Improvements in Health-Related Quality of Life in Chronic Back/Leg Pain Patients with Closed-loop SCS

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Background

- Survey of a representative sample of 100 SCS patients shows that inconsistent dosing (e.g., over- or under stimulation) occurs in over 50% of patients with fixed-output devices, regardless of the waveform. This leads to behaviors such as adjusting therapy up/down/off, avoiding ≥1 activities of daily living, or assuming rescue positions and other adaptations which results in a poor overall therapy experience for the patient.[1]
- This inconsistent dosing results from changes in lead-to-cord distance during activities of daily living. To account for such variations, the closed-loop (CL) algorithm in the study device adjusts amplitude based on the measured physiologic response of the spinal cord – the evoked compound action potential (ECAP).[1] CL-SCS aids in consistent delivery of dose and thereby addresses the side effects of sub-optimal therapy.
- Here we report outcomes with CL-SCS with multiplexed waveforms tailored to the patient's needs (e.g., above/below perception, low dose etc.).

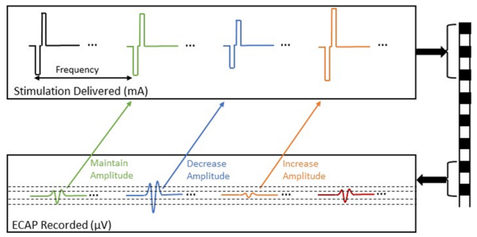


Figure 1. CL algorithm updates stimulation amplitude after each pulse.[2] Design of the algorithm allows interleaving additional therapy waveforms.

Methods

- Prospective study being conducted at 7 sites in Australia (NCT05177354). The study has 2 parts: a) in-clinic, randomized, cross-over, single blind, testing for Primary Endpoint at 1-month and b) long-term, single-arm follow-up for pain outcomes at 3-, 6-, 12-, 18- and 24-months post Device Activation.
- Key Eligibility Criteria: 1) Overall VAS score of ≥60 mm AND 2) Low Back AND/OR Leg VAS of ≥60 mm; OR UL VAS ≥60 mm; 3) Candidate for SCS; 4) No confounding pain; 5) Stable on prescribed pain medications for 28 days prior to SCS trial; 6) No psychiatric comorbidities or other progressive disease, drug-related behavioral issues or pregnancy; 7) No prior trial for SCS, PNS, VNS, DBS or TDD; 8) Not involved in injury claim or current litigation.
- Primary objective is to demonstrate reduction in overstimulation with the CL feature ON relative to CL OFF. The primary analysis set (**PAS**) includes the first **28 back/leg pain** subjects to complete the 1-month visit with measurable ECAPs (see inset in **Figure.2**).
- Secondary objective is to characterize % of subjects with ≥50% reduction in overall, back/leg pain at 3 months.

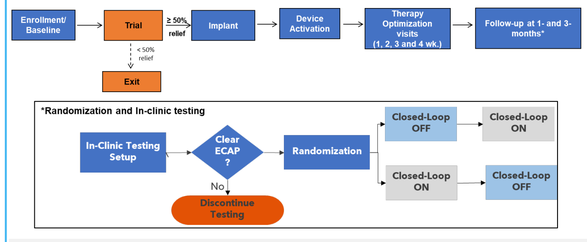


Figure 2. Study visits through the 3-month follow-up are shown here. The randomized in-clinic testing at 1-month and 3-month visits is shown as an inset.

