REPORT TO THE MSRB

Spinal Cord Stimulators

September 2, 2008

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The Department has prepared this report spinal cord stimulators in accordance with the guidelines and formats used in the MSRB Charge to its Medications Task Force (October 14, 2004 MSRB meeting). The overall clinical question considered in this review was:

> 1. What is the proper use of spinal cord stimulators in the treatment of chronic spinal pain and complex regional pain syndrome (reflex sympathetic dystrophy)?

This overall question was addressed by identifying and synthesizing the best available medical data on the following specific issues:

> Are spinal cord stimulators ***effective*** in the treatment of chronic spinal pain and complex regional pain syndrome (reflex sympathetic dystrophy)?
> Are spinal cord stimulators ***safe***?
> What is the appropriate trial period for determining if a patient will have a favorable response to treatment with a spinal cord stimulator?
> What are the appropriate criteria for judging whether a patient had a favorable response during a trial period?

Department Work Plan

The Department used the same "evidence-based medicine" approach to spinal cord stimulators as had been employed by the MSRB's Medications Task Force in preparing its report on non-steroidal anti-inflammatory drugs (NSAIDs)[1]. Evidence-Based Medicine (EBM) "is the process of systematically reviewing, appraising and using clinical research findings to aid the delivery of optimum clinical care to patients." [2] EBM replaces clinical intuition, observations from personal clinical experience, and hypothetical arguments based on pathophysiological principles, as the principle grounds for clinical decision-making. Instead evidence from systematic surveys and critical appraisals of peer-reviewed, methodologically-sound clinical research is gathered, reviewed and synthesized using standardized, objective protocols based on agreed rules of evidence.

Key components of the evidence-based medicine approach used by the Department are:

a) the systematic search for, and retrieval of, all the relevant medical literature regarding the use of spinal cord stimulators that addresses one or more of the specific issues listed above;
b) sorting the retrieved literature by level of evidence;
c) critical appraisal of that literature to systematically examine its validity, results and relevance; and,
d) synthesis of the findings, with a grade of recommendation.

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1 Final Report. MSRB Task Force On Medications. Nonsteroidal Anti-Inflammatory Drugs, July 21, 2005
2 Rosenberg W, Donald A. "Evidence-based medicine: an approach to clinical problem solving" BMJ 1995; 310(6987): 1122–1126
Strauss SE, Richardson WS, Glasziou P, Haynes RB Evidence-based Medicine: How to Practice and Teach EBM Edinburgh; Churchill Livingstone, 2005

The search and retrieval of the medical literature was done using computerized search engines and on-line bibliographical databases of the medical literature. In order to maximize the efficient use of time and resources, the same strategies as used by the MSRB's Medications Task Force in its analysis on NSAIDs were adopted to target the searches to the best and most recent evidence by using a step-wise search process.

First, the Department searched the medical literature by "level of evidence." The levels of evidence (Table 1) are a hierarchy representing the strength of the conclusion that can be drawn from a study of that type. Level I evidence is the most compelling, while Level VI evidence is the weakest. The Department restricted the initial search of the medical literature to Level I evidence – systematic reviews and meta-analyses. A systematic review is itself a review of the medical literature conducted using methods (including systematic search and retrieval of all the relevant primary source evidence and critical appraisal of the evidence found using standardized techniques) designed to minimize the likelihood of bias in the results. A meta-analysis is a systematic review in which quantitative methods are used to summarize the results of the review[3]. Not only are systematic reviews and meta-analyses the strongest evidence available but they have the additional property of representing the other levels of evidence.

Table 1: Levels of Evidence[4]

I	systematic reviews/meta-analyses of multiple randomized, controlled trials
II	randomized, controlled trials
IIIA	controlled studies without randomization
IIIB	other types of quasi-experimental study
IV	non-experimental descriptive studies
V	case series
VI	expert committee reports or opinions/clinical experience of respected authorities, or both

Using Level I evidence means that the Department could review efforts by other researchers who had already searched the medical literature for Level II and higher evidence, retrieved and reviewed these studies to determine their relevance and methodological quality, abstracted and evaluated their findings, and synthesized the results. This allowed the Department to leverage its resources to review a much larger body of evidence.

Second, the Department tried to focus the search on the most recent studies, so as to best represent the most current information.

The Department also searched for any already published, evidence-based guidelines for the use of spinal cord stimulators.

[3] Guyatt G, Rennie D Users' Guides to the Medical Literature. Essentials of Evidence-Based Clinical Practice AMA Press, 2002
FOCUS "Critical Appraisal Tool" at http://www.focusproject.org.uk/

[4] Adapted from Phillips B, Ball C, Sackett D, Badenoch D, Straus S, Haynes B, Dawes M "Levels of Evidence and Grades of Recommendation" Oxford Centre for Evidence-based Medicine, 1998 http://www.cebm.net/levels_of_evidence.asp

Prior to beginning the literature search, the Department adopted a set of guidelines for determining when and how the searches would be extended that were similar to those used by the MSRB's Medications Task Force in its analysis on NSAIDs. If at least 10 valid and unrelated references to systematic reviews were not found, the search would be extended to look for all articles in category II (randomized controlled trials) and for all articles in category I (systematic reviews) in the entire database.

The search for relevant medical literature was in fact extended to all levels of evidence. And the search was extended back in time to encompass all of the available literature in the on-line databases.

The Department conducted the literature searches in two electronic bibliographic databases:

1. Medline through the PubMed portal at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi ; and,
2. The Cochrane Library (The Cochrane Database of Systematic Reviews, Database of Abstracts of reviews of Effects, and The Cochrane Central Register of Controlled Trials) through the Lumina portal of the University of Minnesota Libraries at http://tc.liblink.umn.edu/sfx_local/a-z/default.

