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Computer implemented method for determining a medical intervention, training method and system

The invention relates to a computer implemented method for determining a medical
10 intervention based on multiple sources of patient medical data.

Furthermore, the invention relates to a computer-implemented method for providing a
trained machine learning algorithm configured to determine a medical intervention based on
multiple sources of patient medical data.

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In addition, the invention relates to a system for determining a medical intervention based
on multiple sources of patient medical data.

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Many diseases of the heart are accompanied by changes in the ECG. These could be detected
at an early stage by close-meshed ECG checks. However, this is logistically not feasible in
everyday life.

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Conventionally, said ECG is recorded at after care visits of the patient having an implantable
medical device at a health provider, such after care visits typically being scheduled every 1
to 3 months. To this end, a twelve-channel ECG is recorded at the health provider's site. The
recording of a conventional twelve-channel ECG is however associated with a relevant
expenditure of time and personnel. Alternatively, remote transmission of a twelve-channel
ECG requires the active cooperation and compliance of the patient, who may be overtaxed.

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In addition to optimal treatment of concomitant diseases and adjustment of drug therapy,
patient self-management (e.g., regular medication, adherence to diets and regular exercise)
is an important factor for a good prognosis.

WO 2007/035696 A1 discloses that a data set is generated by an implanted medical device, during operation of the device. The data set includes data characterizing various physiological states of the patient. The data set is communicated from the device to a patient monitoring apparatus. The patient monitoring apparatus develops its own data set by posing questions to the patient, and optionally by measuring a physiological parameter of the patient, such as weight. The two data sets are combined and are analyzed to determine medical information concerning the patient, such as impending decompensation of heart failure.

WO 2018/204307 A1 discloses systems and methods for managing machine-generated medical alerts associated with physiological events detected from one or more patients. An alert management system may receive medical events detected from a patient and physiological data associated with patient historical medical alerts. The system comprises an alert prioritizer circuit to generate an event priority indicator for the detected medical event, using a comparison between the detected medical event and the physiological data associated with patient historical medical alerts. The system can identify prolific alert patients using the information about the historical medical alerts. The alert prioritizer circuit can adjust a priority of the detected medical event, and an output circuit can present a priority to a user or a process using the event priority indicator and the identification of prolific alert patient.

Even though the above-mentioned methods query the patient for additional information or manage machine-generated medical alerts the data analysis used in said methods does not yield patient adapted recommendations for medical interventions.

It is therefore an object of the present invention to provide an improved method for automated remote monitoring of cardiac current curves (possibly including or together with other accompanying medical data such as patient activity or chest impedance) for evaluating a heart failure status of at least one patient with higher frequency and accuracy than possible by outpatient follow-up with the aim of providing patient adapted recommendations for medical interventions.

The object is solved by a computer implemented method for determining a medical intervention based on multiple sources of patient medical data having the features of claim 1.

5 Furthermore, the object is solved by a computer-implemented method for providing a trained machine learning algorithm configured to determine a medical intervention based on multiple sources of patient medical data having the features of claim 14.

10 In addition, the object is solved by a system for determining a medical intervention based on multiple sources of patient medical data having the features of claim 15.

Further developments and advantageous embodiments are defined in the dependent claims.

15 The present invention provides a computer implemented method for determining a medical intervention based on multiple sources of patient medical data.

The method comprises providing a first data set comprising cardiac current curve data of at least one patient (possibly including or together with other accompanying medical data such as patient activity or chest impedance) acquired by an implantable medical device and
20 applying a first machine learning algorithm and/or a rule-based algorithm to the pre-acquired cardiac current curve data for classification of a deviation from or conformity with a norm of at least one medical parameter of the pre-acquired cardiac current curve data.

The opposite of the deviation of one parameter is the conformity of all parameters. The AI
25 classification categorize everything into one of the three classes: deviation of at least one parameter (Class C1) or conformity of all parameters (C2) or erroneous data input (C3).

The first data set and/or the cardiac current data may (further) comprise accompanying medical data such as patient activity or chest impedance.

