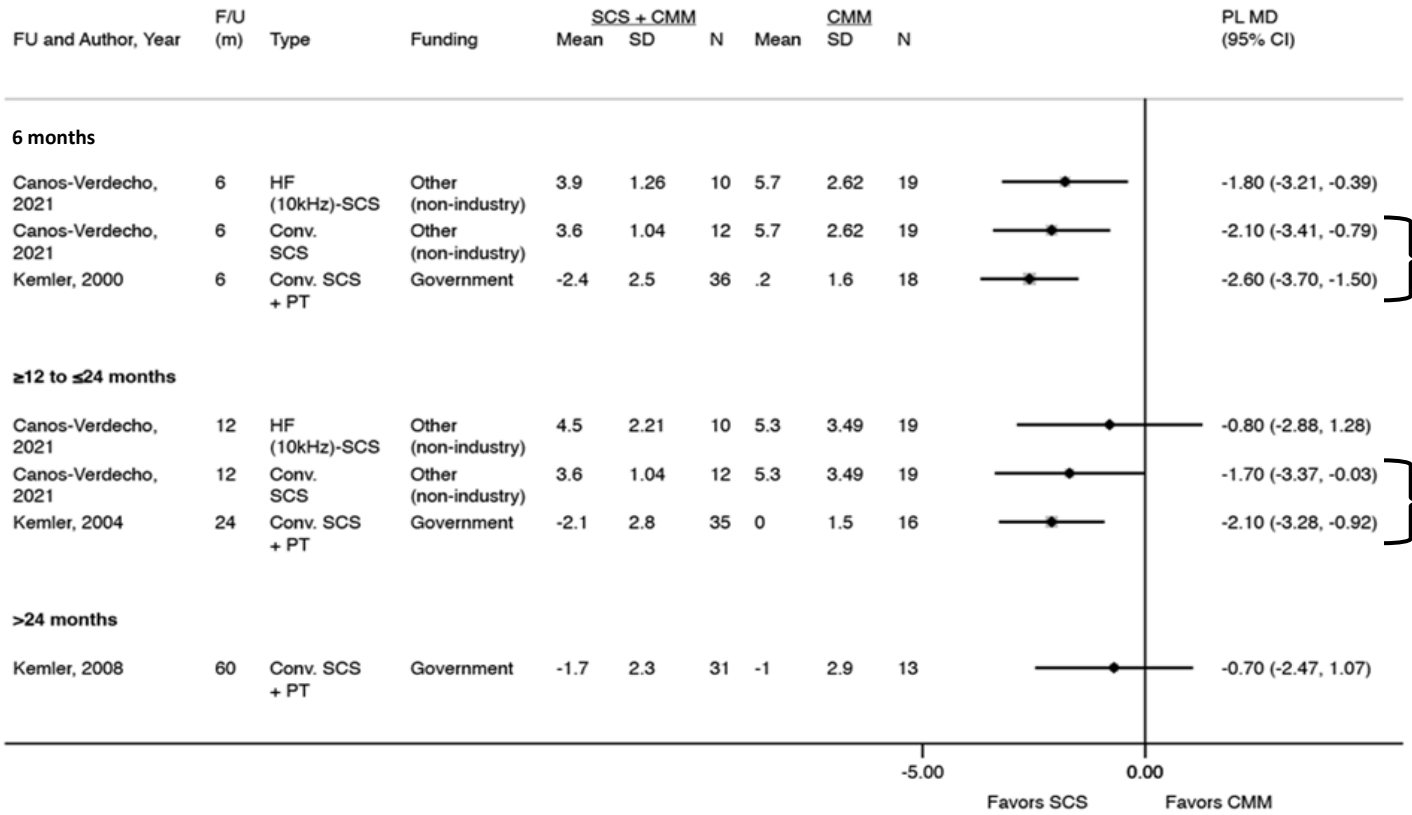
KQ 1 CRPS – SCS vs. CMM, Parallel RCTs
Function scores (ODI, 0-100)

Evidence from one poor-quality trial was INSUFFICIENT to draw conclusions

			Mean (SE)			MD (95% CI)	
Author, year	**Outcome**	**Timing**	**10 kHz SCS (n=10)**	**Conv. SCS (n=12)**	**CMM (n=19)**	**10 kHz SCS vs. CMM**	**Conv. SCS vs. CMM**
Canos-Verdecho, 2021 ***Poor-quality*** **ITT analyses**	ODI (0-100, worst)	*Baseline*	*65.0 (6.6)*	*58.5 (4.3)*	*32.4 (4.4)*	*32.6 (25.76, 39.44)*	*26.1 (20.56, 31.64)*
		3 mos.	29.4 (3.4)	17.3 (3.0)	31.5 (4.4)	-2.1 (-5.66, 1.46)	-14.2 (-18.81, -9.59)
		6 mos.	31.20 (3.6)	16.8 (3.0)	22.9 (4.5)	8.3 (4.54, 12.06)	-6.1 (-10.77, -1.43)
		12 mos.	33.2 (4.8)	17.0 (3.0)	22.0 (4.7)	11.2 (6.23, 16.17)	-5.0 (-9.79, -0.21)

Aggregate Analytics

KQ 1 CRPS – SCS vs. CMM, Parallel RCTs
Pain scores (VAS/NRS 0-10)



Conv. SCS: 6 months, pooled MD -2.39 (-3.39 to -1.34), I^2=0%

Conv. SCS: 12-24 months, pooled MD -1.97 (-3.08 to -0.77), I^2=0%

- **HF (10 kHz) SCS, 1 poor-quality RCT:** Moderate improvement at 6 mos., similar at 12 mos. *(**SOE: INSUFFICIENT,** ROB, unknown consistency, imprecision)*

- **Conv. SCS, 1 fair-, 1 poor-quality RCT:** Large (6 mos.) and moderate (12-24 mos.) improvement, similar at 60 mos. *(**SOE: LOW** based on fair-quality trial)*

KQ 1 CRPS – SCS vs. Placebo (Crossover trial)

Evidence from one poor-quality trial was INSUFFICIENT to draw conclusions

Outcome	SCS type	SCS Mean (SD)	Sham Mean (SD)	MD, (95% CI unadjusted)	MD, (95% CI adjusted) O'Connell – Cochrane
Primary Outcomes					
VAS Pain (0-10)	40 Hz	3.98 (2.53)	6.37 (1.89)	-2.39 (-3.57 to -1.22)	-2.39 (-4.35 to -0.43)
	500 Hz	4.01 (2.66)		-2.36 (-3.58 to -1.15)	Not calculated
	1200 Hz	4.29 (2.58)		-2.08 (-3.27 to -0.89)	-2.08 (-4.1 to -0.06)
	Burst	4.798 (2.82)		-1.58 (-2.84 to -0.31)	-1.5 (-3.79 to 0.65)
McGill NRS Average pain (0-10)	40 Hz	4.70 (2.15)	7.07 (1.51)	-2.37 (-3.35 to 1.39)	NR
	500 Hz	5.10 (2.42)		-1.97 (-3.03 to -0.91)	NR
	1200 Hz	5.31 (2.48)		-1.76 (-2.84 to -0.68)	NR
	Burst	5.66 (2.64)		-1.41 (-2.54 to -0.28)	NR

Aggregate Analytics

Key Question (KQ) 2: Safety

Aggregate Analytics

KQ 2: Safety and Adverse events
Evidence from trials – SOE Low

Low SOE for the following AE categories reported in RCTs:

- **Any SCS related AE:** 12.4% to 17.6% within 6 months (2 RCTs, Ns = 102 and 113) and 24.1% to 32.1% between 12-24 months (3 RCTs, Ns 84 to 174) in parallel group RCTs; 18% in 1 cross-over trial (N=50)

- **SCS-related AEs requiring surgery**: 11.8% to 16.7% at 6 months (Ns 24 and 102) and from 23.8% to 37.5% at 12-24 months (Ns, 24 to 102) in 2 parallel group RCTs

- **Withdrawal due to AEs** similar for SCS and CMM within 6 months of implant; substantial imprecision in estimates noted.