PubMed is a service of the National Library of Medicine (NLM) available via the National Center of Biotechnology's Entrez retrieval system. PubMed is a public access search engine for MEDLINE, NLM's premier bibliographic database for medical literature. MEDLINE contains bibliographic citations and author abstracts from more than 4,800 biomedical journals published in the United States and 70 other countries. The database contains over 12 million citations dating back to mid-1960.

The Cochrane Library consists of a regularly updated collection of evidence-based medicine databases created by the Cochrane Collaboration, an international non-profit independent organization of health care providers and health care researchers. The Cochrane Library is a collection of evidence-based medicine databases, which is up-dated quarterly from the best available information about healthcare interventions found in both published and unpublished medical studies from around the world. The Cochrane Database of Systematic Reviews (CDSR) is the collection of systematic reviews done by Cochrane Collaboration work groups. The Database of Abstracts of Reviews of Effects (DARE) contains summaries of systematic reviews done by others, which have met strict quality criteria established by the Cochrane Collaboration. Included reviews have to be about the effects of interventions. The Cochrane Central Register of Controlled Trials (CENTRAL) includes details of clinical trials found in bibliographic databases (notably MEDLINE and EMBASE), and other published and unpublished sources.

The Department used the same inclusion criteria used by the MSRB's Medications Task Force in its analysis on NSAIDs to determine which of the studies found in the automated searches would be retrieved for further analysis. First, the title of the article was reviewed to confirm that the article was about the therapeutic use of spinal cord stimulators in humans. The abstracts and bibliographical data were then retrieved for articles meeting the first screening and reviewed to determine if:

- the article addressed one of the specific issues of relevance about spinal cord stimulators;
- the article represented a study of the appropriate level of evidence;
- it was a study published during the search time frame;
- the article was published in English; and
- the article was available on-line through the University of Minnesota Bio-Medical Library.

Articles selected for inclusion after a review of the article abstract were retrieved in electronic format from the University of Minnesota Bio-Medical Library through the Lumina portal. An electronic database was created listing the authors, the title of the article, and the journal reference. Each article's abstract and full text was then hyperlinked to its citation in the database. Retrieved articles were evaluated for their level of evidence and assigned a "relevance" category. Systematic reviews (and/or meta-analyses) and randomized controlled trials were considered to be of "high" relevance. Other types of controlled trials and economic evaluations were considered to be of "medium" relevance. Unsystematic reviews, editorials, case series, case studies and all other types of articles were considered to be of "low" relevance.

An additional computerized search for guidelines, using the key words "pain" and "spinal cord stimulation" was conducted at the websites of organizations known to be active in guideline development, appraisal, or cataloging:

Country	***Name of organization***	***Website***
Netherlands	Dutch Institute for Healthcare Improvement	http://www.cbo.nl
New Zealand	New Zealand Guidelines Group	http://www.nzgg.org.nz
	Accident Compensation Corporation	http://www.acc.co.nz/index.htm
Scotland	Scottish Intercollegiate Network	http://www.sign.ac.uk
Sweden	Swedish Council on Technology Assessment in Health Care	http://www.sbu.se
UK	National Library of Guidelines	http://www.library.nhs.uk/guidelinesfinder
USA	National Institutes of Health Consensus Development Program	http://consensus.nih.gov
	National Guideline Clearinghouse	http://www.guideline.gov
	Agency for Healthcare research & Quality	http://www.ahrq.gov/

Finally, the computerized searches were supplemented by hand searches of the bibliographies of key articles (particularly systematic reviews and guidelines) and with articles submitted by interested parties.

Articles chosen for analysis were then assessed for their quality using criteria that were appropriate to the study type.

For systematic reviews, the quality criteria chosen were:

1. Study Identification	
Multiple electronic databases	
Unbiased explicit searching strategies	
Hand searches	
Attempts to include "gray" literature	
Estimation of potential publication bias	
2. Study selection	
Only randomized controlled trials included	
Explicit inclusion/exclusion criteria	
Selection criteria applied uniformly	
Rationale for excluding studies	
3. Appraisal of studies	
Described in detail	
Uniformly applied to all studies	
Important parameters addressed • random allocation • double blinding • relevant outcome measures • follow-up of at least 80 per cent of participants • analysis consistent with the study design	 ___ ___ ___ ___ ___
Effect of study quality on conclusions assessed	
4. Data Collection	
Was missing information considered?	
5. Data synthesis	
Assessment for heterogeneity	
All valid studies used	
Sensitivity analysis performed	
Variations between studies considered	

For randomized controlled trials, the quality criteria were:

Random allocation	
Minimal dropouts (< 15%)	
Blinding of patient	
Blinding of the assessor	
Co-treatments have been used in an equivalent manner among treatment groups.	
Assessment of the extent of patient adherence to the prescribed therapy	
No unintended crossovers from one study treatment to the other.	
Adequate consideration of statistical and clinical significance of findings.	
Adequate demographic description of patients, including at least age, gender, and referral source.	
Adequate clinical description, including pain duration, neurologic deficits, sciatica, previous surgery, and other inclusion or exclusion criteria.	
Adequate description of treatment in terms of dosage, duration, frequency, and technique.	
Reporting of all relevant outcomes, which may include symptoms, physiologic changes, functional ability, costs of care, and psychological measures.	