Furthermore, the method comprises outputting a second data set comprising at least a first class representing a deviation of the at least one medical parameter from the norm or a second class representing a conformity of at the least one medical parameter with the norm.

- 5 The method moreover comprises in response to outputting the first class, triggering a patient information request, providing a third data set comprising the first data set and data provided in response to the patient information request, applying a second machine learning algorithm to the third data set for determining a medical intervention, and outputting a fourth data set representing at least one medical intervention, wherein the fourth data set comprises multiple
10 medical interventions having a highest probability of implementation by the patient based on first historical data of a patient population, wherein each intervention of the fourth data set is weighed using a factor representing a probability of implementation of the medical intervention by the patient based on second historical data of the patient, and wherein the interventions are ranked in ascending or descending order according to the probability of
15 implementation of the medical intervention by the patient.

Moreover, the present invention provides a computer-implemented method for providing a trained machine learning algorithm configured to determine a medical intervention based on multiple sources of patient medical data.

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- The method comprises receiving a first training data set comprising first cardiac current curve data of at least one patient acquired by an implantable medical device, receiving a second training data set comprising data provided in response to the patient information request and training the machine learning algorithm by an optimization algorithm which
25 calculates an extreme value of a loss function for determining a medical intervention.

In addition, the present invention provides a system for determining a medical intervention based on multiple sources of patient medical data comprising an implantable medical device for providing a first data set comprising cardiac current curve data of at least one patient.

30

Furthermore, the system comprises a first control unit configured to apply a first machine learning algorithm and/or a rule-based algorithm to the pre-acquired cardiac current curve

data for classification of a deviation from or conformity with a norm of at least one medical parameter of the pre-acquired cardiac current curve data, wherein the control unit is configured to output a second data set comprising at least a first class representing a deviation of the at least one medical parameter from the norm or a second class representing a conformity of at the least one medical parameter with the norm, and wherein the control unit is further configured to, in response to outputting the first class, triggering a patient information request.

The system moreover comprises a second control unit configured to provide a third data set comprising the first data set and data provided in response to the patient information request, wherein the second control unit is further configured to apply a second machine learning algorithm to the third data set for determining a medical intervention, and to output a fourth data set representing at least one medical intervention.

An idea of the present invention is the automatic, regular transmission of data from active cardiac implants, in particular the current curves of the heart. The system evaluates this data and, in the event of abnormalities, causes further to be requested from the patient.

From the overall view of current and historical data, especially the success of previous interventions, the system selects appropriate interventions to increase patient compliance and delivers them to the patient's smartphone. The physician and appropriate caregivers receive evaluations of initial events, suggested interventions, and subsequent outcomes. If the change in heart failure exceeds a level that can be set by the physician, the physician and nursing staff are also alerted directly.

Machine learning algorithms are based on using statistical techniques to train a data processing system to perform a specific task without being explicitly programmed to do so. The goal of machine learning is to construct algorithms that can learn from data and make predictions. These algorithms create mathematical models that can be used, for example, to classify data or to solve regression type problems.

Further, the fourth data set comprises multiple medical interventions having a highest probability of implementation by the patient based on first historical data of a patient population. According to an alternative aspect of the invention, the fourth data set comprises multiple parameters representing multiple medical interventions (having a highest probability of implementation by the patient based on first historical data of a patient population).

The second machine learning algorithm that is applied to the third data set for determining a medical intervention is thus trained using said first historical data of a patient population.

The fourth data set output by the second machine learning algorithm hence comprises a list of medical interventions having a highest probability of implementation by the respective patient.

Further, each medical intervention (or each parameter representing a medical intervention) of the fourth data set is weighed using a factor representing a probability of implementation of the medical intervention by the patient based on second historical data of the patient, and wherein the interventions (or parameters) are ranked in ascending or descending order according to the probability of implementation of the medical intervention by the patient.

In order to generate a patient instruction for an intervention suitable to the respective patient condition, the data outputted by the second algorithm is thus further processed using said second historical data of the specific patient, said second historical data comprising data of how said patient reacted to years recommendations for medical interventions. In using said specific patient data, a probability of patient compliance with present and future recommendations for medical interventions can advantageously be increased.

