(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 298 158 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
30.11.2016 Bulletin 2016/48

(51) Int Cl.:
A61B 5/00 *(2006.01)*

(21) Application number: **10178619.2**

(22) Date of filing: **22.04.2002**

(54) **Adaptive selection of a warning limit in patient monitoring**

Adaptive Auswahl der Warngrenze bei der Patientenüberwachung

Sélection adaptative d'une limite d'alarme dans la surveillance d'un patient

(84) Designated Contracting States:
DE ES FR GB IT

(30) Priority: **23.04.2001 US 841153**

(43) Date of publication of application:
23.03.2011 Bulletin 2011/12

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
02764319.6 / 1 381 309

(73) Proprietor: **CardioNet, Inc.**
Malvern, PA 19355 (US)

(72) Inventor: **Eggers, Phillip N**
Salt Lake City, UT 84121 (US)

(74) Representative: **Pisani, Diana Jean et al**
Ropes & Gray International LLP
60 Ludgate Hill
London EC4M 7AW (GB)

(56) References cited:
WO-A-94/13197 **US-A- 3 925 762**
US-A- 5 749 907

EP 2 298 158 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates to the monitoring of a physiological characteristic of a patient, and, more particularly, to establishing a warning limit that may be used to indicate a variation of the physiological characteristic that necessitates immediate attention.

BACKGROUND OF THE INVENTION

[0002] Advances in sensor technology, electronics, and communications have made it possible for physiological characteristics of patients to be monitored even when the patients are ambulatory and not in continuous, direct contact with a hospital monitoring system. For example, US Patent 5,959,529 describes a monitoring system in which the patient carries a remote monitoring unit with associated physiological sensors. The remote monitoring unit conducts a continuous monitoring of one or more physiological characteristics of the patient according to the medical problem of the patient, such as the heartbeat and its waveform.

[0003] Under prescribed conditions, the remote monitoring unit contacts a central unit to communicate information on the condition of the patient. The communication may be accomplished in some cases on a routine reporting basis (e.g., a regular once-a-day report at night on a land telephone line while the patient sleeps) and in other cases on an urgent basis that signifies an event wherein the patient may need immediate attention (e.g., over a cellular telephone link as the patient experiences discomfort or an attack). The remote monitoring unit contains logic, which may be generally be described as a warning limit, that is used to determine whether the communication is to be made on an urgent basis. The warning limit is usually based both on the nature of an evaluation criterion for specific events and also on a quantitative threshold for the selected criterion.

[0004] In the studies leading to the present invention, the inventor has observed that the application of these fundamental principles of warning limits is straightforward conceptually but complex in practice. Although many physiological characteristics may be described in a textbook manner, large variations from the textbook description are encountered in everyday situations. For example, variations in sensor performance, individual human characteristics and responses, personal experiences, and the like make it difficult to establish warning limits that are universally applicable, or even applicable for the same patient under all conditions.

[0005] The warning limits are normally selected in a conservative manner when viewed from the standpoint of patient safety. That is, it is preferable to make urgent communications more often than necessary, rather than to fail to make an urgent communication when it is necessary. On the other hand, too many urgent communications are wasteful in terms of power consumption of the remote monitoring unit (establishing and maintaining a cell phone connection consumes a relatively large amount of power and thus reduces available battery life), telephone connection time expense, and resource use at the central unit.

[0006] US 5,749,907 describes a system and method for identifying and displaying medical data which violate programmable alarm conditions. In US 5,749,907, the medical practitioner is automatically alerted if changes or deviations in parametric and physiologic medical data items violate programmable alarm conditions.

[0007] For these reasons, it is important to establish realistic warning limits characteristic of situations that are truly urgent. There are not currently available any approaches which meet this requirement, and consequently a need exists for establishing warning limits for use in such situations. The present invention fulfils this need, and further provides related advantages.

SUMMARY OF THE INVENTION

[0008] The present approach provides a technique for monitoring a patient in which one or more warning limits are recursively reevaluated as necessary. Proposed changes to the warning limits are made without human intervention, but in some cases the proposed changes may be reviewed by a human being to be certain that they are realistic. The present approach is fully compatible with adjustments to warning limits made by medical personnel. The present approach allows a patient monitoring system to be continuously refined and customized for the individual patient and the individual monitoring system through an adaptive learning process.