KQ 2: Safety and Adverse events
Evidence across study designs: SOE Low or moderate

- **Device-related events (SOE low for all):**

  <u>Most common</u>
  - Any IPG device explantation: 1.4% to 25.2%
  - Any IPG revision or replacement: 0.9% to 22%
  - IPG removal for inadequate pain relief, loss of efficacy, lack of efficacy, inadequate benefit: 0% to 20.3%
  - Any lead/electrode replacement or revision: 3.4% to 17.9% (1 small trial excluded)
  - Lead failure or migration (surgery not specified): 0.9% to 9.5%
  - Lead fracture or failure: 1.1% to 15.8%

  <u>Less common</u>
  - IPG removal for infection (1% to 5%) or infect or dehiscence (2.5% to 4.8%)
  - IPG revision or removal due to IPG displacement or migration: 0.5% to 1.2%
  - Serious infection (deep, fatal, leading to revision, removal, or hospitalization): 1.4% to 6%; reported within 30 days 0.9%
- **Unintentional durotomy 6% (3/50); CSF leak, dural tear 0.6% to 0.7%**
- **Neurologic injury** (deficit, paralysis, intraspinal abscess): 0% to 4% (SOE Moderate)

KQ 2: Safety and Adverse events
Evidence across study designs: SOE Insufficient

- **RCTs (parallel group and crossover)**
  - Mortality
  - Any SCS-related AE requiring surgery long term (60 months)
  - Any serious SCS-related AE
  - Withdrawal due to AE (NOS)
  - 1 small trial in CRPS: serious AE, Electrode dislocation or reconfiguration, unable to attain comfortable paresthesia, SCS parameter concerns
- **Across study designs (for NRSI, studies of >100 pts)**
  - IPG removal due to malfunction
  - Allergic reaction or anaphylaxis
  - AE requiring hospitalization

Aggregate Analytics

Key Question (KQ) 3: Differential efficacy or safety

No Evidence

Key Question (KQ) 4: Cost effectiveness

(Overall SOE is not done for economic studies)

Aggregate Analytics

KQ 4: Cost effectiveness – new studies

8 full new economic studies, 5 industry funded, 2 US-based

- **Back pain, 2 US-based studies –mixed results**
  - FBSS: Cost effectiveness study in Workers Compensation population (good quality)
    - SCS not cost-effective at common WTP thresholds vs. pain clinic referral or UC, 24-month time-horizon
    - Applicability to other populations unclear
  - Nonsurgical refractory back pain (NSRBP):
    - CUA of 10kHz SCS + CMM vs. CMM (poor quality)
    - Base case: SCS cost-effective vs. CMM at 6 months, modeling excluded initial SCS and procedure costs; Inclusion of these costs - ICER <$200K/QALY at 6 months, $100K/QALY at 12 months, cost-effectiveness at ~2.1 years
    - Unclear modeling of AEs, limited sensitivity analyses

KQ 4: Cost effectiveness – new non-US studies

- FBSS, 4 CUAs outside of US (3 good quality, 1 poor):
  - SCS + CMM cost-effective vs. CMM (3 studies) and vs. reoperation (1 study
  - Limitations: time-horizons beyond available clinical data, unclear modeling of long-term benefits and complications. Not all included initial SCS trial or implantation procedure costs; effectiveness assumptions unclear
- CRPS, 3 good quality CUAs
  - SCS + CMM was more cost-effective than CMM alone based on usual willingness to pay thresholds
  - All note concern about lack of high-quality long-term data on benefits, harms, and costs to support long-term modeling but modeled 15-20 year.
  - Modeling of AEs unclear
- PDN, 1 good quality CUA
  - SCS was not cost-effective short term due to substantial initial SCS cost; SCS considered more effective; Cost-effectiveness sensitive to baseline cost imbalances; the impact of imputing missing data was unclear.
- Applicability of non-US studies to US system unclear

Aggregate Analytics

Summary of Findings

Summary: KQ1
Chronic Back Pain, SCS vs. Sham, Crossover Trials

Measure	SCS type(s)	≤3 months	>3 to <12 months	≥12 months
Chronic radiculopathy				
Function: ODI (0-100)	Burst	No evidence	Similar, 1 RCT (SOE: Moderate)	No evidence
VAS back pain (0-10)	Burst	No evidence	Similar, 1 RCT (SOE: Moderate)	No evidence
VAS leg pain (0-10)	Burst	No evidence	Similar, 1 RCT (SOE: Low)	No evidence
FBSS				
Function (any measure)	Various frequencies	No evidence	No evidence	No evidence
VAS back pain (0-10)	1200 Hz 3030 Hz 5882 Hz	Insufficient*	No evidence	No evidence
VAS leg pain (0-10)	1200 Hz 3030 Hz 5882 Hz	Insufficient	No evidence	No evidence
VAS pain, NOS (0-10)	1000 Hz LF tonic Cluster tonic	Insufficient	No evidence	No evidence

Aggregate Analytics

*Favors SCS unless otherwise indicated

Summary: KQ1
FBSS (with radiculopathy*): Conventional SCS vs. CMM – Parallel Trials

Measure	3 months	6 months	≥12 months (comparative)
FBSS with radiculopathy,* Conventional SCS			
LBP Responders (≥50% on VAS/NPRS)	No evidence	Large increase, 1 RCT (N=218) SOE: Low	No evidence
Leg Pain Responders (≥50% on VAS/NPRS)	Large increase, 1 RCT (N=94) SOE: Low	Large increase, 2 RCTs (N=312) SOE: Low	No evidence
LBP pain scores (VAS/NPRS, 0-10)	Small, 1 RCT (N=94) SOE: Low	Moderate, 2 RCTs (N=312) SOE: Low	No evidence
Leg pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=94) SOE: Low	Moderate, 2 RCTs (N=312) SOE: Low	No evidence
Function Responders (≥10-pt. reduction, ODI)	No evidence	No evidence	No evidence
Function scores (ODI, 0-100)	No evidence	Small, 2 RCTs (N=312) SOE: Low	No evidence
Proportion of patients still using opioids	No evidence	Small decrease, 2 RCTs (N=290) SOE: Low	No evidence
Opioid use: mean MME dose	No evidence	2 RCTs (N=312) SOE: Insufficient	No evidence

Favors SCS unless otherwise noted

*1 RCT, patients with leg pain greater than back pain; the other, patients with back pain greater than leg pain

Summary: KQ1
NSRBP, HF (10 kHz) SCS vs. CMM – Parallel Trial

Measure	3 months	6 months	≥12 months (comparative)
Nonsurgical Refractory Back Pain (NSRBP), HF (10 kHz) SCS			
LBP Responders (≥50% on VAS/NPRS)	Large increase, 1 RCT (N=159) SOE: Low	Large increase, 1 RCT (N=140) SOE: Low	No evidence
Leg Pain Responders (≥50% on VAS/NPRS)	No evidence	No evidence	No evidence
LBP pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=143) SOE: Low	Large, 1 RCT (N=140) SOE: Low	No evidence
Leg pain scores (VAS/NPRS, 0-10)	No evidence	No evidence	No evidence
Function Responders (≥10-pt. reduction, ODI)	Large, 1 RCT (N=143) SOE: Low	Large, 1 RCT (N=140) SOE: Low	No evidence
Function scores (ODI, 0-100)	No evidence	Large, 1 RCT (N=140) SOE: Low	No evidence
Proportion of patients who stopped or decreased opioids	No evidence	Large increase, 1 RCT (N=140) SOE: Low	No evidence
Opioid use: mean MME dose	No evidence	1 RCT (N=74) SOE: Insufficient	No evidence

Aggregate Analytics

Favors SCS unless otherwise noted

Summary: KQ1
FBSS, SCS vs. Reoperation – Parallel Trials

Evidence from one poor quality RCT (N=60) was INSUFFICIENT to draw conclusions

Measure	Mean 2.9 years
Treatment success (≥50% pain improvement and patient satisfaction)	Large, 1 RCT (N=45)
Opioid use: % taking a stable or decrease dose	Moderate, 1 RCT (N=45)