According to a further aspect of the invention, the medical intervention or a combination of medical interventions is selected, wherein based on the selected medical intervention or combination of medical interventions, a patient instruction is generated prompting the patient to take a predefined action. The patient thus receives a patient instruction specifically directed towards said specific patient offering a high probability of compliance based on said historical data.

An optimal medical intervention is predicted/determined by the second machine learning algorithm based on the patient's response to the patient information request together with either the at least one medical parameter or its source directly, which is the cardiac current curve data (along with or including accompanying medical data).

5

According to an alternative aspect of the invention, the parameter representing the medical intervention or multiple (medical) parameters representing a combination of medical interventions is selected, wherein based on the selected at least one parameter, a patient instruction is generated prompting the patient to take a predefined action.

10

According to a further aspect of the invention, the patient instruction is sent to a patient communication device and/or smartphone, and wherein the patient instruction comprises a physical activity recommendation, a reminder to take a medication, a diet recommendation, implementation of a learning module and/or a fluid intake recommendation. This wide
15 variety of potential recommendations for medical interventions is thus suitable for the specific preferences of an individual patient.

20

According to a further aspect of the invention, the patient information request is sent to a patient communication device and/or smartphone, said patient information request
20 prompting the patient to provide a body weight, symptoms, a medication intake, a patient activity and/or other information. The patient information request thus elicits data that can be recorded by the implantable medical device and hence supplements the data set provided by the implantable medical device.

25

According to a further aspect of the invention, data on the patient's response to the patient instruction comprising the at least one intervention is collected and sent from the patient communication device and/or smartphone to a central server. A control unit which is part of the central server can thus use said data of the patient's response for further processing.

30

According to a further aspect of the invention, the cardiac current curve data is acquired by the implantable medical device at predetermined intervals and/or on request, and wherein the cardiac current curve data is transmitted to the central server via a patient communication

device or smartphone. Said intervals can advantageously be set according to specific patient requirements and/or requirements set by a medical practitioner of the healthcare provider.

According to a further aspect of the invention, the second data set further comprises a third
5 class representing erroneous cardiac current curve data not suitable for application of the machine learning algorithm and/or the rule-based algorithm for classification of the deviation or conformity of at least one medical parameter of the pre-acquired cardiac current curve data from the norm. By classifying erroneous cardiac current curve data (and/or erroneous accompanying medical data) in a separate class, false classifications in the first
10 and second classes can be advantageously prevented.

According to a further aspect of the invention, the patient instruction is further prompting the patient to acknowledge reading said patient instruction, wherein if a reading confirmation is not sent to the central server within a predetermined period, a notification is sent to a
15 communication device of a health care provider. This advantageously notifies the healthcare provider that further action needs to be taken.

According to a further aspect of the invention, the notification, the patient instruction and the second data set (and the third data set) outputted by the machine learning algorithm
20 and/or the rule-based algorithm is stored on the central server and is accessible via a front-end application on the communication device, in particular a smart phone and/or a personal computer, of the health care provider.

The physician can view the communication via the front end, but will only be informed if
25 the communication with the patient is unsuccessful, i.e. if the patient does not respond to the triggered data request, if he or she does not consider the recommendations or if the abnormalities identified in the patient data are outside a normal range.

According to a further aspect of the invention, the at least one medical parameter of the pre-
30 acquired cardiac current curve data deviates from the norm if at least one numerical value of the pre-acquired cardiac current curve data is outside a predetermined range, exceeds or falls below a predetermined threshold value. By comparing the at least one numerical value of

the pre-acquired cardiac current curve data to said predefined range, deviations in said cardiac current curve data are effectively identified.

According to a further aspect of the invention, the first data set comprises (cardiac current curve data and accompanying medical data, such as) arrhythmia data, a heart rate, a patient activity, a chest impedance, a PQ time, an atrioventricular ratio, a heart rate daily profile, a heart rate at rest, a QRS width, a heart rate variability and/or readings from electrodes or electrical contacts of the implantable medical device. Some of these data may be not delivered by the implantable device directly but will be determined by the first machine learning algorithm forms/edits the cardiac current curve data and accompanying medical data.