[0009] In accordance with a first aspect of the invention, a method of monitoring a patient provided with a sensor for sensing a physiological characteristic of the patient, the sensor forming part of, or being in communication with, a central processing unit of a remote monitoring unit associated with the patient, the monitoring according to an established currently warning limit for the physiological characteristic of the patient, comprises measuring a value of the physiological characteristic of the patient using the sensor as a function of time, determining an operating characteristic of the sensor, selecting a revised warning limit for the physiological characteristic, without human intervention, and responsive to at least one of a change in the determined operating characteristic of the sensor and time variations in the value of the measured physiological characteristic of the patient, the selecting based on interpretation of an output signal from said sensor and performed by at least one of the remote monitoring unit and a central monitoring unit in communication with the remote monitoring unit, determining whether an event is occurring that requires urgent communication between the remote monitoring unit and the central monitoring unit by comparing at least one subsequent measured value of the physiological characteristic with the revised warning limit, and, responsive to a determination that the event is occurring, establishing a

communication link between said remote monitoring unit and said central monitoring unit on an urgent basis.

[0010] The sensor is provided for the physiological characteristic, such as the heartbeat, for example, and a measured value of the physiological characteristic of the patient is measured using the sensor. The measured value and the current warning limit may be compared, and a warning signal may be generated responsive to the step of comparing in the event that the measured value is outside the value defined by the current warning limit. The method includes selecting a revised warning limit without human intervention (i.e., automatically). However, a human being may review the revised warning limit. That is, the automated system may select the revised warning limit, subject to revision by the human being.

[0011] A new revised warning limit may, additionally, be made responsive to any of a wide variety of other circumstances.

The selecting of the new warning limit may be additionally responsive to a second physiological characteristic or to a patient history.

[0012] In one embodiment, the present invention is practiced using a monitoring apparatus including a remote monitoring unit associated with the patient, a central unit, and a communications device which selectively establishes a communications link between the remote monitoring unit and the central unit responsive to a warning signal. This apparatus provides a real-time urgent communications capability. It may also be practiced in other operable situations, such as monitors whose data are periodically transmitted, non-ambulatory situations, and the like.

[0013] The present invention allows the patient to be monitored and acceptable limits for the physiological conditions of the patient to be defined increasingly precisely over time. With continued experience as the monitoring apparatus adapts to the individual patient, the incidence of unnecessary urgent communications is expected to decrease. The result is that the efficiency of resource utilization is expected to increase over time. Additionally, the monitoring apparatus discovers which warning limits are most meaningful for the individual patient, so that the precision of the generation of warnings is increased.

[0014] Another aspect of the invention may provide patient monitoring apparatus configured to perform a method according to the first aspect as described above, the apparatus comprising a remote monitoring unit associated with the patient and including a communications device which selectively establishes a communications link between the remote monitoring unit and a central monitoring unit, a sensor for measuring a value of a physiological characteristic of the patient, the sensor being in communication with a central processing unit of the remote monitoring unit, or forming part of the remote monitoring unit, and a central monitoring unit in communication with the remote monitoring unit. Yet another aspect of the invention may provide patient apparatus configured to perform a method according to the first aspect as described above, the apparatus comprising a monitoring unit associated with the patient, wherein the monitoring unit either comprises a central processing unit configured to communicate with a sensor for measuring a value of a physiological characteristic of the patient, or comprises a sensor for measuring a value of a physiological characteristic of the patient, and wherein the monitoring unit is arranged to communicate with a central monitoring unit.

[0015] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The scope of the invention is not, however, limited to this preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Figure 1 is a block flow diagram of a method for practicing the present approach; and

Figure 2 is a simplified schematic block diagram of a preferred apparatus with which the present invention may be used.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Figure 1 depicts an approach for practicing the present invention. A monitoring apparatus is provided, numeral 20. The monitoring apparatus may be of any operable form, and one preferred form of the monitoring apparatus 50 is illustrated in Figure 2. The monitoring apparatus 50 is shown in a simplified form illustrating only those portions that are required to discuss the present invention. The monitoring apparatus 50 is generally like that disclosed in US Patent 5,959,529, but modified as discussed herein.