Aggregate Analytics

Summary: KQ1
PDN, SCS vs. CMM – Parallel Trials

Measure	3 months	6 months	≥12 months (comparative)
Conventional SCS			
LE Responders (≥50% on VAS/NPRS)	No evidence	Large increase, 2 RCTs (N=96) SOE: Low	No evidence
LE Pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=36) SOE: Low	Large, 2 RCTs (N=96) SOE: Low	No evidence
Opioid use: Proportion of patients still taking opioid; MSQ II scores	No evidence	Similar, 1 RCT (N=60) SOE: Low	No evidence
HF (10 kHz) SCS			
LE Responders (≥50% on VAS/NPRS)	Large increase, 1 RCT (N=184) SOE: Low	Large increase, 1 RCT (N=184) SOE: Low	No evidence
LE Pain scores (VAS/NPRS, 0-10)	Large, 1 RCT (N=180) SOE: Low	Large, 1 RCT (N=180) SOE: Low	No evidence
Opioid use	No evidence	No evidence	No evidence

Aggregate Analytics

*Favors SCS unless otherwise noted

Summary: KQ1
CRPS, SCS vs. CMM or Sham

Parallel Trials: SCS vs. CMM

	3 months	6 months	12-24 months	60 months (comparative)
Conventional SCS				
Pain scores (VAS/NRS, 0-10)	Large, 2 RCTs (N=85) SOE: Low	Large, 2 RCTs (N=85) SOE: Low	Moderate, 2 RCTs (N=82) SOE: Low	1 RCT (N=44) SOE: Insufficient
Function scores (ODI, 0-100)	Moderate, 1 RCT (N=31) SOE: Low	Small, 1 RCT (N=31) SOE: Low	Small, 1 RCT (N=31) SOE: Low	No evidence
HF (10 kHz) SCS				
Pain scores (VAS/NRS, 0-10)	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	No evidence
Function scores (ODI, 0-100)	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	1 RCT (N=29) SOE: Insufficient	No evidence

Crossover Trial: SCS vs. Sham

Measure	SCS type(s)	≤3 months	>3 to <12 months	≥12 months
VAS pain (NOS) (0-10)	40 Hz 500 Hz 1200 Hz Burst SCS	Insufficient	No evidence	No evidence
McGill NRS average pain (0-10)		Insufficient	No evidence	No evidence

Aggregate Analytics

*Favors SCS unless otherwise indicated

Summary: KQ 1b
Harms and Safety of SCS

- Substantial heterogeneity in classification, reporting, lack of consistency in definitions and severity description
- SCS-related AEs common, substantial range of event frequencies
- RCTs (SOE Low)
  - Any SCS-related AE: 12.4% to 17.6% (6 months), 24.1% to 32.1% (12-24 months)
  - SCS-related, requiring surgery: 11.8% to 16.7% (6 months), 23.8% to 37.5% (12-24 months)
  - Withdrawal due to AE: similar within 6 months
- Across designs, most common (SOE: Low)
  - Any IPG device explantation: 1.4% to 25%
  - Any IPT revision or replacement: 0.9% to 22%
  - IPG removal-inadequate relief, loss of efficacy, lack of efficacy, inadequate benefit: 3% to 20%
  - Any lead/electrode replacement or revision: 3.4% to 20.8%
  - Lead fracture or failure: 1.1% to 15.8%

Summary: KQ 1b
Harms and Safety of SCS

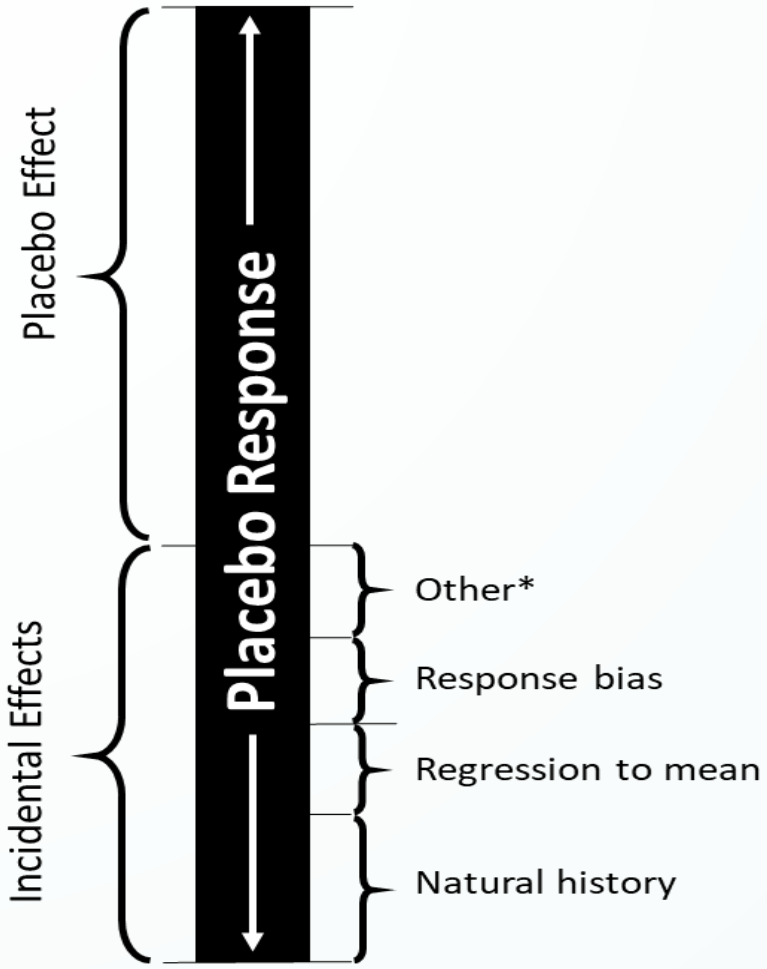
- Across designs, less common (SOE Low)
  - Lead failure or migration (surgery not specified): 0.9% to 9.5%
  - IPG removal for infection (1% to 5%) or infect or dehiscence (2.5% to 4.8%)
  - Serious infection (deep, fatal, leading to revision, removal, or hospitalization): 0% to 6%
  - Unintentional durotomy 6% (3/50)
- Across designs, least common (SOE low unless noted)
  - IPG revision, removal for IPG displacement or migration: 0.5% to 1.2%
  - Serious infection reported within 30 days 0.9%
  - CSF leak, dural tear 0.5% to 0.7%
  - Neurologic injury (deficit, paralysis, intraspinal abscess): 0% to 4% (SOE Moderate)

KQ 4: Cost-effectiveness

- Only 2 U.S.-based full economic studies
  - One good quality cost-effectiveness study in Workers Compensation population with FBSS found SCS is not cost effective at common WTP thresholds
  - One poor quality CUA in patients with NSRBP reported that SCS was cost-effective vs. CMM alone in modeling that did not include costs for initial SCS procedure costs for base case and would be cost-effective within 2.1 years when these were included in the model.
- Non-U.S. based full economic studies, mostly good quality
  - In patients with FBSS 4 studies reported SCS+ CMM was cost effective vs. CMM alone; one also reported SCS + CMM was cost-effective versus reoperation.
  - In patients with CRPS, 3 studies reported SCS + CMM was more cost-effective than CMM alone.
  - SCS not cost effective in one study in patients with PDN
- Limitations: time horizon in the absence of long-term data, limited sensitivity analyses, assumptions regarding effectiveness, modeling of AEs; unclear applicability of non-US studies