The machine learning algorithm and/or the rule-based algorithm thus uses a plurality of medical parameters and analyzes them in isolation and or in combination in order to identify deviations or conformity of the at least one medical parameter of the pre-acquired cardiac current curve data from a norm.

The herein described features of the system for determining a medical intervention based on multiple sources of patient medical data are also disclosed for the computer implemented method for determining a medical intervention based on multiple sources of patient medical data and vice versa.

For a more complete understanding of the present invention and advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings. The invention is explained in more detail below using exemplary embodiments, which are specified in the schematic figures of the drawings, in which:

Fig. 1 shows a flowchart of a computer implemented method and system for determining a medical intervention based on multiple sources of patient medical data according to a preferred embodiment of the invention; and

Fig. 2 shows a flowchart of a computer implemented method for providing a trained machine learning algorithm configured to determine a medical intervention based on multiple sources of patient medical data according to the preferred embodiment of the invention.

5

The system 1 shown in Fig. 1 comprises an implantable medical device 10 for providing S1 a first data set DS1 comprising cardiac current curve data D of at least one patient 11. The first data set and/or the cardiac current data may (further) comprise accompanying medical data such as patient activity or chest impedance.

10

The system 1 further comprises a patient communication device 20, a central server 16, a communication device 22 (a health care provider) and a front-end application 24, wherein the central server 16 includes (or is connected to) a first control unit 26 and a second control unit 28.

15

The first control unit 26 is configured to apply a first machine learning algorithm A1 and/or a rule-based algorithm to the pre-acquired cardiac current curve data D for classification of a deviation from or conformity with a norm of at least one medical parameter 12 of (and/or derived from) the pre-acquired cardiac current curve data D. The at least one medical parameter 12 may either be determined by the implantable medical device 10 or by the first machine learning algorithm A1.

20

Furthermore, the first control unit 26 is configured to output a second data set DS2 comprising at least a first class C1 representing a deviation of the at least one medical parameter 12 from the norm or a second class C2 representing a conformity of at the least one medical parameter 12 (or accompanying medical data) with the norm. In addition, the first control unit 26 is further configured to, in response to outputting the first class C1, triggering a patient information request R.

25

The opposite of the deviation of one parameter is the conformity of all parameters. The AI classification categorize everything into one of the three classes: deviation of at least one parameter (Class C1) or conformity of all parameters (C2) or erroneous data input (C3).

30

The second control unit 28 is configured to provide a third data set DS3 comprising the first data set DS1 and data provided in response to the patient information request R. DS3 may be a completed questionnaire. The second control unit 28 is further configured to apply a
5 second machine learning algorithm A2 to the third data set DS3 for determining a medical intervention, and to output a fourth data set DS4 representing at least one medical intervention. The first control unit 26 and the second control unit 28 are depicted in Fig. 1 outside of the central server 16. This is only for illustration.

10 The fourth data set DS4 comprises multiple (medical) parameters representing medical interventions having a highest probability of implementation by the patient 11 based on first historical data HD1 of a patient population. HD1 is used to train the second machine learning algorithm A2.

15 Each parameter representing a medical intervention of the fourth data set DS4 is weighed using a factor representing a probability of implementation of the medical intervention by the patient 11 based on second historical data HD2 of the patient 11. HD2 is used to calculate a weighting factor. This data HD2 may be collected and stored on the central server and will be given to second machine learning algorithm A2 and the second control unit 28, together
20 with the patient's response to the information request R. The calculation of the weighting factor and a weighting of DS4 is done in the second control unit 28.

Furthermore, the parameters are ranked in ascending or descending order according to the probability of implementation of the medical intervention by the patient 11.

25 The parameter representing the medical intervention or multiple (medical) parameters representing a combination of medical interventions is selected, wherein based on the selected at least one parameter, a patient instruction 14 is generated prompting the patient 11 to take a predefined action.

30 The patient instruction 14 is sent to the patient communication device 20 and/or smartphone. The patient instruction 14 further comprises a physical activity recommendation, a reminder

to take a medication, a diet recommendation, implementation of a learning module and/or a fluid intake recommendation.