[0018] The monitoring apparatus 50 includes a remote monitoring unit (RMU) 52 carried by an ambulatory patient, and a central unit (CU) 54. The central unit 54 is typically a file server or a network. Other remote monitoring units, that are not "portable" but may be at a fixed location in a patient's home or hospital facility, may be used as well. A sensor 56 measures a physiological characteristic of a patient, and is typically in contact with the patient. ("Patient" is used in a broad sense, and refers to a person being monitored.) There may be one sensor or more than one sensor 56, depending upon the parameters of the patient that are of interest. Examples of operable sensors 56 include a heart monitor sensor, a blood pressure monitor sensor, a temperature monitor sensor, a respiration sensor, a brain wave sensor, a blood chemistry sensor, a blood glucose sensor, a blood oxygen saturation sensor, a patient position sensor, and a patient activity sensor. Sensors of various types are known in

the art, and details of their construction and operation does not form a part of the present invention.

[0019] In either event, the sensor 56 is in communication with a central processing unit (CPU) 58 of the remote monitoring unit 52, with intermediate signal conditioning equipment as necessary (not shown here). The central processing unit 58 performs analyses of the signals of the sensor 56, as will be discussed subsequently. Similarly, the central unit 54 includes a central processing unit (CPU) 60 to perform calculations and analyses, as will be discussed subsequently. (As noted, the central unit 54 and its CPU 60 may be of any operable type, such as a dedicated system, a network, or a file server.) The remote monitoring unit 52 and the central unit 54 may be placed in two-way communication with each other through a transceiver 62 located in the remote monitoring unit 52 and a communicating transceiver 64 located in the central unit 54. The transceivers 62, 64 may include any operable type of communications devices. For example they may include a modem to establish communications over a conventional land-line telephone for routine communications. They may also include a cellular telephone transceiver to establish communications on an urgent basis. The transceivers 62, 64 may also be equipped for two-way voice communication between the patient and a person at the central unit 54. The present invention is concerned in part with establishing the criteria for determining when a communication should be routine or urgent, by adaptively selecting the warning limits that signal a need for an urgent communication. The central unit 54 is provided with an interface to allow human review 66 of recommended actions of the central processing unit 60, as by the patient's physician.

[0020] Returning to the discussion of Figure 1, a current warning limit is established, numeral 22. The current warning limit relates to the type of physiological condition being monitored by the sensor 56. In the case of a heart sensor that measures a voltage as a function of time, for example, the warning limit may relate to any of a wide variety of types of information that may be determined from the heart sensor output to the central processing unit 58. Examples of warning limits may include, for example, the frequency of heartbeats, the shape of a particular part of the heartbeat waveform, the amplitude of a particular part of the heartbeat signal, or any other feature of the signal. There may also be quantitative values placed on some of these types of warning limits, such as a maximum or minimum number of heartbeats per minute, a maximum or minimum amplitude, a maximum number of features of a particular shape or type per minute (or hour), etc. The current warning limit is normally established in step 22 as input values from the experience of the medical caregiver responsible for the patient.

[0021] The physiological characteristics of the patient are measured using the sensor 56, numeral 24, and provided to the central processing unit 58. In the case of a heartbeat sensor, for example, the data output is a series of data pairs of sensor voltage output as a function of time (provided by a clock in the central processing unit 58).

[0022] The central processing unit 58 preliminary evaluates the sensor signals. It optionally evaluates the sensor performance, numeral 26. For example, it is known that the performance of some sensors degrades over time. That is, if a single feature such as the same heartbeat is measured by two sensors that are otherwise identical but wherein one has been used for five days and the other is new, the output voltages of the two sensors typically vary. If a warning limit is based on this voltage output, then different performance will be obtained for the used sensor and the new sensor. The change of performance of the sensor may be tracked by any operable approach, such as calibration signals or historical information. The sensor evaluation of step 26 keeps track of these changes over time.

[0023] The sensor signal is interpreted, numeral 28. The interpretation step 28 extracts the type of information of interest from the sensor signal. For example, if the information of interest is the frequency of heartbeats, a counting procedure is used. If the information of interest is a shape of the voltage-time output, then curve-shape analysis procedures are used. The methodology of such interpretation techniques is known in the art.

[0024] Using this information, event detection is performed, numeral 30. Event detection preferably includes comparing the measured value of a feature from the interpretation step 28 with the current warning limit for that feature as provided in step 22. For example, it may be significant if the heartbeat rate exceeds 100 per minute, or if more than a selected number of heartbeat shapes occurs per minute or per hour. Comparisons of other measured physiological characteristics, such as respiration rate blood pressure, and the like may be made as well.