These criteria were adapted from recommendations for critical appraisal of systematic reviews and randomized controlled trials found in the peer-reviewed literature and textbooks of evidence-based medicine.[5]

For guidelines, the quality criteria were derived from the instrument developed by The AGREE Collaboration started in 1998 as a research project under the Biomedicine and Health Research (BIOMED 2) Programme, funded by the European Union[6]:

Scope and purpose	
Objective(s) of the guideline are specifically described.	
The clinical question(s) is specifically described.	
The patients to whom the guideline is meant to apply is specifically described.	
Stakeholder involvement	
The guideline development group includes individuals from all the relevant professional groups.	
The patients' views and preferences are sought.	
Rigour of development	
Systematic methods are used to search for evidence.	
The criteria for selecting the evidence are clearly described.	
The methods used for formulating the recommendations are clearly described.	
The health benefits, side effects and risks are considered in formulating the recommendations.	
There is an explicit link between the recommendations and the supporting evidence.	
The guideline was externally reviewed by experts prior to publication.	
A procedure for updating the guideline is provided.	
Clarity and presentation	
The recommendations are specific and unambiguous.	
The different options for diagnosis and/or treatment of the condition are clearly presented.	
Key recommendations are easily identifiable.	
Applicability	
The target users of the guideline are clearly defined.	
The potential organizational barriers in applying the recommendations are discussed.	
The potential cost implications of applying the recommendations were considered.	
The guideline is supported with tools for application.	
The guideline presents key review criteria for monitoring and audit purposes	
The guideline was piloted among end users.	
Editorial independence	
The guideline is editorially independent from the funding body.	
Conflicts of interest of guideline development members are recorded.	

Articles were scored "yes", "no", "can't tell" on each item. A summary score was determined by adding together the "yes" responses, dividing by the total number of criteria. This scoring system is a short hand way of indicating overall study quality and is similar to systems used in many systematic reviews for evaluating primary source literature.

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5 Oxman AD, Cook DJ, Guyatt GH "Users' guides to the medical literature. VI How to use an overview" Journal of the American Medical Association 1994; 272(17): 1367-1371
Guyatt GH, Sackett DL, Cook DJ "Users' guides to the medical literature. II. How to use an article about therapy or prevention. A. Are the results of the study valid?" Journal of the American Medical Association 1993; 270(21): 2598-601.
Crombie IK The Pocket Guide to Critical Appraisal: A Handbook for Healthcare Professionals London; BMJ Publishing Group, 1996
6 http://www.agreecollaboration.org/

In addition, the author's conclusions regarding spinal cord stimulator were abstracted, and, in the case of the systematic reviews, the primary literature relied upon by the author(s) in reaching their conclusions was identified and tabulated. The results of the quality review, the author's conclusions, and, if relevant, the bibliography of the primary source literature were entered into a "Summary Sheet" for each article. These Summary Sheets were then also hyperlinked to the Department database.

Finally, the abstracted conclusions from each article were transferred to a separate spreadsheet. There, the conclusions were first sorted onto different pages based on the clinical population addressed in the study (Failed back Surgery Syndrome (and other spinal pain problems), Complex Regional Pain Syndrome, and Mixed Chronic Pain Patients); then they were arranged thematically into columns for comparison across articles.

Results

The first PubMed search used a search string published in the medical literature that has been validated as both sensitive and specific for retrieving systematic reviews.[7] The search string was combined first with the key words "spinal cord stimulator" and "neurostimulator." Because a search done limiting articles to those published since1990 yielded less than 10 unique references, this search was expanded to the entire Pub Med database. Expanding this search to the entire PubMed database still did not yield more than 10 unique references, so the search was eventually expanded to include other types of articles. Separate searches were done for articles reporting on the use of spinal cord stimulator in low back pain patients and in patients with complex regional pain syndrome (reflex sympathetic dystrophy). The results of the searches can be found in the documents "SCS and LBP.doc", "SCS and RSD.doc", "Neurostim and LBP.Doc", "Neurostim and RSD.Doc", "SCS-CT.doc", "SCS-meta_analysis.doc", and "SCS-RCT.doc" (Available at: http://www.doli.state.mn.us/msrb/scs/).

These searches retrieved 161 titles, some found more than once. Of these, 63 articles were presumed relevant based on their title and retrieved for further review.

The searches of the Cochrane Database of Systematic Reviews (CDSR) of the Database of Abstracts of Reviews of Effects (DARE) were done using the key word "spinal cord stimulator" and did not yield any new references not found in the PubMed search.

The hand search added 4 articles which were considered potentially relevant (their ID# marked with a suffix "h" in the database) and 2 articles were submitted by interested parties (their ID# marked with a suffix "s" in the database).

[7] " ((meta-analysis [pt] OR meta-analysis [tw] OR metanalysis [tw]) OR ((review [pt] OR guideline [pt] OR consensus [ti] OR guideline* [ti] OR literature [ti] OR overview [ti] OR review [ti]) AND ((Cochrane [tw] OR Medline [tw] OR CINAHL [tw] OR (National [tw] AND Library [tw])) OR (handsearch* [tw] OR search* [tw] OR searching [tw]) AND (hand [tw] OR manual [tw] OR electronic [tw] OR bibliographi* [tw] OR database* OR (Cochrane [tw] OR Medline [tw] OR CINAHL [tw] OR (National [tw] AND Library [tw])))) OR ((synthesis [ti] OR overview [ti] OR review [ti] OR survey [ti]) AND (systematic [ti] OR critical [ti] OR methodologic [ti] OR quantitative [ti] OR qualitative [ti] OR literature [ti] OR evidence [ti] OR evidence-based [ti]))) BUTNOT (case* [ti] OR report [ti] OR editorial [pt] OR comment [pt] OR letter [pt]) " found in Shojania KG, Bero LA. "Taking advantage of the explosion of systematic reviews: an efficient MEDLINE search strategy" Eff Clin Pract 2001;4(4): 157-62.

The search for guidelines on the World Wide Web found 9 and another was submitted by an interested party.