Considerations

Placebo Response



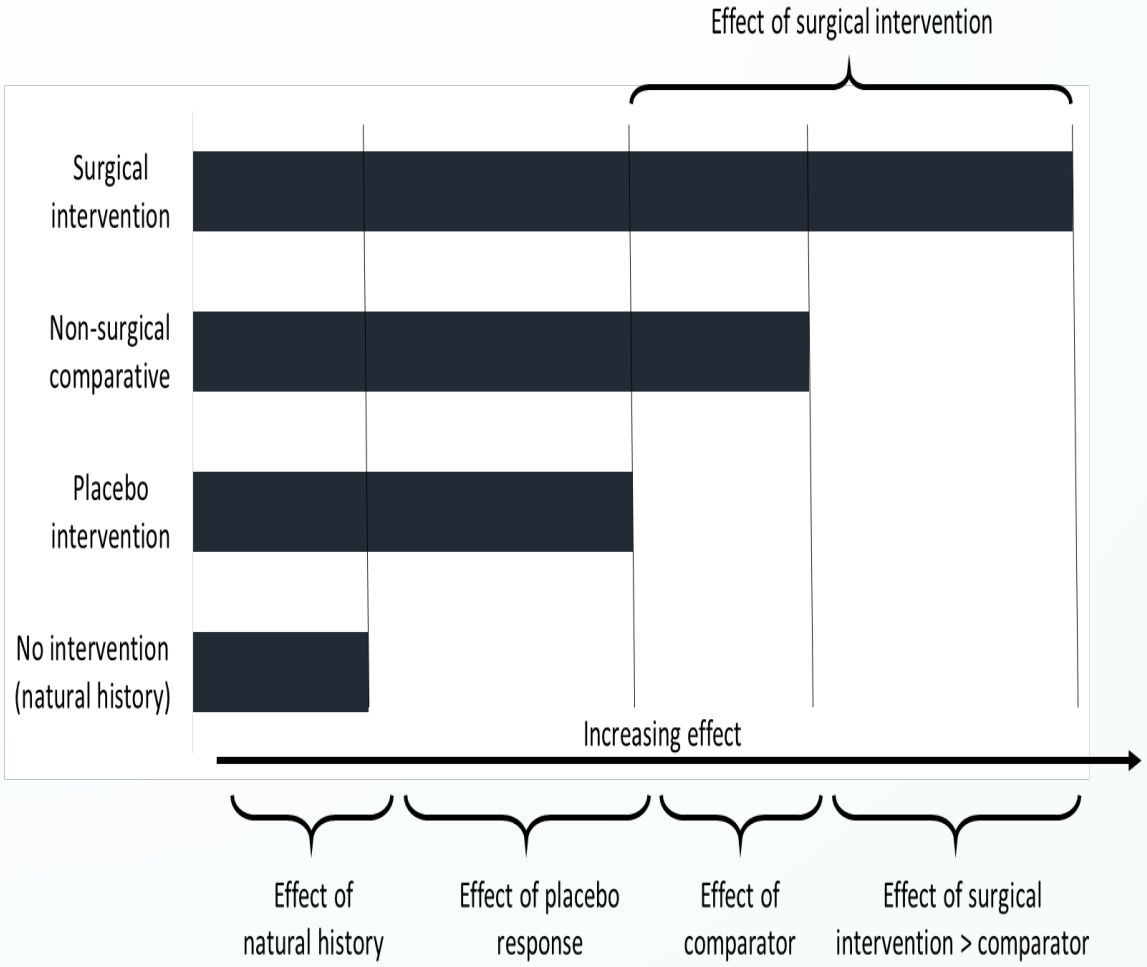
*such as diet, exercise, sleep, stress, support structure, physical or psychological treatment

- Total response attributable to placebo (or sham) administration
- Includes proportion of response that would be likely to occur even without treatment (i.e., incidental effects)
- Placebo effect is the proportion of improvement (or worsening) that remains after controlling for incidental effects

Aggregate Analytics

Dettori, JR, et. al. Global Spine Journal Vol. 9(6) 680-683

Conceptual contribution of effects following an intervention



- Treatment response is more than the effect of a given treatment: culture, presentation and ceremony around the treatment and expectation of provider and patient impact outcome
- The placebo response heightens the significance of having a comparative group to evaluate treatment effectiveness; case series should rarely be interpreted as supporting treatment effectiveness

Dettori, JR, et. al. Global Spine Journal Vol. 9(6) 680-683

Aggregate Analytics

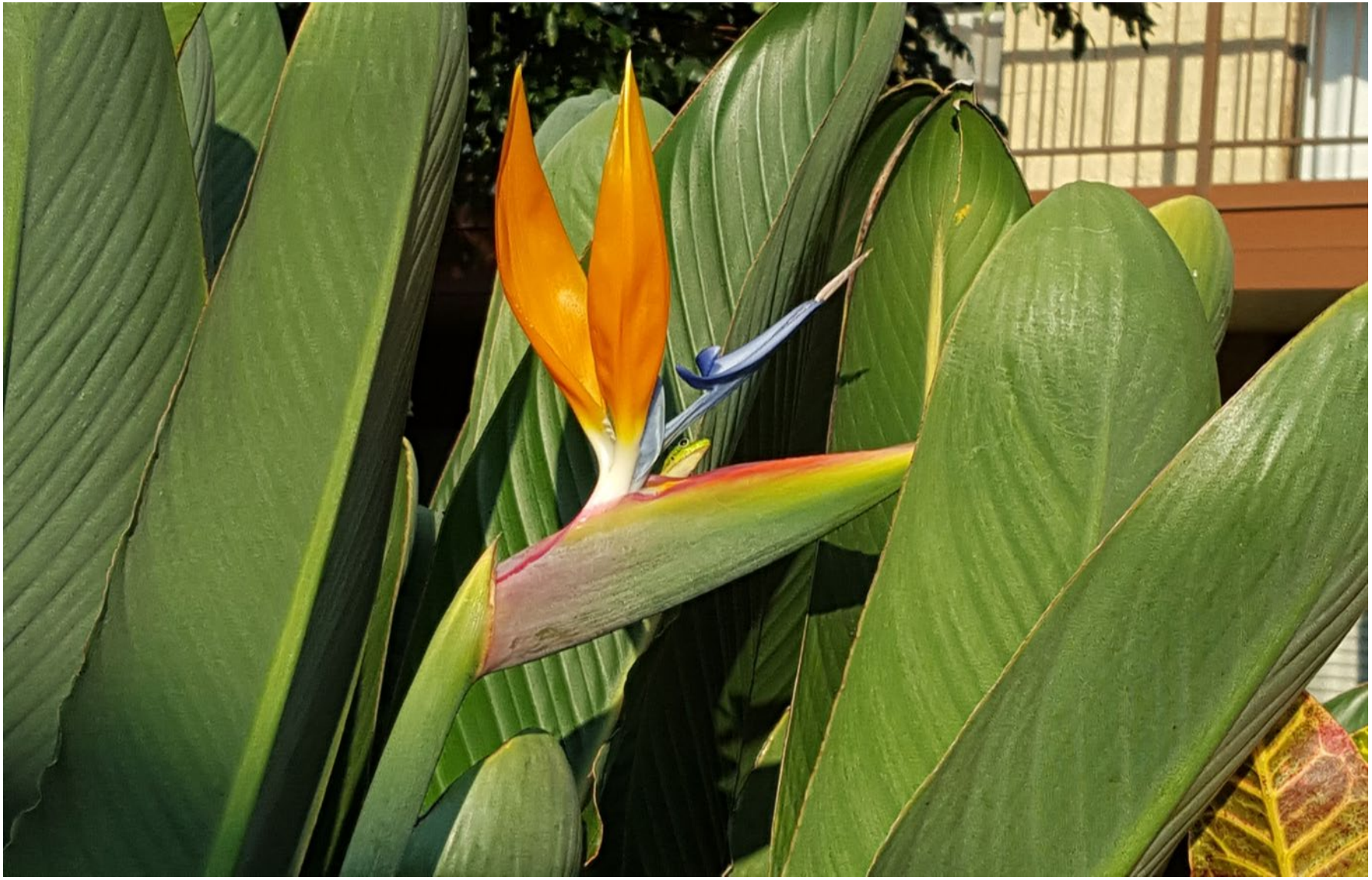
Considerations

- Effect magnitude varied depending on comparator (sham, CMM).
- Effects may at least in part be due to lack of patient blinding, expectation of benefit and other non-specific effects as well as an intervention.
- Heterogeneity in patient populations, SCS (types, delivery, parameters), CMM components and concurrent medications across studies is noted.
- Our clinical experts suggest that it is unclear how comparable or applicable the parameters used in the RCTs are to usual clinical practice, that there is likely substantial heterogeneity in what is used clinically; SCS delivery parameters are tailored to the patient.
- Substantial lack of precision in effect estimates, particularly when effect sizes were large for some outcomes may call into question the stability of effect size estimates, decreasing confidence in them; consistency across single studies is unknown.