[0025] The comparisons with the current warning limits are used to determine whether an event is occurring that requires urgent communication between the remote monitoring unit 52 and the central unit 54, numeral 34. The determination may be based on a single variable or multiple variables. For example, if the heartbeat exceeds a heartbeat warning limit value and the blood oxygen saturation level also exceeds a blood oxygen warning limit value, then an urgent communication may be called for. Based on this determination, the data is stored for a later routine communication, numeral 36, or the transceivers 62, 64 are activated for an urgent transmission to the central unit 54, numeral 38.

[0026] The current warning limit determines whether the remote monitoring unit 52 will establish a telephonic or other communication link with the central unit 54 on an urgent, immediate basis. In that event, the central unit 54 will be called upon to provide assistance to the patient, either directly or by contacting an emergency service provider, or it may determine that in fact no emergency exists. It is important that an urgent communication be established when an emergency truly exists. It is also de-

sirable that instances of establishing communications where no emergency exists be minimized in order to conserve battery power of the remote monitoring unit, to minimize unnecessary cellular telephone time charges, and to minimize the use of medical personnel who may be called upon unnecessarily to review situations that are not truly emergencies.

[0027] To improve the efficiency of the system, revised warning limits are selected, preferably but not necessarily without human intervention (i.e., "automatically"), numeral 40. This selection may be performed by the remote monitoring unit 52 in some cases and by the central unit 54 via the communication link in other cases. Some revisions to the warning limits are mechanical in nature and almost certainly do not require any human review. For example, if the sensitivity of the sensor changes over time so that a voltage output threshold warning limit that formerly was 9.60 millivolts is to be altered to 9.55 millivolts in order to keep the system sensitive to a constant level of signal amplitude, the change in the warning limit may typically be made by the remote monitoring unit 52. On the other hand, a change that is more closely associated with a medical condition is more likely to require a medical review. Thus, if a heartbeat frequency warning limit of 100 beats per minute is to be changed to 120 beats per minute based on extended experience in order to obtain a better indicator of when urgent communication is required, it is preferred that the central processing unit 60 of the central unit 54 make a recommendation based upon data analysis and without human intervention, and then a human being in the form of the patient's doctor or a medical technician approve the change under the human review 66. Typically, such changes based upon a medical evaluation occur relatively infrequently and may be made responsive to a routine communication rather than an urgent communication.

[0028] A wide variety of grounds for a selection of a revised warning limit are possible, but they generally fall into several classes.

[0029] One ground is related to instrumentation, with an example being the change in sensor sensitivity discussed above.

[0030] Another ground is a change in a warning limit based on a single-valued measured physiological characteristic. For example, a warning limit of 100 beats per minute may be a significant predictor of distress and an emergency for a first patient, but a second patient may naturally have a higher heart rate slightly above this warning limit so that a warning limit of 100 beats per minute produces many unnecessary urgent communications. Experience gained over time with the second patient will establish a more realistic warning limit for the second patient.

[0031] Another ground is a correlation between two or more measured physiological characteristics. For example, a heartbeat rate in excess of 100 beats per minute may signify distress if the patient is at rest and the respiration rate is less than 15 breaths per minute. A heartbeat in excess of 100 beats per minute may be quite normal if the patient is exercising and the respiration rate is equal to or greater than 15 breaths per minute. On the other hand, in the latter case a heartbeat in excess of 130 beats per minute even with a respiration rate faster than 15 breaths per minute may signal an emergency. The heartbeat warning limit may thus be selected responsive to the respiration rate.

[0032] Another ground is a correlation of a measured physiological characteristic with a nonphysiological parameter. For example, a heartbeat of 100 beats per minute may be quite normal for 16 hours per day, but during sleep periods from 11 pm to 7 am such an increase in the sleeping heartbeat rate to 100 beats per minute may signify an emergency. The warning limit may therefore correlate to absolute time according to daytime/night time activity, or it may correlate to a Circadian rhythm of the patient. In another example, if the remote monitoring unit is equipped with an accelerometer, a heartbeat rate in excess of 100 beats per minute coupled with a high temporary accelerometer reading may indicate that the patient has fallen and is injured but unable to otherwise communicate.

[0033] Another ground is a complete change in the information required from the interpretation step 28. It may initially be believed that a good objective correlator of distress in a patient is a heartbeat rate. Over time, however, it is found that the occurrence of more than three premature ventricular contractions (PVCs) per hour is a more dependable predictor of distress in the patient and an emergency situation. The interpretation step 28 is therefore shifted from a heartbeat count to a waveshape analysis.

