



US009510777B2

(12) **United States Patent**
Hezi-Yamit et al.

(10) **Patent No.:** **US 9,510,777 B2**
(45) **Date of Patent:** **Dec. 6, 2016**

(54) **MONITORING OF NEUROMODULATION USING BIOMARKERS**

(71) Applicant: **Medtronic Ardian Luxembourg S.a.r.l.**, Luxembourg (LU)

(72) Inventors: **Ayala Hezi-Yamit**, Santa Rosa, CA (US); **Rudy Beasley**, Santa Rosa, CA (US); **Susan Thornton Edwards**, Santa Rosa, CA (US); **Lori Garcia**, Santa Rosa, CA (US); **Michele Lee Silver**, Santa Rosa, CA (US); **Christopher W. Storment**, Santa Rosa, CA (US); **Carol M. Sullivan**, Santa Rosa, CA (US); **Joseph A. Traina**, Santa Rosa, CA (US); **Stefan Stoyanov Tunev**, Santa Rosa, CA (US)

(73) Assignee: **Medtronic Ardian Luxembourg S.a.r.l.**, Luxembourg (LU)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 337 days.

(21) Appl. No.: **13/791,681**

(22) Filed: **Mar. 8, 2013**

(65) **Prior Publication Data**

US 2013/0282001 A1 Oct. 24, 2013

Related U.S. Application Data

(60) Provisional application No. 61/608,625, filed on Mar. 8, 2012, provisional application No. 61/608,626, filed on Mar. 8, 2012, provisional application No. 61/746,528, filed on Dec. 27, 2012.

(51) **Int. Cl.**
A61B 18/18 (2006.01)
A61N 1/32 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **A61B 5/1405** (2013.01); **A61B 5/14503** (2013.01); **A61B 5/14546** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61B 10/0045; A61B 10/007; A61B 2018/00511; A61B 2018/00577; A61B 5/1405; A61B 5/201; A61B 2018/00345; A61N 18/1492; A61N 1/3605
USPC 606/34, 42
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,602,624 A 7/1986 Naples et al.
4,649,936 A 3/1987 Ungar et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101489624 7/2009
EP 1169976 1/2002

(Continued)

OTHER PUBLICATIONS

Beale et al., "Minimally Invasive Treatment for Varicose Veins: A Review of Endovenous Laser Treatment and Radiofrequency Ablation". Lower Extremity Wounds 3(4), 2004, 10 pages.

(Continued)

Primary Examiner — Christopher D Koharski
Assistant Examiner — Pamela M Bays

(57) **ABSTRACT**

Provided herein are methods, devices, compositions, and kits for monitoring neuromodulation efficacy based on detecting changes in the level or activity of one or more target biomarkers associated with neuromodulation, as well as methods and processes of performing neuromodulation that incorporate monitoring of neuromodulation efficacy based on changes in level or activity of one or more target biomarkers.

29 Claims, 45 Drawing Sheets