References for all the articles chosen for further review were combined in an Excel database, spinal-stim.xls (see Appendix 3). Of the 79 articles (9 systematic reviews, 6 randomized controlled trials, 12 guidelines, 3 clinical trials, 6 economic evaluations, 11 unsystematic reviews/editorials, and 32 case series/studies), the full article was available electronically for 44 of them through the Lumina portal at the University of Minnesota (9 systematic reviews, 5 randomized controlled trials, 2 guidelines, 2 clinical trials, 6 economic evaluations, 6 unsystematic reviews/editorials, and 14 case series/studies). Ten guidelines were available through the World Wide Web or were made available by an interested party. When available, the full article was hyperlinked to the database. The article's abstract was then reviewed to determine level of evidence and the relevance of the article.

In all, 14 articles met the inclusion criteria (9 systematic reviews, 5 randomized controlled trials, 12 guidelines) and were entered into a second Excel database, spinal stim - review.xls (see Appendix 4). A quality review was then performed for each article.

The retrieved articles varied in quality. The systematic reviews had summary quality scores ranging from 5/22 to 20/22. However, 5 of the 7 systematic reviews had quality scores greater than 15/22. The randomized controlled trials had summary quality scores ranging from 8/12 to 10/12. The guidelines had summary quality scores ranging from 7/23 to 20/23; however, 5 had scores greater than 13/23.

Overall, all of the systematic reviews and RCTs addressed the question of effectiveness. Five of the systematic reviews and three of the RCTs addressed issues of safety. Two systematic reviews focused on the use of spinal cord stimulators in patients with low back pain, two focused on their use in patients with complex regional pain syndrome (reflex sympathetic dystrophy) and five assessed the effectiveness of spinal cord stimulators in general. Two RCTs included only patients with low back pain and the others included only patients with complex regional pain syndrome (reflex sympathetic dystrophy). Five of the systematic reviews reported on the criteria used for judging whether a patient had a favorable response during a trial period; four reported on the appropriate trial period.

Three of the guidelines were specific to the use of spinal cord stimulators in patients with complex regional pain syndrome (reflex sympathetic dystrophy); one addressed only use in patients with failed back surgery syndrome, while three addressed their use in chronic pain patients without concern for the underlying condition. The others provided guidance regarding both complex regional pain syndrome (reflex sympathetic dystrophy and failed back surgery syndrome cases. The evidence used in developing the recommendations was referenced in the available text for 10 of the 12 guidelines. Those guidelines all relied, at least in part, on systematic reviews and RCTs; in most cases those systematic reviews and RCTs were the same ones identified in the searches done for this report (as noted in columns K and L of spinal stim - review.xls).

The conclusions made by the article's author(s) were then abstracted and entered into a third database, spinal stim - analysis.xls (see Appendix 4). There, the conclusions were first sorted onto different pages based on the clinical population addressed in the study (Failed back Surgery Syndrome (and other spinal pain problems), Complex Regional Pain Syndrome, and Mixed Chronic Pain Patients); then they were arranged thematically into columns for comparison across articles. Themes were identified inductively from the abstracted conclusions by arranging them into the fewest mutually exclusive categories.

The themes identified were:

theme	*# articles*	*summary quality scores*
Sources of data	SysRev: 9 RCT: 5 Guidelines: 10	SysRev: 5/22 – 20/22 RCT: 8/12 – 10/12 Guidelines: 7/23 – 20/23
Comments on data	SysRev: 7 RCT: 5 Guidelines: 10	SysRev: 5/22 – 20/22 RCT: 8/12 – 10/12 Guidelines: 7/23 – 20/23
Quantitative results	SysRev: 9 RCT: 5 Guidelines: 6	SysRev: 5/22 – 20/22 RCT: 8/12 – 10/12 Guidelines: 10/23 – 20/23
Reported complications	SysRev: 6 RCT: 4 Guidelines: 1	SysRev: 5/22 – 18/22 RCT: 9/12 – 10/12 Guidelines: 14/23
Study design issues	SysRev: 7 RCT: 5 Guidelines: 0	SysRev: 5/22 – 20/22 RCT: 8/12 – 10/12
Author's overall conclusions	SysRev: 8 RCT: 5 Guidelines:11	SysRev: 5/22 – 20/22 RCT: 8/12 – 10/12 Guidelines: 10/23 – 20/23
Comments on length of trial period	SysRev: 3 RCT: 1 Guidelines: 0	SysRev: 5/22 – 20/22 RCT: 10/12
Comments on judging trial success	SysRev: 3 RCT: 5 Guidelines: 0	SysRev: 5/22 – 20/22 RCT: 8/12 – 10/12

Conclusions

The Department found considerable agreement of published opinion on each issue. While the individual articles varied in quality, this variation does not significantly affect the conclusions reached by the authors. Articles of higher quality most often reached the same conclusions as those of lower quality.

Nine of the 12 guidelines recommended the use of spinal cord stimulation in at least some clinical situations (5 of 6 guidelines with recommendations for back pain patients; 7 of 8 guidelines with recommendations for complex regional pain syndrome patients; 2 of 3 guidelines for recommendations for chronic pain patients in general).[8] The guidelines not recommending

[8] Some guidelines had recommendations for more than one clinical situation.

the use of spinal cord stimulators did not differ markedly in quality from those recommending their use but did tend to rely on a smaller base of data.