[0034] The present invention is not intended to identify each specific type of revision that may be made in the warning limits. In fact, there are as many possibilities for types of revisions as there are patients to be monitored. The point of the present invention is to provide a technique and a methodology to allow an adaptive updating of the decision making of the monitoring apparatus as to whether an urgent communication is required instead of a routine communication. Although particular embodiments of the invention have been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.

Claims

1. A method of monitoring a patient provided with a sensor (56) for sensing a physiological characteristic of the patient, the sensor (56) forming part of, or being in communication with, a central processing unit (58) of a remote monitoring unit (52) associated with the patient, the monitoring according to an established current warning limit for the physiological char-

acteristic of the patient, the method comprising:

measuring a value of the physiological characteristic of the patient using the sensor (56) as a function of time;
determining an operating characteristic of the sensor (56);
selecting a revised warning limit for the physiological characteristic, without human intervention, and responsive to at least one of a change in the determined operating characteristic of the sensor (56) and time variations in the value of the physiological characteristic of the patient, the selecting based on interpretation of an output signal from said sensor (56) and performed by at least one of the remote monitoring unit (52) and a central monitoring unit (54) in communication with the remote monitoring unit (52);
determining whether an event is occurring that requires urgent communication between the remote monitoring unit (52) and the central monitoring unit (54) by comparing at least one subsequent measured value of the physiological characteristic with the revised warning limit; and
responsive to a determination that the event is occurring, establishing a communication link between said remote monitoring unit (52) and said central monitoring unit (54) on an urgent basis.

2. The method of claim 1, wherein selecting a revised warning limit comprises making a recommendation of a revised warning limit based upon data analysis responsive to a change in the value of the physiological characteristic of the patient, the method further comprising the step of a human being approving the revised warning limit.

3. The method of claim 1, comprising selecting a new revised warning limit based on a correlation between two or more measured physiological characteristics.

4. The method of claim 1, comprising selecting a new revised warning limit based on a correlation between a measured value of the physiological characteristic and a nonphysiological parameter.

5. The method of claim 4, wherein the remote monitoring unit (52) comprises an accelerometer; and wherein the nonphysiological parameter comprises an accelerometer reading.

6. The method of claim 5, wherein the operating characteristic comprises a sensitivity of the sensor (56).

7. The method of claim 1, wherein the physiological characteristic comprises a characteristic of the heart.

8. The method of claim 1, further comprising:

recursively reevaluating the revised warning limit;
repeating the selecting a revised warning limit as necessary in response to the reevaluating.

9. Patient monitoring apparatus (50) configured to perform the method of any of claims 1 to 8, the apparatus comprising:

a remote monitoring unit (52) associated with the patient and including a communications device which selectively establishes a communications link between the remote monitoring unit (52) and a central monitoring unit (54);
a sensor (56) for measuring a value of a physiological characteristic of the patient, the sensor (56) being in communication with a central processing unit (58) of the remote monitoring unit (52), or forming part of the remote monitoring unit (52); and
a central monitoring unit (54) in communication with the remote monitoring unit (52).

10. Patient monitoring apparatus configured to perform the method of any of claims 1 to 8, the apparatus comprising:

a monitoring unit (52) associated with the patient,
wherein the monitoring unit (52) either comprises a central processing unit (58) configured to communicate with a sensor (56) for measuring a value of a physiological characteristic of the patient, or comprises a sensor (56) for measuring a value of a physiological characteristic of the patient, and
wherein the monitoring unit (52) is arranged to communicate with a central monitoring unit (54).

Patentansprüche

1. Verfahren zur Überwachung eines Patienten, der mit einem Sensor (56) zur Erfassung einer physiologischen Eigenschaft des Patienten versehen ist, wobei der Sensor (56) einen Teil einer zentralen Verarbeitungseinheit (58) einer dem Patienten zugeordneten Fernüberwachungseinheit (52) bildet oder damit in Kommunikation steht, wobei die Überwachung gemäß einer festgelegten aktuellen Warngrenze für die physiologische Eigenschaft des Patienten erfolgt, wobei das Verfahren Folgendes umfasst:

Messung eines Wertes der physiologischen Eigenschaft des Patienten unter Verwendung des Sensors (56) in Abhängigkeit von der Zeit;
Ermittlung einer Betriebskenngröße des Sensors (56);