5 The patient information request R is sent to a patient communication device 20 and/or smartphone, said patient information request R prompting the patient 11 to provide a body weight, symptoms, a medication intake, a patient activity, and/or other information.

10 In addition, further/accompanying medical parameters that may be submitted by the implantable medical device 10 are a thoracic impedance, heart rate parameters, , and/or a proportion of paced beats (in particular for an implantable medical device comprising a pacemaker). Additionally, environmental data, in particular weather data, may be submitted/delivered by the patient communication device 20. Environmental data can be used together with DS1 for classification in A1 and A2.

15 Data on the patient's 11 response (e.g. confirmation from the patient) to the patient instruction 14 comprising the at least one intervention is collected and sent from the patient communication device 20 and/or smartphone to the central server 16.

20 The cardiac current curve data D is acquired by the implantable medical device 10 at predetermined intervals and/or on request. Further, the cardiac current curve data is transmitted to the central server via a patient communication device 20 or smartphone.

25 The second data set DS2 further comprises a third class C3 representing erroneous cardiac current curve data not suitable for application of the machine learning algorithm A1 and/or the rule-based algorithm for classification of the deviation or conformity of at least one medical parameter 12 of (or derived/extracted from) the pre-acquired cardiac current curve data D from the norm.

30 The patient instruction 14 is further prompting the patient 11 to acknowledge reading said patient instruction 14. Further, if a reading confirmation 15 is not sent to the central server 16 with a predetermined period, a notification 18 is sent to the communication device 22 of the health care provider.

The notification 18, the patient 11 instruction 14 and the second data set DS2 outputted by the machine learning algorithm A1 and/or the rule-based algorithm is stored on the central server 16 and is accessible via the front-end application 24. Preferably the front-end application 24 is installed on the communication device 22, in particular a smart phone and/or a personal computer, of the health care provider. Also the third data set DS3 may be stored on the central server 16 and is accessible via the front-end application 24.

The at least one medical parameter 12 of (or derived/extracted from) the pre-acquired cardiac current curve data D deviates from the norm if at least one numerical value of the pre-acquired cardiac current curve data D (e.g. the value of the at least one medical parameter 12) is outside a predetermined range, exceeds or falls below a predetermined threshold value.

The first data set DS1 may comprise arrhythmia data, a heart rate, a patient activity, a chest impedance, a PQ time, an atrioventricular ratio, a heart rate daily profile, a heart rate at rest, a QRS width, a heart rate variability and/or readings from electrodes or electrical contacts of the implantable medical device. Some data from the first data set DS1 (e.g. the PQ time) may be determined by an algorithm performed outside of the implantable medical device 10 (e.g. in the patient communication device 20 or on the central server 16).

Fig. 2 shows a flowchart of a computer implemented method for providing a trained machine learning algorithm configured to determine a medical intervention based on multiple sources of patient medical data according to the preferred embodiment of the invention.

The method comprises receiving S1' a first training data set TD1 comprising first cardiac current curve data D of at least one patient 11 acquired by an implantable medical device 10 (and possibly accompanying medical data), receiving S2' a second training data set TD2 comprising data provided in response to the patient information request R, and training S3' the machine learning algorithm A2 by an optimization algorithm which calculates an extreme value of a loss function for determining a medical intervention. The training data sets TD1, TD2 are based on data from multiple patients, not only from an individual patient.

Reference Signs

	1	system
	10	implantable medical device
5	11	patient
	12	medical parameter
	14	patient instruction
	15	reading confirmation
	16	central server
10	18	notification
	20	patient communication device
	22	communication device of health care provider
	24	front-end application
	26	first control unit
15	28	second control unit
	A1	first machine learning algorithm
	A2	second machine learning algorithm
	C1	first class
	C2	second class
20	C3	third class
	D	cardiac current curve data (along with or incl. accompanying medical data)
	DS1	first data set
	DS2	second data set
	DS3	third data set
25	DS4	fourth data set
	HD1	first historical data
	HD2	second historical data
	R	patient information request
	S1-S6	method steps
30	S1'-S3'	method steps