Considerations

- Impact of the following is unclear: Lack of an adequate washout period between SCS modes and sham, potential for carryover effects from prior phases, and potential for breaking of patient blinding for some modes of operation (e.g., switching from high frequency to low frequency conventional).
- Some studies may have been underpowered to detect uncommon or rare AEs or differences in effectiveness; heterogeneity in classification, description of severity, reporting of AEs is noted.
- Applicability: Most patients failed CMM, were selected following multidisciplinary assessment including psychological evaluation, (specific thresholds, standards not described); most had a positive response to trial SCS prior to permanent implant.
- Definitions, criteria related to FBSS and NSRBP not well described.
- Economic study limitations: Time horizons modeled, limited sensitivity analyses, inconsistent modeling of SCS procedure costs and AEs, support for assumptions regarding effectiveness and harms especially long term are unclear.

Questions?



Washington State Health Care Authority

Agency medical director comments

Spinal Cord Stimulator: Re-review Follow Up

Christopher Chen, MD, MBA
Medical Director, Medicaid
WA Health Care Authority

February 16, 2024

Options for Committee Deliberation

- Option 1: **Non coverage** for all conditions
- Option 2: **Coverage** with criteria **for certain conditions**, for example:
  - Coverage with criteria for PDN
  - Non coverage for FBSS/CBP, CRPS
- Option 3: **Coverage** with criteria **for all reviewed conditions**

Washington State Health Care Authority

Agency Medical Director Group
Recommendation

- Spinal Cord Stimulation is not a covered benefit for:
  - Chronic back pain (including FBSS)
  - Painful Diabetic Neuropathy
  - Complex Regional Pain Syndrome

Proposed criteria: development process

- Reviewed other payer policies
- Reviewed inclusion or exclusion criteria from studies included in the evidence review

Proposed criteria: Qualifying Diagnoses

- Qualifying diagnoses (for Options 2 or 3):
  - Failed Back Surgery Syndrome
  - Chronic Regional Pain Syndrome (by Budapest Diagnostic Criteria)
  - Painful Diabetic Neuropathy
- Out of scope:
  - Dorsal root ganglion stimulation

Washington State Health Care Authority

Proposed exclusion criteria

- Life expectancy < 1 year
- Concurrent substance use disorder (including alcohol or illicit drugs)
- Dependence or addiction to prescription opioids or benzodiazepines
- Related pending or existing worker's compensation claim, or pending or existing litigation
- Substantial pain in other regions that have required treatment in the past year
- Burst stimulation

Proposed coverage criteria

- The patient has moderate to severe (>5 on the VAS pain scale) **neuropathic pain and objective neurologic impairment** with documented pathology related to pain complaint (i.e., abnormal MRI). Neurologic impairment is defined as objective evidence of one or more of the following:
  - Markedly abnormal reflexes
  - Segmental muscle weakness
  - Segmental sensory loss
  - EMG or NCV evidence of nerve root impingement
- Member's functional disability assessed using the Oswestry Disability Index (ODI); member has received an **ODI score greater than or equal to 21%**, AND
- **Psychological evaluation** to rule out substantial mental health disorders, AND
- 12 months of **conservative medical management**, defined as regular attendance, participation and compliance with a multidisciplinary approach including:
  - Full course of physical therapy, AND
  - Cognitive behavioral therapy AND
  - Another modality of conservative management (acupuncture, chiropractic)
- Patient underwent a **7 to 14 day trial** of percutaneous spinal cord stimulation, and
  - Experienced significant pain reduction (50% or more) AND, either:
  - 50% reduction of chronic opioid medications (if applicable) OR
  - Showed objective and clinically meaningful degree of functional improvement

Washington State Health Care Authority

Questions?

More Information:

shtap@hca.wa.gov

HTCC Coverage and Reimbursement Determination
Analytic Tool

HTA's goal is to achieve *better health care outcomes* for enrollees and beneficiaries of state programs by paying for proven health *technologies that work*.

To find best outcomes and value for the state and the patient, the HTA program focuses on three questions:

1. Is it safe?
2. Is it effective?
3. Does it provide value (improve health outcome)?

The principles HTCC uses to review evidence and make determinations are:

Principle One: Determinations are evidence-based

HTCC requires scientific evidence that a health technology is safe, effective and cost-effective[1] as expressed by the following standards[2]:

- Persons will experience better health outcomes than if the health technology was not covered and that the benefits outweigh the harms.
- The HTCC emphasizes evidence that directly links the technology with health outcomes. Indirect evidence may be sufficient if it supports the principal links in the analytic framework.
- Although the HTCC acknowledges that subjective judgments do enter into the evaluation of evidence and the weighing of benefits and harms, its recommendations are not based largely on opinion.
- The HTCC is explicit about the scientific evidence relied upon for its determinations.

Principle Two: Determinations result in health benefit

The outcomes critical to HTCC in making coverage and reimbursement determinations are health benefits and harms[3]:

- In considering potential benefits, the HTCC focuses on absolute reductions in the risk of outcomes that people can feel or care about.
- In considering potential harms, the HTCC examines harms of all types, including physical, psychological, and non-medical harms that may occur sooner or later as a result of the use of the technology.
- Where possible, the HTCC considers the feasibility of future widespread implementation of the technology in making recommendations.

Based on Legislative mandate: RCW 70.14.100(2).

The principles and standards are based on USPSTF Principles at: http://www.ahrq.gov/clinic/ajpmsuppl/harris3.htm

- The HTCC generally takes a population perspective in weighing the magnitude of benefits against the magnitude of harms. In some situations, it may make a determination for a technology with a large potential benefit for a small proportion of the population.
- In assessing net benefits, the HTCC subjectively estimates the indicated population's value for each benefit and harm. When the HTCC judges that the balance of benefits and harms is likely to vary substantially within the population, coverage or reimbursement determinations may be more selective based on the variation.
- The HTCC considers the economic costs of the health technology in making determinations, but costs are the lowest priority.

Using evidence as the basis for a coverage decision

Arrive at the coverage decision by identifying for Safety, Effectiveness, and Cost whether (1) evidence is available, (2) the confidence in the evidence, and (3) applicability to decision.

1. Availability of evidence:

Committee members identify the factors, often referred to as outcomes of interest, that are at issue around safety, effectiveness, and cost. Those deemed key factors are ones that impact the question of whether the particular technology improves health outcomes. Committee members then identify whether and what evidence is available related to each of the key factors.

2. Sufficiency of the evidence:

Committee members discuss and assess the evidence available and its relevance to the key factors by discussion of the type, quality, and relevance of the evidence[4] using characteristics such as:

- Type of evidence as reported in the technology assessment or other evidence presented to committee (randomized trials, observational studies, case series, expert opinion);
- The amount of evidence (sparse to many number of evidence or events or individuals studied);
- Consistency of evidence (results vary or largely similar);
- Recency (timeliness of information);
- Directness of evidence (link between technology and outcome);
- Relevance of evidence (applicability to agency program and clients);
- Bias (likelihood of conflict of interest or lack of safeguards).

Sufficiency or insufficiency of the evidence is a judgment of each clinical committee member and correlates closely to the GRADE confidence decision.

Not Confident	Confident
Appreciable uncertainty exists. Further information is needed or further information is likely to change confidence.	Very certain of evidentiary support. Further information is unlikely to change confidence

[4] Based on GRADE recommendation: http://www.gradeworkinggroup.org/FAQ/index.htm

3. *Factors for Consideration - Importance*

At the end of discussion a vote is taken on whether sufficient evidence exists regarding the technology's safety, effectiveness, and cost. The committee must weigh the degree of importance that each particular key factor and the evidence that supports it has to the policy and coverage decision. Valuing the level of importance is factor or outcome specific but most often include, for areas of safety, effectiveness, and cost:

- Risk of event occurring;
- The degree of harm associated with risk;
- The number of risks; the burden of the condition;
- Burden untreated or treated with alternatives;
- The importance of the outcome (e.g. treatment prevents death vs. relief of symptom);
- The degree of effect (e.g. relief of all, none, or some symptom, duration, etc.);
- Value variation based on patient preference.