Auswahl einer revidierten Warngrenze für die physiologische Eigenschaft ohne menschliche Intervention und als Reaktion auf mindestens eines aus einer Veränderung der ermittelten Betriebskenngröße des Sensors (56) und Zeitschwankungen des Wertes der physiologischen Eigenschaft des Patienten, wobei die Auswahl auf einer Interpretation eines Ausgabesignals von dem Sensor (56) beruht und von mindestens einer der Fernüberwachungseinheit (52) und einer zentralen Überwachungseinheit (54), die mit der Fernüberwachungseinheit (52) in Kommunikation steht, durchgeführt wird;
Ermittlung, ob ein Ereignis eintritt, das eine dringende Kommunikation zwischen der Fernüberwachungseinheit (52) und der zentralen Überwachungseinheit (54) durch Vergleich von mindestens einem aufeinanderfolgenden gemessenen Wert der physiologischen Eigenschaft mit der revidierten Warngrenze erfordert; und
als Reaktion auf eine Ermittlung, dass das Ereignis eintritt, wobei eine dringend erforderliche Kommunikationsverbindung zwischen der Fernüberwachungseinheit (52) und der zentralen Überwachungseinheit (54) hergestellt wird.

2. Verfahren nach Anspruch 1, wobei die Auswahl einer revidierten Warngrenze eine Empfehlung einer revidierten Warngrenze aufgrund einer Datenanalyse als Reaktion auf eine Veränderung des Wertes der physiologischen Eigenschaft des Patienten umfasst, wobei das Verfahren ferner den Schritt der Bestätigung der revidierten Warngrenze durch einen Menschen umfasst.

3. Verfahren nach Anspruch 1, das die Auswahl einer neuen revidierten Warngrenze aufgrund einer Korrelation zwischen zwei oder mehreren gemessenen physiologischen Eigenschaften umfasst.

4. Verfahren nach Anspruch 1, das die Auswahl einer neuen revidierten Warngrenze aufgrund einer Korrelation zwischen einem gemessenen Wert der physiologischen Eigenschaft und einem nicht physiologischen Parameter umfasst.

5. Verfahren nach Anspruch 4, wobei die Fernüberwachungseinheit (52) einen Beschleunigungsmesser umfasst; und wobei der nicht physiologische Parameter einen Messwert des Beschleunigungsmessers umfasst.

6. Verfahren nach Anspruch 5, wobei die Betriebskenngröße eine Sensitivität des Sensors (56) umfasst.

7. Verfahren nach Anspruch 1, wobei die physiologische Eigenschaft eine Eigenschaft des Herzens umfasst.

8. Verfahren nach Anspruch 1, ferner umfassend:

rekursive Neubewertung der revidierten Warngrenze;
gegebenenfalls Wiederholung der Auswahl einer revidierten Warngrenze als Reaktion auf die Neubewertung.

9. Patientenüberwachungsvorrichtung (50), die zur Durchführung des Verfahrens nach einem der Ansprüche 1 bis 8 ausgestaltet ist, wobei die Vorrichtung Folgendes umfasst:

eine dem Patienten zugeordnete Fernüberwachungseinheit (52), die eine Kommunikationsvorrichtung enthält, die selektiv eine Kommunikationsverbindung zwischen der Fernüberwachungseinheit (52) und einer zentralen Überwachungseinheit (54) herstellt;
einen Sensor (56) zur Messung eines Wertes einer physiologischen Eigenschaft des Patienten, wobei der Sensor (56) in Kommunikation mit einer zentralen Verarbeitungseinheit (58) der Fernüberwachungseinheit (52) steht oder Teil der Fernüberwachungseinheit (52) ist; und
eine zentrale Überwachungseinheit (54), die mit der Fernüberwachungseinheit (52) in Kommunikation steht.

10. Patientenüberwachungsvorrichtung, die zur Durchführung des Verfahrens nach einem der Ansprüche 1 bis 8 ausgestaltet ist, wobei die Vorrichtung Folgendes umfasst:

eine dem Patienten zugeordnete Überwachungseinheit (52),
wobei die Überwachungseinheit (52) entweder eine zentrale Verarbeitungseinheit (58) umfasst, die zur Kommunikation mit einem Sensor (56) zur Messung eines Wertes einer physiologischen Eigenschaft des Patienten ausgestaltet ist, oder einen Sensor (56) zur Messung eines Wertes einer physiologischen Eigenschaft des Patienten umfasst, und
wobei die Überwachungseinheit (52) zur Kommunikation mit einer zentralen Überwachungseinheit (54) angeordnet ist.