Claims

1. Computer implemented method for determining a medical intervention based on multiple sources of patient medical data, comprising the steps of:
5 providing (S1) a first data set (DS1) comprising cardiac current curve data (D) of at least one patient (11) acquired by an implantable medical device (10);
applying (S2) a first machine learning algorithm (A1) and/or a rule-based algorithm to the pre-acquired cardiac current curve data (D) for classification of a deviation from or conformity with a norm of at least one medical parameter (12) of the pre-acquired
10 cardiac current curve data (D);
outputting (S3) a second data set (DS2) comprising at least a first class (C1) representing a deviation of the at least one medical parameter (12) from the norm or a second class (C2) representing a conformity of at the least one medical parameter (12) with the norm;
15 in response to outputting the first class (C1), triggering (S4) a patient information request (R);
providing (S4) a third data set (DS3) comprising the first data set (DS1) and data provided in response to the patient information request (R);
applying (S5) a second machine learning algorithm (A2) to the third data set (DS3) for
20 determining a medical intervention; and
outputting (S6) a fourth data set (DS4) representing at least one medical intervention; wherein the fourth data set (DS4) comprises multiple medical interventions having a highest probability of implementation by the patient (11) based on first historical data (HD1) of a patient population, wherein each intervention of the fourth data set (DS4)
25 is weighed using a factor representing a probability of implementation of the medical intervention by the patient (11) based on second historical data (HD2) of the patient (11), and wherein the interventions are ranked in ascending or descending order according to the probability of implementation of the medical intervention by the patient (11).
30
2. Computer implemented method of claim 1, wherein the medical intervention or a combination of medical interventions is selected, wherein based on the selected

medical intervention or combination of medical interventions, a patient instruction (14) is generated prompting the patient (11) to take a predefined action.

3. Computer implemented method of claim 2, wherein the patient instruction (14) is sent
5 to a patient communication device (20) and/or smartphone, and wherein the patient instruction (14) comprises a physical activity recommendation, a reminder to take a medication, a diet recommendation, implementation of a learning module and/or a fluid intake recommendation.
- 10 4. Computer implemented method of claim 3, wherein the patient information request (R) is sent to a patient communication device (20) and/or smartphone, said patient information request (R) prompting the patient (11) to provide a body weight, symptoms, a medication intake, and/or a patient activity.
- 15 5. Computer implemented method of any one of claims 2 to 4, wherein data on the patient's (11) response to the patient instruction (14) comprising the at least one intervention is collected and sent from the patient communication device (20) and/or smartphone to a central server.
- 20 6. Computer implemented method of claim 5, wherein the cardiac current curve data (D) is acquired by the implantable medical device (10) at predetermined intervals and/or on request, and wherein the cardiac current curve data is transmitted to the central server (16) via a patient communication device (20) or smartphone.
- 25 7. Computer implemented method of any one of claims 2 to 6, wherein the patient instruction (14) is further prompting the patient (11) to acknowledge reading said patient instruction (14), wherein if a reading confirmation (15) is not sent to the central server (16) with a predetermined period, a notification (18) is sent to a communication device (22) of a health care provider.
- 30 8. Computer implemented method of claim 7, wherein the notification (18), the patient (11) instruction (14) and the second data set and the third data set (DS2, DS3) outputted

by the first machine learning algorithm (A1) and/or the rule-based algorithm is stored on the central server (16) and is accessible via a front-end application (24) on the communication device (22), in particular a smart phone and/or a personal computer, of the health care provider.

5

9. Computer implemented method of any one of the preceding claims, wherein the second data set (DS2) further comprises a third class (C3) representing erroneous cardiac current curve data not suitable for application of the first machine learning algorithm (A1) and/or the rule-based algorithm for classification of the deviation or conformity of at least one medical parameter (12) of the pre-acquired cardiac current curve data (D) from the norm.

10

10. Computer implemented method of any one of the preceding claims, wherein the at least one medical parameter (12) of the pre-acquired cardiac current curve data (D) deviates from the norm if at least one numerical value of the pre-acquired cardiac current curve data (D) is outside a predetermined range, exceeds or falls below a predetermined threshold value.