The conclusions drawn by the Department from the reviewed literature are:

1. There is limited evidence (predominantly from case series and two RCTs) that permanently implanted spinal cord stimulators are effective in achieving at least a 50% reduction in pain in 50%- 60% of patients with chronic spinal conditions who have a positive response during a screening trial period.

reference	***author's conclusions***
Neurosurgery. 1995 Dec;37(6):1088-95	In sum, approximately 50 to 60% of patients with FBSS report ≥50% pain relief with SCS.
Spine. 2005 Jan 1;30(1):152-60	The level of evidence for the efficacy of SCS in patients with CLBP/FBSS remains "moderate." The greatest level of pain relief following SCS appeared to be associated with case series that were of poor quality, short follow-up duration, undertaken in a multicenter setting, and that recruited patients with CLBP or FBSS specifically.
Neurosurgery. 2005;56(1):98-106	This prospective, randomized trial confirms the inference from previous studies that SCS is superior to reoperation in patients with persistent radicular pain after lumbosacral spine surgery. In patients with persistent radicular pain after lumbosacral spine surgery, therefore, our findings indicate that clinicians should offer SCS as an alternative to repeated operation before exhausting all surgical alternatives.
Pain xxx (2007) xxx–xxx	The favorable effect of SCS on neuropathic pain is consistent with the results of previously reported trials.
Eur Spine J 2006; 15:S192-S300	We cannot recommend the use of spinal cord stimulation for the treatment of chronic nonspecific LBP.
Assessment and management of chronic pain.	Patients with lumbar and cervical radiculopathy who are not surgical candidates, and patients with postlaminectomy syndrome are the best candidates for SCS.
Considered Judgment Form: Neuromodulation-Spinal Cord Stimulation	We do not recommend spinal cord stimulation for the treatment of adults with pain due to failed back surgery syndrome.
Treatment in Workers' Compensation 2006	Recommended only for selected patients in cases when less invasive procedures have failed or are contraindicated, and following a successful temporary trial
J Neurosurg 2004; 100:S254-S67	There is some evidence to indicate that SCS has positive, symptomatic, long-term effects on … failed–back surgery syndrome pain.
Cochrane Database Syst Rev. 2004;(3):CD003783	At the present time there is limited evidence that spinal cord stimulators are effective for some types of chronic pain (FBSS …).
J Pain Symptom Manage 2004; 27:370-378	SCS is economically favorable in comparison to other therapies for patients with FBSS…. The initial acquisition costs of SCS appear to be offset by a reduction in healthcare resources, such as drug therapy, physician visits, and hospitalization episodes.
Spinal cord stimulation for the management of pain: recommendations for best clinical practice	For indications strongly supported by evidence, i.e. …, neuropathic pain following spinal surgery…, SCS should be considered early in the patient's management when simple first line therapies have failed. SCS should not necessarily be considered a treatment of last resort.
Evidence-based clinical practice guideline for interdisciplinary rehabilitation of chronic non-malignant pain syndrome patients	Do not recommend using spinal cord stimulators with chronic pain patients.
Summary and Conclusions of the SBU Report on: Methods of Treating Chronic Pain. A Systematic Review	Spinal cord stimulation has been shown to reduce … low back (Evidence Grade 2) pain.

2. There is limited evidence (predominantly from case series and one RCT) that permanently implanted spinal cord stimulators are effective in achieving at least a 50% reduction in pain in 50%- 67% of patients with complex regional pain syndrome (reflex sympathetic dystrophy) who have a positive response during a screening trial period.

reference	***author's conclusions***
Clin J Pain. 2003 Nov-Dec;19(6):371-83	We conclude that available evidence suggests that SCS is effective for

	the management of pain for patients with CRPS who did not respond to more conservative medical management (grade B/C).
Eur J Pain 2006 10(2) 91-101	SCS appears to be an effective therapy in the management of patients with CRPS type I (Level A evidence) and type CRPS II (Level D evidence). Moreover, there is evidence to demonstrate that SCS is a cost-effective treatment for CRPS type I.
N Engl J Med. 2000 Aug 31;343(9):618-24	In carefully selected patients with chronic reflex sympathetic dystrophy, electrical stimulation of the spinal cord can reduce pain and improve health-related quality of life.
Ann Neurol. 2004 Jan;55(1):13-8	We conclude that after careful selection and successful test stimulation SCS is safe and has long-term effectiveness in reducing pain.
N Engl J Med. 2006 Jun 1;354(22):2394-6	The pain-alleviating effect of SCS in CRPS diminishes with time, and is no longer statistically significant after 3 years.
Spinal Cord Stimulation. Use in Patients with Complex Regional Pain Syndrome	Incorporating the lack of high level medical research on this subject, along with its significant potential adverse effect rate and poor compensation outcome measures when SCS are used, the WCB should continue with its present position of not authorizing its use in the injured worker population.
Eur J Neurol 2007; 14:952-970	Level B evidence for effectiveness of SCS in CRPS I
Assessment and management of chronic pain.	Patients with complex regional pain syndrome (CRPS) type 1 or (RSD) are the best candidates for SCS.
Considered Judgment Form: Neuromodulation-Spinal Cord Stimulation	We recommend spinal cord stimulation should be used in highly selected patients with complex regional pain syndrome type I.
Complex Regional Pain Syndrome type 1 Guidelines	Pain control with spinal cord stimulation is a responsible choice for carefully selected CRPS-I patients who have not responded to other treatments.
Treatment in Workers' Compensation 2006	Recommended only for selected patients in cases when less invasive procedures have failed or are contraindicated, and following a successful temporary trial
Evidence Based Review. Spinal Cord Stimulation	There is no quality evidence that SCS is superior treatment long term especially when a cost/benefit perspective is required
J Neurosurg 2004; 100:S254-S67	There is some evidence to indicate that SCS has positive, symptomatic, long-term effects on CRPS I and II …
Cochrane Database Syst Rev. 2004;(3):CD003783	At the present time there is limited evidence that spinal cord stimulators are effective for some types of chronic pain (… CRPS Type 1).
J Pain Symptom Manage 2004; 27:370-378	SCS is economically favorable in comparison to other therapies for patients with … CRPS. The initial acquisition costs of SCS appear to be offset by a reduction in healthcare resources, such as drug therapy, physician visits, and hospitalization episodes.
Spinal cord stimulation for the management of pain: recommendations for best clinical practice	For indications strongly supported by evidence, i.e. CRPS, … SCS should be considered early in the patient's management when simple first line therapies have failed. SCS should not necessarily be considered a treatment of last resort.
Evidence-based clinical practice guideline for interdisciplinary rehabilitation of chronic non-malignant pain syndrome patients	Do not recommend using spinal cord stimulators with chronic pain patients.
Summary and Conclusions of the SBU Report on: Methods of Treating Chronic Pain. A Systematic Review	Spinal cord stimulation has been shown to reduce peripheral neuropathic (Evidence Grade 3) … pain. Notwithstanding high initial expenses, spinal cord stimulation combined with physical therapy is cost-effective in treating neuropathic pain (Evidence Grade 3).