Results and Discussion

Baseline Characteristics	N = 60
Age – Mean(SD) years	57.9 (14.1)
Female – n (%)	27 (45.0)
Pain VAS – Mean (SD) mm	
Overall	80.3 (10.5)
Back	73.7 (19.9)
Leg	73.1 (22.7)
Upper Limb	81.3 (6.4)
Etiology – n (%)	
DDD	23 (38.3)
PSPS-Type2	20 (33.3)
Radicular Pain Syndrome	5 (8.3)
Post Laminectomy Pain	4 (6.7)
CRPS	4 (6.7)
Other	4 (6.7)
Severe Disabled/Worse (ODI) – n (%)	49 (86.0)
On Opioids – n (%)	45 (75.0)
Onset of Pain – Mean(SD) years	10.1 (9.7)

Table 1. Baseline Characteristics for implanted subjects (57 Low Back/Leg and 3 UL pain)

- 94 subjects were enrolled, 75 trialed and 60 were implanted with the CL-SCS device.
- 4/75 subjects that completed the Trial had <50% relief and were not eligible for implant. 11/75 were exited for other reasons - per PI/subject (8), deviation (2) and AE (1).
- 3 subjects exited prior to and 2 missed the 1-month study visit resulting in 55 completing the visit.
- 54 subjects completed the 3-month visit – 1 subject exited prior to the visit due to an AE, 1 withdrawal of consent and 1 missed the visit. This includes 51 subjects with Low Back/Leg pain and 3 with UL pain.
- 51 subjects completed the 6-month visit; 4 missed the follow-up.

Closed-Loop works with multiplexed or tonic waveforms tailored to patient preference at 6 mo.

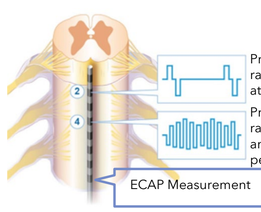


Figure 3a. Illustration of CL programming for multiplexed waveforms like DTM

Program 1 generates the ECAP signal.

Additional therapy was provided on Program 2

CL makes adjustments to both program amplitudes ratiometrically.

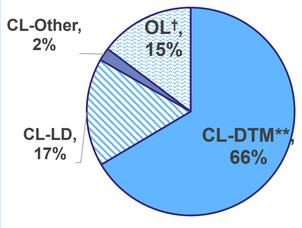


Figure 3b. CL works with a variety of tonic and multiplexed waveforms.*

*Some subjects chose to use more than 1 therapy setting (e.g., for pain flares) – chart shows the most used group by % time.

** DTM includes therapy with multiplexed low-rate (<200 Hz) and high-rate (≥200 Hz) waveforms applied at 2 targets. 59% (19/32) of subjects programmed to CL-DTM had 900 Hz and the rest had a lower frequency prime program.

† Some subjects did not have usable ECAPs at locations with best therapy outcomes and hence, are programmed with OL waveforms.

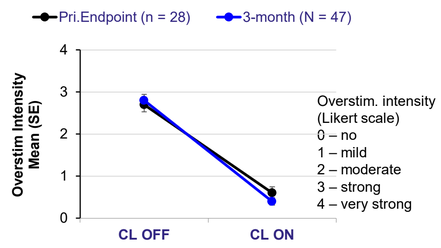
Figure 3c. Therapy can be programmed sub- or supra-perception.

Amplitude and PT for program 1 of the preferred therapy setting shown in the pie chart above.

Amplitudes above the dashed line indicates supra-perception waveforms.

CL is effective in addressing inconsistent dosing and related side effects, thereby providing a more comfortable overall experience.

In-clinic testing of CL Performance (1- and 3mo. outcomes)*



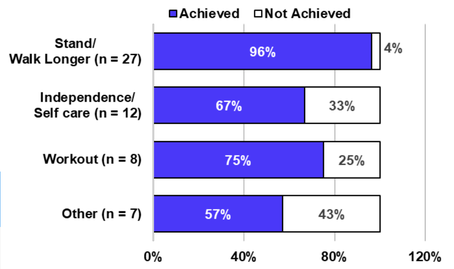
98% had reduced overstimulation with closed-loop ON (n = 47, 3mo.)

83% expressed preference for CL ON vs. OFF during blinded testing (n = 47; 3mo.)

Figure 4. In-clinic, randomized cross-over testing of CL performance in reducing overstimulation.