15

11. Computer implemented method of any one of the preceding claims, wherein the first data set (DS1) comprises arrhythmia data, a heart rate, a patient activity, a chest impedance, a PQ time, an atrioventricular ratio, a heart rate daily profile, a heart rate at rest, a QRS width, a heart rate variability and/or readings from electrodes or electrical contacts of the implantable medical device.

20

12. Computer-implemented method for providing a trained machine learning algorithm (A1) configured to determine a medical intervention based on multiple sources of patient medical data, comprising the steps of:
receiving (S1') a first training data set (TD1) comprising first cardiac current curve data (D) of at least one patient (11) acquired by an implantable medical device (10);
receiving (S2') a second training data set (TD2) comprising data provided in response to the patient information request (R); and

25

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training (S3') the machine learning algorithm (A2) by an optimization algorithm which calculates an extreme value of a loss function for determining a medical intervention.

13. System for determining a medical intervention based on multiple sources of patient medical data, comprising:

an implantable medical device (10) for providing (S1) a first data set (DS1) comprising cardiac current curve data (D) of at least one patient (11);

a first control unit (26) configured to apply a first machine learning algorithm (A1) and/or a rule-based algorithm to the pre-acquired cardiac current curve data (D) for classification of a deviation from or conformity with a norm of at least one medical parameter (12) of the pre-acquired cardiac current curve data (D), wherein the first control unit (26) is configured to output a second data set (DS2) comprising at least a first class (C1) representing a deviation of the at least one medical parameter (12) from the norm or a second class (C2) representing a conformity of at the least one medical parameter (12) with the norm, and wherein the first control unit (26) is further configured to, in response to outputting the first class (C1), triggering a patient information request (R);

a second control unit (28) configured to provide a third data set (DS3) comprising the first data set (DS1) and data provided in response to the patient information request (R), wherein the second control unit (28) is further configured to apply a second machine learning algorithm (A2) to the third data set (DS3) for determining a medical intervention, and to output a fourth data set (DS4) representing at least one medical intervention, wherein the fourth data set (DS4) comprises multiple medical interventions having a highest probability of implementation by the patient (11) based on first historical data (HD1) of a patient population, wherein each intervention of the fourth data set (DS4) is weighed using a factor representing a probability of implementation of the medical intervention by the patient (11) based on second historical data (HD2) of the patient (11), and wherein the interventions are ranked in ascending or descending order according to the probability of implementation of the medical intervention by the patient (11).