3. There is inconsistent evidence as to whether spinal cord stimulators improve other clinical outcomes in patients with either chronic spinal conditions or complex regional pain syndrome (reflex sympathetic dystrophy).

reference	***author's conclusions***
Neurosurgery. 1995 Dec;37(6):1088-95	However, there is insufficient evidence to draw conclusions … about the effects of SCS on patient work status, functional disability, and health care and medication use.
Clin J Pain. 2003 Nov-Dec;19(6):371-83	Definitive conclusions cannot be made with regard to any of the secondary outcome measures, in part due to poor methodological design and in part due to inadequate reporting by the authors.
Spinal Cord Stimulation. Use in Patients with Complex Regional Pain Syndrome	Incorporating the lack of high level medical research on this subject, along with its significant potential adverse effect rate and poor compensation outcome measures when SCS are used, the WCB should continue with its present position of not authorizing its use in the

	injured worker population.
Pain. 2004 Mar;108(1-2):137-47	We conclude that the literature on SCS for FBSS … remains inadequate to make definitive statements about efficacy in reducing physical disability, work disability, and medication consumption.

4. There is inconsistent evidence as to whether spinal cord stimulators are more effective than alternatives for relieving pain in patients with either chronic spinal conditions or complex regional pain syndrome (reflex sympathetic dystrophy).

reference	***author's conclusions***
Neurosurgery. 1995 Dec;37(6):1088-95	No conclusions may be drawn concerning the efficacy of SCS for FBSS relative to other treatments, placebo treatments, or no treatment.
N Engl J Med. 2006 Jun 1;354(22):2394-6	The pain-alleviating effect of SCS in CRPS diminishes with time, and is no longer statistically significant after 3 years.
Complex Regional Pain Syndrome type 1 Guidelines	Pain control with spinal cord stimulation is a responsible choice for carefully selected CRPS-I patients who have not responded to other treatments.
Treatment in Workers' Compensation 2006	Recommended only for selected patients in cases when less invasive procedures have failed or are contraindicated, and following a successful temporary trial
Evidence Based Review. Spinal Cord Stimulation	There is no quality evidence that SCS is superior treatment long term especially when a cost/benefit perspective is required
Pain. 2004 Mar;108(1-2):137-47	Using recently published criteria for levels of evidence, there is moderate evidence (one high-quality RCT) that SCS plus PT is more effective than PT-only for patients with CRPS type I in relieving pain at 6- and 12-month follow-ups. Both the RCT and lower-quality studies suggest a modest pain-relieving effect on average. Less regarding comparisons with placebo controls, other treatments, or the natural history can be gleaned from the literature.

5. Complications occur in 1/3 to 1/2 of cases, but are often mild and mostly involving problems with the equipment or local infection. But up to 1/3 of patients will require re-operation in the first two years due to complications.

reference	***complications***
Neurosurgery. 1995 Dec;37(6):1088-95	o 13 studies: 42% (range 20-75%) of patients had some kind of complication. o 20 studies: 5% (range 0-12%) of patients had an infection. o 17 studies: 9% (range 0-42%) of patients had a biological complication other than infection. o 13 studies: 30% (range, 0-75%) of patients had one or more stimulator-related complications.
Spine. 2005 Jan 1;30(1):152-60	o RCT: Four (17%) and six (26%) patients with FBSS experienced complications at 6 and 12 months post SCS implantation, respectively. o Case Series: Overall, 43% of patients with CBLP/FBSS experienced one or more complications with SCS. The majority of these complications were due to electrode or lead problems (195/722; 27%). Infections (6%), generator problems (6%), extension cable problems (10%), or other issues, such as cerebrospinal fluid leaks (7%), accounted for the remainder.
Neurosurgery. 2005;56(1):98-106	One SCS patient developed an infection at the receiver site, which was treated by removal of the system followed by specific antibiotic therapy. The system was replaced without further complication. Three SCS patients (9% of permanent implants) underwent hardware revisions because of technical problems (electrode migration or malposition).
Pain xxx (2007) xxx–xxx	Of 84 patients, 27 (32%) experienced a total of 40 device-related complications. For 20 patients (24%), surgery was required to resolve the event. Principal complications were electrode migration (10%), infection or wound breakdown (8%), and loss of paresthesia (7%).
Pain Physician. 2007 Jan;10(1):7-111	Complications with spinal cord stimulation range from infection, hematoma, nerve damage, lack of appropriate paresthesia coverage,