Clinical committee findings and decisions

Efficacy considerations

- What is the evidence that use of the technology results in more beneficial, important health outcomes? Consider:
  - Direct outcome or surrogate measure
  - Short term or long term effect
  - Magnitude of effect
  - Impact on pain, functional restoration, quality of life
  - Disease management
- What is the evidence confirming that use of the technology results in a more beneficial outcome, compared to no treatment or placebo treatment?
- What is the evidence confirming that use of the technology results in a more beneficial outcome, compared to alternative treatment?
- What is the evidence of the magnitude of the benefit or the incremental value?
- Does the scientific evidence confirm that use of the technology can effectively replace other technologies or is this additive?
- For diagnostic tests, what is the evidence of a diagnostic tests' accuracy?
  - Does the use of the technology more accurately identify both those with the condition being evaluated and those without the condition being evaluated?
- Does the use of the technology result in better sensitivity and better specificity?
- Is there a tradeoff in sensitivity and specificity that on balance the diagnostic technology is thought to be more accurate than current diagnostic testing?
- Does use of the test change treatment choices?

Safety

- What is the evidence of the effect of using the technology on significant morbidity?
  - Frequent adverse effect on health, but unlikely to result in lasting harm or be life-threatening, or;
  - Adverse effect on health that can result in lasting harm or can be life-threatening?
- Other morbidity concerns?
- Short term or direct complication versus long term complications?
- What is the evidence of using the technology on mortality – does it result in fewer adverse non-fatal outcomes?

Cost impact

- Do the cost analyses show that use of the new technology will result in costs that are greater, equivalent or lower than management without use of the technology?

Overall

- What is the evidence about alternatives and comparisons to the alternatives?
- Does scientific evidence confirm that use of the technology results in better health outcomes than management without use of the technology?

Next step: Cover or no cover

If not covered, or covered unconditionally, the chair will instruct staff to write a proposed findings and decision document for review and final adoption at the following meeting.

Next step: Cover with conditions

If covered with conditions, the committee will continue discussion.

1) Does the committee have enough information to identify conditions or criteria?
   - Refer to evidence identification document and discussion.
   - Chair will facilitate discussion, and if enough members agree, conditions and/or criteria will be identified and listed.
   - Chair will instruct staff to write a proposed findings and decision document for review and final adoption at next meeting.
2) If not enough or appropriate information, then Chair will facilitate a discussion on the following:
   - What are the known conditions/criteria and evidence state
   - What issues need to be addressed and evidence state

The chair will delegate investigation and return to group based on information and issues identified. Information known but not available or assembled can be gathered by staff ; additional clinical questions may need further research by evidence center or may need ad hoc advisory group; information on agency utilization, similar coverage decisions may need agency or other health plan input; information on current practice in community or beneficiary preference may need further public input. Delegation should include specific instructions on the

task, assignment or issue; include a time frame; provide direction on membership or input if a group is to be convened.

Clinical committee evidence votes

First voting question

The HTCC has reviewed and considered the technology assessment and information provided by the administrator, reports and/or testimony from an advisory group, and submissions or comments from the public. The committee has given greatest weight to the evidence it determined, based on objective factors, to be the most valid and reliable.

Discussion document: What are the key factors and health outcomes and what evidence is there? (Applies to the population in the PICO for this review)

Safety outcomes	Importance of outcome	Safety evidence/ confidence in evidence
Any adverse event		
AEs requiring surgery		
Withdrawal due to AEs		
Durotomy		
Neurologic injury		
Death		
Allergic reaction		

Efficacy – effectiveness outcomes	Importance of outcome	Efficacy / Effectiveness evidence
Pain (VAS, NRS etc)		
Function (ODI, etc)		
Opioid use		
ODI		

Cost outcomes	Importance of outcome	Cost evidence
Cost		
Cost-effectiveness		

Special population / Considerations outcomes	Importance of outcome	Special populations/ Considerations evidence
Age		
Sex		
Comorbidity		
Adolescents		
Pregnant individuals		

For safety:

Is there sufficient evidence that the technology is safe for the indications considered?

No relevant studies	Low Risk Safe	Moderate Risk	High Risk Unsafe
	Confidence: Low Medium High	Confidence: Low Medium High	Confidence: Low Medium High

For efficacy/ effectiveness:

Is there sufficient evidence that the technology has a meaningful impact on patients and patient care compared to the evidence-based alternative(s)?

No relevant studies	Less Less effective	Equivocal	More More effective at least in some
	Confidence: Low Medium High	Confidence: Low Medium High	Confidence: Low Medium High

For cost outcomes/ cost-effectiveness:

Is there an accepted scale for cost effectiveness for treatments for this disease? If so, how does this treatment compare with evidence-based alternatives?

No relevant studies	**Less** Less cost effective	**Equivocal**	**More** More cost effective at least in some
	Confidence: Low Medium High	Confidence: Low Medium High	Confidence: Low Medium High

Discussion

Based on the evidence vote, the committee may be ready to take a vote on coverage or further discussion may be warranted to understand the differences of opinions or to discuss the implications of the vote on a final coverage decision.

- Evidence is *insufficient* to make a conclusion about whether the health technology is *safe, efficacious, and cost-effective*;
- Evidence is *sufficient* to conclude that the health technology is *unsafe, ineffectual, or not cost-effective*
- Evidence is *sufficient* to conclude that the health technology is *safe, efficacious, and cost-effective for all indicated conditions*;
- Evidence is *sufficient* to conclude that the health technology is *safe, efficacious, and cost-effective for some conditions or in some situations*

A straw vote may be taken to determine whether, and in what area, further discussion is necessary.

Second Vote

Based on the evidence about the technologies' safety, efficacy, and cost-effectiveness, it is:

Not covered	**Covered unconditionally**	**Covered with conditions**

Discussion item

Is the determination consistent with identified Medicare decisions and expert guidelines, and if not, what evidence is relied upon.

The report "identified no Medicare national coverage determination on the use of SBRT or any local coverage determinations that apply to the state of Washington."

Medicare Coverage

[see page 60 of final report]

- **Centers for Medicare and Medicaid Services (CMS) National Coverage Determination**
  NCD – Electrical Nerve Stimulators (160.7) - There are two types of implantations covered by this instruction: Dorsal Column (Spinal Cord) Neurostimulation - The surgical implantation of neurostimulator electrodes within the dura mater (endodural) or the percutaneous insertion of electrodes in the epidural space is covered. Depth Brain Neurostimulation - The stereotactic implantation of electrodes in the deep brain (e.g., thalamus and periaqueductal gray matter) is covered.

Clinical Practice Guidelines
[see page 19-24 of final report]

Guideline	Year	Evidence Base	Recommendation	Rating/Strength of Recommendation
American Society of Regional Anesthesia and Pain Medicine	2023	NR	• In patients with chronic low back pain and/or leg pain, limb ischemia due to peripheral vascular disease, painful diabetic neuropathy, and/or CRPS type I or II a trial of SCS should be performed prior to a definitive SCS implant.	• Moderate (US Preventative Services Task Force rating)
Dutch Quality of Healthcare Institute	2022	NR	• Given the high initial costs and the invasiveness, the scientific committee has followed the general rule that primarily more conservative therapies should be used to treat the complaints. If there is insufficient effect and/or if relevant, too many side effects, neurostimulation can be advised. • **FBSS**: In the case of insufficient effect on conservative treatments, minimally invasive treatment can be considered. Treatment with epidural injections with local anesthesia and possibly corticosteroids in a PSPS (FBSS) in which there is scar pain can be considered. In a PSPS (FBSS) in which the neuropathic and/or nociplastic pain is prominent, a pulsed radio frequency of a nerve root can be considered. • **CRPS**: Based on the available literature, combined with the expert opinion, the Scientific Committee recommends considering the following conservative treatments before applying neurostimulation. In the case of insufficient effect on conservative treatments, minimally invasive treatment can be considered. In upper extremity CRPS where vasomotor dysregulation is prominent, a thoracic block(T2–3) with local anesthetic and corticosteroids can be considered. In a residual CRPS situation in which neuropathic and/or nociplastic pain is prominent, a low dose of intravenous ketamine therapy can be considered. • **PDPN**: Based on the available literature, combined with the expert opinion, the Scientific Committee recommends considering conservative treatments before applying neurostimulation. In the case of insufficient effect of conservative treatments, minimally invasive treatment can be considered. Transcutaneous electrical nerve stimulation can	NR