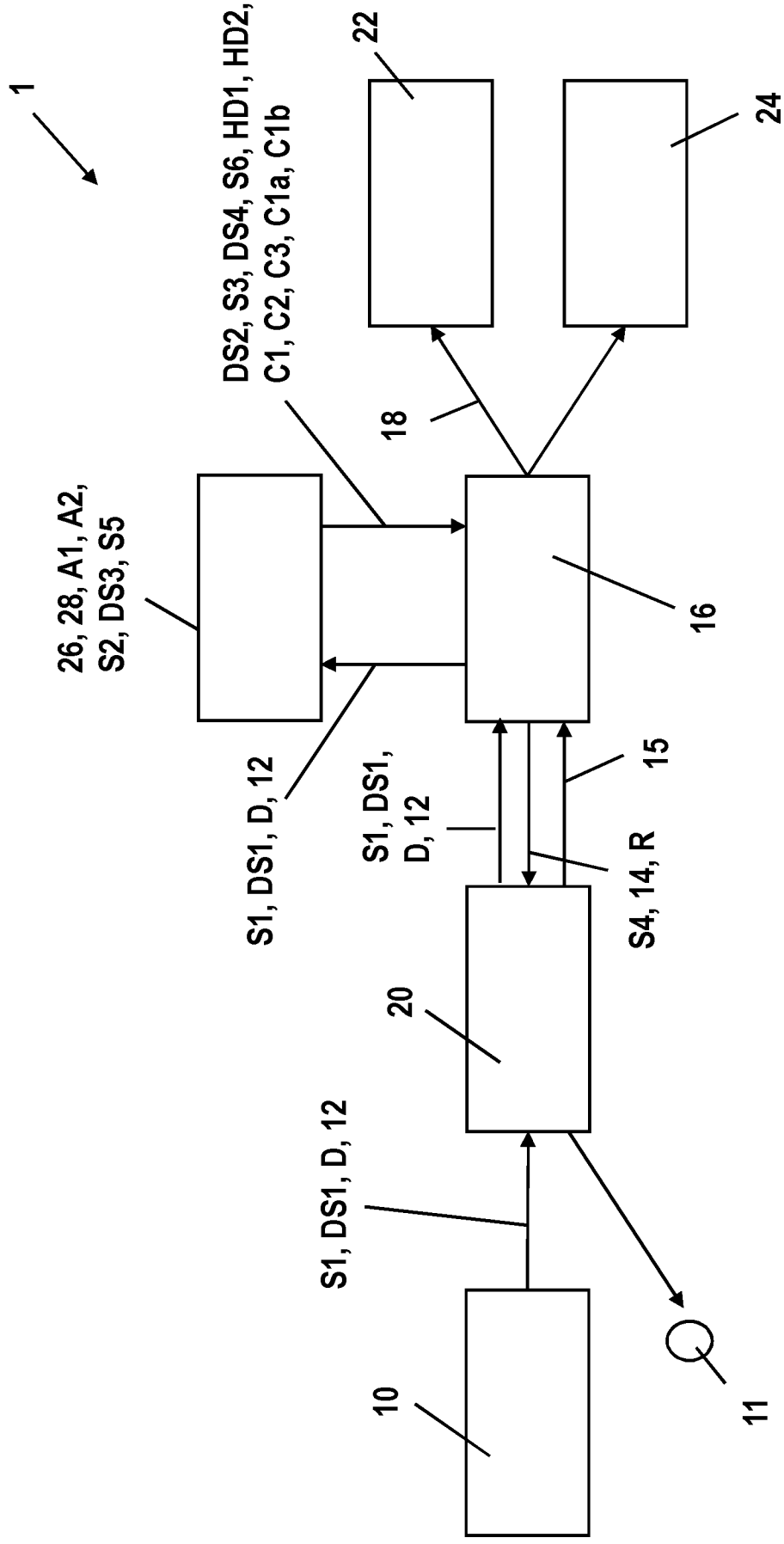


FIG. 1

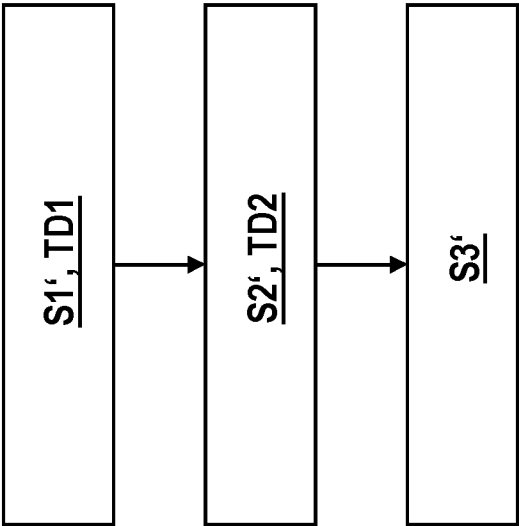


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/077687

A. CLASSIFICATION OF SUBJECT MATTER INV. G16H20/40 G16H50/20 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G16H		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2022/233119 A1 (SHELTON IV FREDERICK E [US] ET AL) 28 July 2022 (2022-07-28) paragraphs [1209], [1921], [1927], [2270], [0430], [2018], [2019], [0782], [1211] paragraph [1591] -----	1-13
A	US 2022/296906 A1 (WESTPHAL PHILIP [NL] ET AL) 22 September 2022 (2022-09-22) paragraphs [0005], [0011], [0106], [0116], [0146] -----	1-13
Y	US 2004/176678 A1 (MURPHY GREGORY [US] ET AL) 9 September 2004 (2004-09-09) paragraph [0205] -----	1-13
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