	paralysis, nerve injury, and death.
Clin J Pain. 2003 Nov-Dec;19(6):371-83	o The proportion of patients with at least one complication ranged from 9% to 50%. o The infection rate ranged from 1.4% to 11.1%. o The rate of complication due to technical problems such as equipment failure, lead migration, or lost coverage ranged from 8.3% to 42.8%. o The rate of reoperation ranged from 11.1% to 50%.
Eur J Pain 2006 10(2) 91-101	o RCT: Six of the 36 patients receiving SCS plus physical therapy experienced complications (n = 11) at 6 months but only one complication (infection) was reported at 12 months. A total of 9 of the 24 patients (38%) experienced 22 complications needing operation during the 2-years after implantation. o Case Series: Overall, in eight studies, 33.0% (22/66) of patients reported at least one complication with SCS. The majority of complications were related to electrode issues (20% of patients), infections (4% of patients), generator issues (2% of patients) or extension cable issues (1%) of patients. A further 6% of patients had other complications such as hematomas.
N Engl J Med. 2000 Aug 31;343(9):618-24	Six of the 24 patients had complications that required additional procedures, including removal of the device in 1 patient. Four of the six had long term complications.
Ann Neurol. 2004 Jan;55(1):13-8	o 9 of 24 patients (38%) suffered 22 complications needing operation during the 2 years after implantation. o The most frequent complications were electrode displacement and pain from the pulse generator pocket. o Two patients underwent permanent removal of the system on the grounds of recurrent rejection and relapsing ulcerative colitis subscribed to the system, respectively .o Side effects were reported by all 22 patients who still had an implanted system at 2 years.
Pain Physician. 2007 Jan;10(1):7-111	Complications with spinal cord stimulation range from infection, hematoma, nerve damage, lack of appropriate paresthesia coverage, paralysis, nerve injury, and death.
J Neurosurg 2004; 100:S254-S67	Most complications were not life threatening and could usually be resolved by removing the device. The most common complication was lead migration. The most serious complication was paralysis
Pain. 2004 Mar;108(1-2):137-47	18 articles: average of 34% (range 0–81%) of the patients who received a permanent stimulator had one or more undesirable outcomes during the study follow-up period. These included superficial and deep infections, local pain in the region of stimulator components, biological complications other than infection or local pain (e.g. dural puncture), equipment failure, a stimulator revision (additional operation to correct an equipment problem; we did not include battery changes in this category), and stimulator removal (most commonly because of infection, equipment failure, or lack of pain relief). Removals included both permanent removals and removals followed by eventual re-implantations (e.g. removal due to infection and stimulator implantation after resolution of the infection).

6. Trial screening periods in the reported case series and clinical trials have lasted from 1 day up to 30 days, with most lasting from 3 to 7 days. There is no information to judge whether the length of the trial period influences the reported efficacy of spinal cord stimulation.

reference	***trail period***
Neurosurgery. 1995 Dec;37(6):1088-95	In 34 studies, there were temporary electrode trials, lasting 1 to 3 days in 4studies, 4 to 7 days in 8 studies, 8 to 14 days in 4 studies, and more than 2 weeks in 2 studies. The length of the trial considerably varied across patients in 1 study and was not specified in 15 studies.
Neurosurgery. 2005;56(1):98-106	SCS treatment began with percutaneous placement of a temporary electrode for a therapeutic trial lasting at least 3 days.
Clin J Pain. 2003 Nov-Dec;19(6):371-83	Eleven studies reported the duration of the stimulation trial period that ranged from 3 to 30 days. Six of these studies reported trial stimulation

	that lasted 7 days or less. The remaining 5 studies reported trial stimulation of greater than 7 days.
Cochrane Database Syst Rev. 2004;(3):CD003783	1of 2 studies: Percutaneous placement of a temporary electrode for routine 2- 1/2 day trial.

7. The most common measure of success in the trial period was relief of pain and the most common criteria was pain relief of at least 50%.

reference	***trial success***
Neurosurgery. 1995 Dec;37(6):1088-95	In the 34 studies in which patients were screened with temporary electrodes to determine suitability for permanent implants, the criteria for permanent implants were specifically stated to be pain relief in 19 studies, region of paresthesia in 8 studies, decreased medication use in 2 studies, and increased activity in 2 studies. Only eight articles stated a threshold percentage of pain relief for permanent implantation, and across these studies, the minimum percent pain relief for implantation ranged from 30 to 75% (30% in one study, 50% in five, 70% in one, and 75% in one).
Neurosurgery. 2005;56(1):98-106	The SCS patients could receive a permanent implant if they reported at least 50% estimated relief of pain by standard pain rating methods and demonstrated stable or improved analgesic medication intake, with improved physical activity commensurate with neurological status and age.
Pain xxx (2007) xxx–xxx	Criteria for implanting SCS: at least 80% overlap of pain distribution with stimulation-induced paresthesia and at least 50% leg pain relief.
Clin J Pain. 2003 Nov-Dec;19(6):371-83	There was considerable variability in the criteria used to determine successful trial stimulation. Quantitative and validated measures of pain relief were not used by all studies to determine trial success. A 50% decrease in VAS score for pain or a rating of 6 on the global perceived effect (GPE) scale was necessary to define success in 2 studies. Three studies used 50% pain relief from baseline VAS scores, while 1 study used walking distance along with 70% pain relief as the primary outcome measure. Other studies used nonspecific outcomes such as “patient satisfied”, “acceptable degree of analgesia”, “patient benefited”, or “pain relief to avoid heavy analgesic use.”
N Engl J Med. 2000 Aug 31;343(9):618-24	The decision to implant the permanent SCS system was made when pain intensity during the testing period was at least 50% lower as compared with the original (baseline) visual analog score, or if “much improvement” was reported on a seven-point global perceived effect scale.
Cochrane Database Syst Rev. 2004;(3):CD003783	1 of 2 studies: If a patient reports at least 50% estimated relief of pain, while demonstrated stable or improved medication intake, and improved physical activity commensurate with neurologic status and age, a permanent implant was offered.

Recommendations

Based on the conclusions derived from the literature the Department proposes the following draft recommendations to the Medical Services Review Board, to be used as the basis for changes to the Permanent Treatment Parameters governing the use of spinal cord stimulators in workers' compensation claims.