Intensity of overstimulation sensation was reduced significantly with Closed-Loop ON both at 1- and 3-month. The primary endpoint analysis (PAS) cohort includes the first 28 subjects with Low Back/Leg Pain to complete the randomized testing at 1-month (**inset Figure 2**). All subjects that completed the 3-month visit and had usable ECAPs were included in the in-clinic testing. Outcomes for the low-back/leg pain cohort is shown here to remain consistent with the PAS.

At home experience during activities (3-mo. outcomes)



82% were able to **achieve** their intended goal

85% **Compared to SCS survey data** where subjects reported **avoiding 1 or more activities** to avoid under- or overstimulation[1]

Figure 5.

(**Left**) Subject's perception of stimulation related sensation.

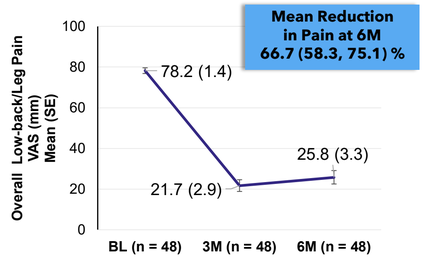
(**Right**) 82% of subjects were able to achieve their intended activity goal at 3 mo.

Self care/Independence category includes being able to dress, drive, bathe, tie shoelaces, sit longer and sleep better. The Other category includes return to work, family care and participation in social activities.

ADL: activities of daily living.

*These assessments are not done at 6 mo. Hence, the 3 mo. outcomes are shown here,

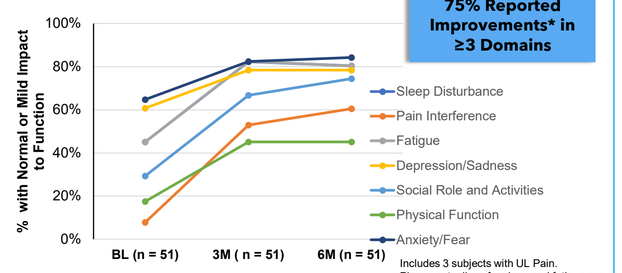
Sustained and Significant improvement in Pain and Quality of life were seen at 6 mo.



Mean Reduction in Pain at 6M 66.7 (58.3, 75.1) %

41% Reduced/ Stopped Opioid use (n = 34 with MME>0 at BL)

98% Expressed Satisfaction with therapy



75% Reported Improvements* in ≥3 Domains

Includes 3 subjects with UL Pain.
Please note: lines for sleep and fatigue are overlapping and hence, not separately visible.

SUMMARY

- The Closed-Loop algorithm effectively reduced Overstimulation in 98% of subjects during the in-clinic, randomized, crossover testing at the time of the 3-month visit.
  - 83% expressed a preference for SCS with CL On (vs CL Off); subjects were blinded to the CL setting during this testing (see inset in **Figure 2** for Study Design).
  - CL performance in reducing overstimulation remained consistent from 1- to 3-month visits.
- Over 80% of subjects were able to achieve their stated goals for SCS therapy and 74% felt comfortable engaging in ADLs without fear of therapy side effects. This contrasts with survey data that suggests 85% of subjects avoid one or more ADLs to avoid therapy side effects[1]
- Significant and sustained improvements were observed in Pain, Physical function and Quality of Life at 6-months.
- Although the study did not include a weaning protocol, 41% of subjects with MME>0 at Baseline, reduced/stopped use at 6-months. Median (min – max) MME: 75 (7.5 – 225) vs. 54 (0 – 160).
- Follow-ups are ongoing to evaluate the long-term benefits of CL-SCS with customized, multiplexed waveforms.

References:

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2. Vallejo et al. Journal of Pain Research, 2021; vol.14, 3909 – 3918.
3. PROMIS® Score Cut Points. Northwestern University. https://www.healthmeasures.net/score-and-interpret/interpret-scores/promis/promis-score-cut-points. Accessed May 20, 2023.
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Disclosures:

MAR and VM have consulted for Medtronic. VM, MAR, RS, PG, CDB and JY are participating investigators in this study.

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Please reach out to Abi Franke at franka22@Medtronic.com with questions.

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