

(19) World Intellectual Property
Organization
International Bureau

(43) International Publication Date
23 July 2020 (23.07.2020)



(10) International Publication Number
WO 2020/150346 A8

(51) International Patent Classification:

A61B 5/02 (2006.01) *A61M 1/10* (2006.01)
A61B 5/0215 (2006.01) *A61B 5/00* (2006.01)
A61B 5/029 (2006.01)

(21) International Application Number:

PCT/US2020/013672

(22) International Filing Date:

15 January 2020 (15.01.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

62/793,239 16 January 2019 (16.01.2019) US

(71) Applicant: **ABIOMED, INC.** [US/US]; 22 Cherry Hill Drive, Danvers, MA 01923 (US).

(72) Inventors: **EL KATERJI, Ahmad**; c/o Abiomed, Inc., 22 Cherry Hill Drive, Danvers, MA 01923 (US). **TAN, Qing**; c/o Abiomed, Inc., 22 Cherry Hill Drive, Danvers, MA 01923 (US). **KROEKER, Erik**; c/o Abiomed, Inc., 22 Cherry Hill Drive, Danvers, MA 01923 (US). **WANG,**

Rui; c/o Abiomed, Inc., 22 Cherry Hill Drive, Danvers, MA 01923 (US).

(74) Agent: **BOTOS, Richard J.** et al.; Botos Churchill IP Law LLP, 430 Mountain Avenue, Suite 401, New Providence, NJ 07974 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: LEFT VENTRICULAR VOLUME AND CARDIAC OUTPUT ESTIMATION USING MACHINE LEARNING MODEL

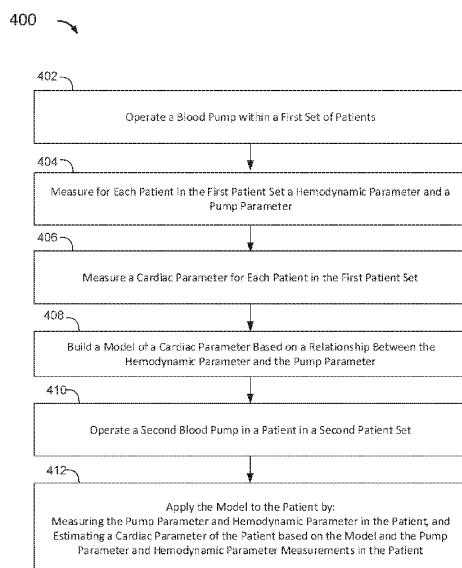


FIG. 4

(57) Abstract: Methods and systems are disclosed for creating and using a neural network model to estimate a cardiac parameter of a patient, and using the estimated parameter in providing blood pump support to improve patient cardiac performance and heart health. Particular adaptations include adjusting blood pump parameters and determining whether and how to increase or decrease support, or wean the patient from the blood pump altogether. The model is created based on neural network processing of data from a first patient set and includes measured hemodynamic and pump parameters compared to a cardiac parameter measured *insitu*, for example the left ventricular volume measured by millar (in animals) or inca (in human) catheter. After development of a model based on the first set of patients, the model is applied to a patient in a second set to estimate the cardiac parameter without use of an additional catheter or direct measurement.

[Continued on next page]

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(48) Date of publication of this corrected version:

18 November 2021 (18.11.2021)

(15) Information about Correction:

see Notice of 18 November 2021 (18.11.2021)