I. Spinal cord stimulators can effectively relieve pain in some patients with chronic spinal pain or complex regional pain syndrome (reflex sympathetic dystrophy).

II. An adequate trial period of at least three days is needed to determine who might benefit from spinal cord stimulation.

III. Adequate pain relief of at least 50% during the trial period is needed to determine if a patient might benefit from spinal cord stimulation.

Appendix 1

The Word files "SCS and LBP.doc", "SCS and RSD.doc", "Neurostim and LBP.Doc", and "Neurostim and RSD.Doc", "SCS-CT.doc", "SCS-meta_analysis.doc", "SCS-RCT.doc" list all of the articles found in the literature searches.

Appendix 2

The Excel workbook spinal-stim.xls lists all of the articles that were selected by the Department for further review.

Column A is an ID number
Column B lists the authors of the article.
Column C is the title of the article.
Column D gives the abbreviated citation as found in Medline and is an active link. Clicking on the journal citation will call up the abstract and/or article
Column E identifies the type of article:

- "SysRev" is a systematic review,
- "RCT" is a randomized controlled trial
- "CT" is a nonrandomized trial
- "CE" is an economic evaluation
- "Guide" is an evidence-based treatment guideline
- "Review" is an unsystematic review
- "Editorial" is a statement of a single physician's opinion
- "CaseSer" is a case series
- "CaseRep" is a single case report

Column F indicates whether the article was determined to be relevant for the purposes of this study based on the levels of evidence hierarchy.
Column G indicates the availability of the article.
Column H indicates the patient subgroup(s) discussed in the article.

Appendix 3

The Excel workbook spinal stim - review.xls lists the results of the quality review of the articles that were selected by the Department for this analysis.

Column A is an ID number
Column B lists the authors of the article.
Column C gives the abbreviated citation as found in Medline and is an active link. Clicking on the journal citation will call up the abstract and/or article
Column D identifies the type of article:
"SysRev" is a systematic review,
"RCT" is a randomized controlled trial
"Guide" is an evidence-based treatment guideline.
Column E is marked with an "X" if the article discusses efficacy.
Column F is marked with an "X" if the article discusses safety.
Column G indicates the patient subgroup(s) discussed in the article.
Column H is a hyperlink to the summary sheet for the article
Column I is the summary quality score of the article
Column J includes any comments about the article

For guidelines only:
Column K lists the ID# for any systematic reviews included in this analysis that were used by the authors of the guideline.
Column L lists the ID# for any randomized clinical trials included in this analysis that were used by the authors of the guideline.
Column M lists the ID# for any guidelines included in this analysis that were used by the author's of the guideline.

Appendix 4

The Excel workbook spinal stim -analysis.xls lists the author's findings and conclusions regarding the efficacy and safety of spinal cord stimulators, and any other information relevant to the questions posed for this analysis. Wherever possible, the conclusions are stated in the authors' own words.

This workbook has 3 spreadsheets or pages:

The **first page** lists the results for articles that addressed the use of spinal cord stimulators in patients with low back pain.

> **Column A** gives the abbreviated citation as found in Medline and is an active link. Clicking on the journal citation will call up the abstract and/or article
> **Column B** identifies the type of article: "SR" is a systematic review, "RCT" is a randomized controlled trial, and "Guide" is an evidence-based treatment guideline.
> **Column C** lists the sources of information used.
> **Column D** lists any comments made by the authors regarding the sources of information.
> **Column E** lists the quantitative results of the study.
> **Column F** lists any information regarding complications.
> **Column G** lists any comments made by the authors regarding the study design or other methodological issues.
> **Column H** lists the authors' overall conclusions on the use of spinal cord stimulation.
> **Column I** is intentionally blank.
> **Column J** lists any information given regarding the conduct of a trial period.
> **Column K** lists any information given regarding the criteria for judging a trial as successful.

The **second page** lists the results for articles that addressed the use of spinal cord stimulators in patients with complex regional pain syndrome.

> **Column A** gives the abbreviated citation as found in Medline and is an active link. Clicking on the journal citation will call up the abstract and/or article
> **Column B** identifies the type of article: "SR" is a systematic review, "RCT" is a randomized controlled trial, and "Guide" is an evidence-based treatment guideline.
> **Column C** lists the sources of information used.
> **Column D** lists any comments made by the authors regarding the sources of information.
> **Column E** lists the quantitative results of the study.
> **Column F** lists any information regarding complications.
> **Column G** lists any comments made by the authors regarding the study design or other methodological issues.
> **Column H** lists the authors' overall conclusions on the use of spinal cord stimulation.
> **Column I** is intentionally blank.
> **Column J** lists any information given regarding the conduct of a trial period.
> **Column K** lists any information given regarding the criteria for judging a trial as successful.

The **third page** lists the results for articles that addressed the use of spinal cord stimulators in chronic pain patients in general.

Column A gives the abbreviated citation as found in Medline and is an active link. Clicking on the journal citation will call up the abstract and/or article
Column B identifies the type of article: "SR" is a systematic review, "RCT" is a randomized controlled trial, and "Guide" is an evidence-based treatment guideline.
Column C lists the sources of information used.
Column D lists any comments made by the authors regarding the sources of information.
Column E lists the quantitative results of the study.
Column F lists any information regarding complications.
Column G lists any comments made by the authors regarding the study design or other methodological issues.
Column H lists the authors' overall conclusions on the use of spinal cord stimulation.
Column I is intentionally blank.
Column J lists any information given regarding the conduct of a trial period.
Column K lists any information given regarding the criteria for judging a trial as successful.

Appendix 5

The Excel workbook spinal stim –primary sources.xls lists all of the original studies referenced by the authors of systematic reviews and evidence-based guidelines.

Column A gives the ID#(s) ID# of included in this analysis that referenced this primary source
Column B is the citation of the primary source