			be considered for a PDPN in which pain is the main focus. In the case of a PDPN in which vasomotor dysregulation is prominent, a sympathetic blockade can be considered.	
European Academy of Neurology	2016	• **Post-surgical chronic leg and back pain (CBLP)**: Spinal cord stimulation added to conventional medical management versus conventional management alone or versus reoperation in post-surgical CBLP: 2 RCTs • **CRPS and PDN**: Spinal cord stimulation added to conventional medical management versus conventional management alone in CRPS and PDN: 2 or 3 RCTs	• **CBLP**: There is weak recommendation for the use of SCS added to conventional medical management versus conventional medical management and for the use of SCS as an alternative to reoperation in post-surgical CBLP • **CRPS and PDN**: There is weak recommendation for the use of SCS added to conventional medical management versus conventional medical management in PDN and CRPS I	• **CBLP**: Moderate (GRADE) • **CRPS and PDN**: Low (GRADE)
Dutch Orthopedic Association and the Dutch Neurosurgical Society	2015	• 2 RCTs	• FBSS: Neuromodulation is recommended for patients with FBSS who have pronounced leg pain and for whom conservative therapy has provided insufficient or no effect.	• **FBSS**: Based on the lack of a scientific conclusion and these other considerations, the task force developed the following positive recommendation for practice (because effectiveness is demonstrated in various RCTs, and the benefits clearly outweigh the risks and burdens)

American Society of Interventional Pain Physicians	2013	• 2 RCTS, 12 NRSIs	• **FBSS**: SCS is indicated in chronic low back pain with low-er extremity pain secondary to FBBS, after exhausting multiple conservative and interventional modalities.	• **FBSS**: The evidence is fair for spinal cord stimulation (SCS) in managing patients with failed back surgery syndrome (FBSS)
Neuropathic Pain Special Interest Group	2013	• **FBSS**: 2 RCTs • **CRPS type I**: 1 RCT, 1 SR, 1 Guideline • **CRPS type II**: NR • **PDN**: 1 NRSI	• **FBSS**: SCS is effective in treating FBSS • **CRPS type I**: SCS is effective in treating CRPS type I • **CRPS type II**: Very limited evidence • **PDN:** Weak evidence with small, positive case series with large effects in refractory DPN over long-term follow-up	• **FBSS**: Quality of evidence: Moderate; Strength of recommendation: Weak • **CRPS type I**: Quality of evidence: Moderate; Strength of recommendation: Weak • **CRPS type II:** Quality of evidence: Low; Strength of recommendation: Inconclusive • **PDN**: Quality of evidence: Low; Strength of recommendation: Inconclusive
Canadian Pain Society	2012	• 2 RCTs, 1 SR, 1 Guideline	• **FBSS**: In patients with FBSS who are not candidates for corrective surgery and who have failed conservative therapy, a SCS trial should be considered • **CRPS**: In patients with CRPS who are not candidates for corrective surgery and who have failed conservative therapy, a SCS trial should be considered	• **FBSS**: Level of evidence: Good; Rating of recommendation: B • **CRPS**: Level of evidence: Good; Rating of recommendation: B
Neuromodulation Access Therapy Coalition	2008 (Incorrectly noted in Deer, 2014)	• 8 RCTs	• SCS is effective in treating chronic neuropathic pain	NR
National Institute for Health and Care Excellence Technology appraisal guidance [TA159],	2008 (Original) 2014 Re-review	• 11 RCTs (3 RCTs in people with neuropathic pain due to FBSS)	• SCS is recommended as a treatment option for adults with chronic pain of neuropathic origin who continue to experience chronic pain of at least 50mm on a 0–100mm VAS for at least six months despite appropriate conventional medical management, and who have had a successful trial of stimulation.	• NR; no overall description of level of evidence in guideline document. • The Committee noted that only a small

Spinal cord stimulation for chronic pain of neuropathic or ischaemic origin *[2008 original assessment included in prior review]* *See Table 5 for device-specific evaluations by NICE*		• 8 RCTs in patients with ischaemic pain, 4 of which were for treatment of angina	• SCS should be provided only after an assessment by a multidisciplinary team experienced in chronic pain assessment and management of people with spinal cord stimulation devices, including experience in the provision of ongoing monitoring and support of the person assessed. • When assessing the severity of pain and the trial of stimulation, the multidisciplinary team should be aware of the need to ensure equality of access to treatment with SCS. Tests to assess pain and response to SCS should take into account a person's disabilities (such as physical or sensory disabilities), or linguistic or other communication difficulties, and may need to be adapted. • If different SCS systems are considered to be equally suitable for a person, the least costly should be used. Assessment of cost should take into account acquisition costs, the anticipated longevity of the system, the stimulation requirements of the person with chronic pain and the support package offered. **2014 Re-review Decision**: The implementation section updated to clarify that spinal cord stimulation is recommended as an option for treating chronic pain of neuropathic or ischemic origin. Nothing new that affects the recommendations in this guidance was identified. This guidance will be reviewed if there is new evidence that is likely to change the recommendations.	number of clinical trials had been identified and that relatively small numbers of people were included in these studies. The Committee accepted that there was some uncertainty about how the effects of pain treatments were sustained over time, but concluded that benefits could be sustained for at least up to 5 years in pain of neuropathic origin (for FBSS, CRPS)

Next step: proposed findings and decision and public comment

At the next public meeting the committee will review the proposed findings and decision and consider any public comments as appropriate prior to a vote for final adoption of the determination.

1) Based on public comment was evidence overlooked in the process that should be considered?
2) Does the proposed findings and decision document clearly convey the intended coverage determination based on review and consideration of the evidence?

Next step: final determination
Following review of the proposed findings and decision document and public comments:

Final vote

Does the committee approve the Findings and Decisions document with any changes noted in discussion?

If yes, the process is concluded.

If no or unclear (i.e., tie), outcome chair will lead discussion to determine next steps.

Washington State Health Care Authority

FINAL Key Questions

Spinal Cord Stimulation

Background

Chronic pain is a leading cause of disability and is an immense public health challenge. Pain is chronic when it occurs for extended periods (usually defined as >3 months), and can affect other aspects of an individual's health and function, including physical, emotional, social, and mental, often leading to a loss in quality of life[1-6]. Treatment of chronic pain aims to improve function and quality of life in addition to pain relief. Primary treatments include disease and injury-specific treatments such as nerve root decompression or reoperation, and other therapies such as pharmaceuticals, physical therapy, behavioral and psychological therapies, and neurostimulation therapies such as transcutaneous nerve electrical stimulation (TENS). Spinal cord stimulation (SCS) may be considered for moderate or severe pain that does not respond to standard therapies. A 2020 U.S. Food and Drug Administration (FDA) communication estimated that 50,000 SCS devices are implanted annually.[7]

SCS was developed in the 1960's based on the Melzack and Wall's gate-control theory and has been used to treat a number of chronic pain issues.[8,9] Mechanisms of pain relief using SCS are not completely understood, although current theories suggest stimulation occurs through a pulse delivering a specific current to dorsal fibers which interfere with or suppress the transmission of pain signals between nerves and the brain.[10-12] Originally, pain relief through parameter changes were completely dependent on user input. Open loop and closed loop systems have been described. *Open loop* (OL) systems ignore external stimuli, such as movement of the spinal cord, heart rate, and respiration.[13,14] In contrast, *closed loop* (CL) systems automatically adapt and modify stimulator settings in response to patient position and activity in real time, maintaining stimulation within an individualized therapeutic range.[13,14] Further details on the mechanism of SCS systems have been described in great detail elsewhere.[11,12,15]

SCS systems involve percutaneous implantation of electrode leads into the epidural space until they reach the dorsal column of the spinal cord. Currently, 16 FDA approved SCS devices are available. Approved musculoskeletal indications generally include Failed Back Surgery Syndrome (FBSS), Complex regional pain syndrome (CRPS) Types I and II, intractable low back pain and leg pain. Other indications include epidural fibrosis, degenerative disc disease, and arachnoiditis. Some SCS devices are approved for treatment of diabetic neuropathy. In 2016 the FDA gave premarket approval (PMA) to the first generation of devices implanted onto the dorsal root ganglion (DRG) of the posterior root to treat CRPS type I or type II, reflex sympathetic dystrophy and causalgia.[16-18] Compared with SCS devices, in which leads are implanted into the epidural space, DRG leads enter the epidural space, exit the neuroforamina, and stimulate the adjacent DRG, potentially providing more focused pain relief through specific targeting, as well as decreased paresthesia.[11,19]

The pulse frequency used in SCS, measured in hertz (Hz), can be adjusted to meet the needs of individual pain thresholds.[11,12] Traditional SCS systems are considered "low-frequency", typically defined as 30 Hz to 200 Hz, but may be as low as 10 Hz or high as 1200 Hz.[12] Low-frequency SCS is often associated with paresthesia, a feeling of tingling or buzzing that is perceived differently depending on the individual, which may or may not bring discomfort. "High frequency" (also referred to as "paresthesia free") SCS systems, often defined as greater than 200 Hz, produce stimulations that are

typically unperceivable by patients, and may be preferred.[20] Currently, the highest frequency available is 10,000 Hz. Additionally, in 2016 the FDA approved a clinician application for SCS systems that provide stimulation in "bursts" rather than constant rates (referred to as tonic stimulation or burst stimulation), which may provide greater relief at lower frequencies.[21-24]

Topic Background

A Health Technology Assessment (HTA) on SCS was performed in 2010 and reviewed by the Washington Health Technology Assessment Program (HTAP). The prior report focused on evidence for the effectiveness of and complications for traditional SCS (dorsal column) in patients with chronic neuropathic pain. Signal updates were performed in 2014, 2016, and 2018, all of which concluded that there was not substantial, high-quality new evidence comparing SCS with medical or surgical interventions that did not involve neuromodulation (e.g., SCS, DRG stimulators, peripheral nerve neuromodulation) to trigger an updated report. The HTAP is interested in re-evaluation of spinal cord stimulation as additional evidence on technical advances related to use of SCSs, including use of high frequency and burst stimulation, may be available. Dorsal root ganglion stimulators will not be included in this review, given differences in lead placement compared with traditional SCS. This is consistent with the scope of the prior report. The proposed assessment update will be restricted to devices approved by the FDA for management of the FDA-approved conditions related to neuropathic and non-neuropathic musculoskeletal pain as described in the PICOTS (Table 1). Comments from the public posting of the KQ and PICOTS and consultation with the HTAP were considered for finalization of the Key Questions and scope.

Final Key Questions and Scope

Key Questions (KQ)
When used in adult patients who have failed other treatment options for pain related to failed back surgery syndrome, chronic back pain, complex regional pain syndrome, or peripheral neuropathy (phantom limb or stump pain, diabetic neuropathy or postherpetic neuralgia):

Key Question 1:
What is the evidence of short and long-term effectiveness of spinal cord stimulation compared with medical and/or surgical treatment (appropriate to condition) that does not include neuromodulation devices?

Key Question 2:
What is the evidence of the safety of spinal cord stimulation compared with medical and/or surgical treatment (appropriate to condition) that does not include neuromodulation devices?

Key Question 3:
What is the evidence that spinal cord stimulation has differential efficacy or safety issues in sub-populations of interest?

Key Question 4:
What is the evidence of cost-effectiveness of spinal cord stimulators compared with other medical or surgical options that do not include neuromodulation?

Table 1. Draft PICOTS Scope

Study Component	Inclusion	Exclusion

Participants	Adults with one of the following: • chronic low back pain, failed back surgery syndrome (low back pain and persistent, significant radicular pain following surgery), complex regional pain syndrome, peripheral neuropathy (phantom limb or stump pain, diabetic neuropathy or postherpetic neuralgia) Special populations/factors of interest: Sex, age, psychological or psychosocial co-morbidities, diagnosis or pain type, provider type, setting or other provider characteristics, health care system type, including worker's compensation, Medicaid, state, employees	• Children, patients <18 years old • Patients with prior use of SCS • Patients who are pregnant • All other pain conditions (e.g., cancer pain, chronic refractory anginal pain, heart failure, critical limb ischemia, peripheral vascular pain, pain at end of life, MS, fibromyalgia, headache, trigeminal neuralgia, chronic pancreatitis, chronic pelvic pain, chronic abdominal pain, post-stroke pain • Studies in which < 75% of patients have chronic musculoskeletal or neuropathic pain or other included pain conditions
Intervention	FDA-approved spinal cord stimulation (permanently implanted pulse generator systems and radiofrequency receiver systems)	• Temporarily implanted spinal cord stimulation devices • Neurostimulation of other parts of the nervous system (e.g., peripheral nerves, deep brain), dorsal root ganglion stimulation • Transcutaneous electrical nerve stimulation (TENs) • Non-FDA approved devices (unless final, phase III trial) • Intrathecal pumps
Comparators	Medical and/or surgical treatment (appropriate to condition) that does not include comparison of SCS methods/devices or other neuromodulation devices	• Comparisons of SCS devices • Comparison of SCS combined with other interventions vs. the other intervention alone • Comparisons of different types/modalities of SCS (e.g., comparisons of low versus high frequency, burst vs. tonic, etc.)
Outcomes	**Primary Outcomes (SOE)** • Function • Pain • Opioid use • **Complications** and adverse effects (e.g., procedural complications and technical failures, harms, infection, revision, removal, painful paresthesia or loss of paresthesia, mortality, serious adverse events) **Secondary outcomes (No SOE)**	• Non-clinical outcomes • Non-validated measures • Intermediate outcomes • Return to work

	• Health-related quality of life (HR-QoL) • Anxiety and depression • Patient satisfaction • Global perceived effect (GPE)/global impression of change	
Setting	Any	
Study design	• RCTs will be the primary focus; prospective high quality comparative nonrandomized studies of intervention (NRSI) with concurrent controls that control for confounding will be considered if RCTs are not available; question 3 is limited to RCTs • NRSIs including case series designed to evaluate harms with at least 5 years follow-up, or which report on rare harms for question 2 will be considered. • Formal cost-effectiveness analyses assessing initial placement and replacement will be considered for question 4	• Case reports • Case series (for KQ1, 3, 4) • Case series not designed to evaluate harms, those with < 5 years follow-up for question 2 unless they report on rare harms outcomes • Non-clinical studies (e.g., animal studies) • Studies with N < 10 patients total or < 10 per group • Studies not reporting on primary outcomes or harms
Publication	• Studies published in English in peer reviewed journals, published HTAs or publicly available FDA reports • Full formal economic analyses (e.g., cost-utility analyses) published in English in an HTA, or in a peer-reviewed journal published after those represented in previous HTAs	• Abstracts, editorials, letters, books, conference proceedings • Studies without abstracts available online • Duplicate publications of the same study which do not report on different outcomes • Single reports from multicenter trials • Studies reporting on the technical • aspects spinal cord stimulation • White papers • Narrative reviews • Articles identified as preliminary reports when results are published in later versions/publications • Other types of economic evaluations (e.g., costing studies, cost-minimization analyses, cost-benefit analyses)

DRGS = Dorsal Root Ganglion Stimulation; FDA = Food and Drug Administration; GPE = Global perceived effect; HFSCS = High-frequency spinal cord stimulation; HR-QoL = Health-related quality of life; HTA = Health Technology Assessment; MS = multiple sclerosis; NRSI = Non-randomized studies of interventions; RCT = Randomized Control Trial; SCS = Spinal cord stimulator; SOE = Strength of Evidence; TENS = Transcutaneous electrical nerve stimulation.

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