Revendications

1. Procédé de surveillance d'un patient pourvu d'un capteur (56) destiné à détecter une caractéristique physiologique du patient, le capteur (56) faisant partie d'une unité de traitement centrale (58) d'une unité de surveillance à distance (52) associée au patient,

ou étant en communication avec celle-ci, la surveillance étant fonction d'une limite d'avertissement de courant établie pour la caractéristique physiologique du patient, le procédé comprenant :

la mesure d'une valeur de la caractéristique physiologique du patient en utilisant le capteur (56) en fonction du temps ;
la détermination d'une caractéristique de fonctionnement du capteur (56) ;
la sélection d'une limite d'avertissement révisée pour la caractéristique physiologique, sans intervention humaine, et répondant à au moins l'un parmi un changement de la caractéristique de fonctionnement déterminée du capteur (56) et des variations temporelles de la valeur de la caractéristique physiologique du patient, la sélection étant basée sur l'interprétation d'un signal de sortie provenant dudit capteur (56) effectuée par au moins l'une parmi l'unité de surveillance à distance (52) et une unité de surveillance centrale (54) en communication avec l'unité de surveillance à distance (52) ;
le fait de déterminer s'il se produit un événement qui nécessite une communication urgente entre l'unité de surveillance à distance (52) et l'unité de surveillance centrale (54) en comparant au moins une valeur mesurée ultérieure de la caractéristique physiologique à la limite d'avertissement révisée ; et
en réponse à une détermination que l'événement se produit, l'établissement d'une liaison de communication entre ladite unité de surveillance à distance (52) et ladite unité de surveillance centrale (54) sur une base urgente.

2. Procédé selon la revendication 1, dans lequel la sélection d'une limite d'avertissement révisée comprend la réalisation d'une recommandation d'une limite d'avertissement révisée sur la base d'une analyse de données répondant à un changement de la valeur de la caractéristique physiologique du patient, le procédé comprenant en outre l'étape d'un être humain approuvant la limite d'avertissement révisée.

3. Procédé selon la revendication 1, comprenant la sélection d'une nouvelle limite d'avertissement révisée sur la base d'une corrélation entre deux, ou plus, caractéristiques physiologiques mesurées.

4. Procédé selon la revendication 1, comprenant la sélection d'une nouvelle limite d'avertissement révisée sur la base d'une corrélation entre une valeur mesurée de la caractéristique physiologique et un paramètre non physiologique.

5. Procédé selon la revendication 4, dans lequel l'unité de surveillance à distance (52) comprend un accéléromètre ; et dans lequel le paramètre non physiologique comprend une lecture d'accéléromètre.

6. Procédé selon la revendication 5, dans lequel la caractéristique de fonctionnement comprend une sensibilité du capteur (56).

7. Procédé selon la revendication 1, dans lequel la caractéristique physiologique comprend une caractéristique du coeur.

8. Procédé selon la revendication 1, comprenant en outre :

la réévaluation récursive de la limite d'avertissement révisée ;
la répétition de la sélection d'une limite d'avertissement révisée si nécessaire en réponse à la réévaluation.

9. Appareil de surveillance de patient (50) configuré pour effectuer le procédé selon l'une quelconque des revendications 1 à 8, l'appareil comprenant :

une unité de surveillance à distance (52) associée au patient et incluant un dispositif de communication qui établit sélectivement une liaison de communication entre l'unité de surveillance à distance (52) et une unité de surveillance centrale (54) ;
un capteur (56) destiné à mesurer une valeur d'une caractéristique physiologique du patient, le capteur (56) étant en communication avec une unité de traitement centrale (58) de l'unité de surveillance à distance (52), ou faisant partie de l'unité de surveillance à distance (52) ; et
une unité de surveillance centrale (54) en communication avec l'unité de surveillance à distance (52).

10. Appareil de surveillance de patient configuré pour effectuer le procédé selon l'une quelconque des revendications 1 à 8, l'appareil comprenant :

une unité de surveillance (52) associée au patient,
dans lequel l'unité de surveillance (52) comprend une unité de traitement centrale (58) configurée pour communiquer avec un capteur (56) pour mesurer une valeur d'une caractéristique physiologique du patient ou comprend un capteur (56) destiné à mesurer une valeur d'une caractéristique physiologique du patient, et
dans lequel l'unité de surveillance (52) est agencée pour communiquer avec une unité de surveillance centrale (54).

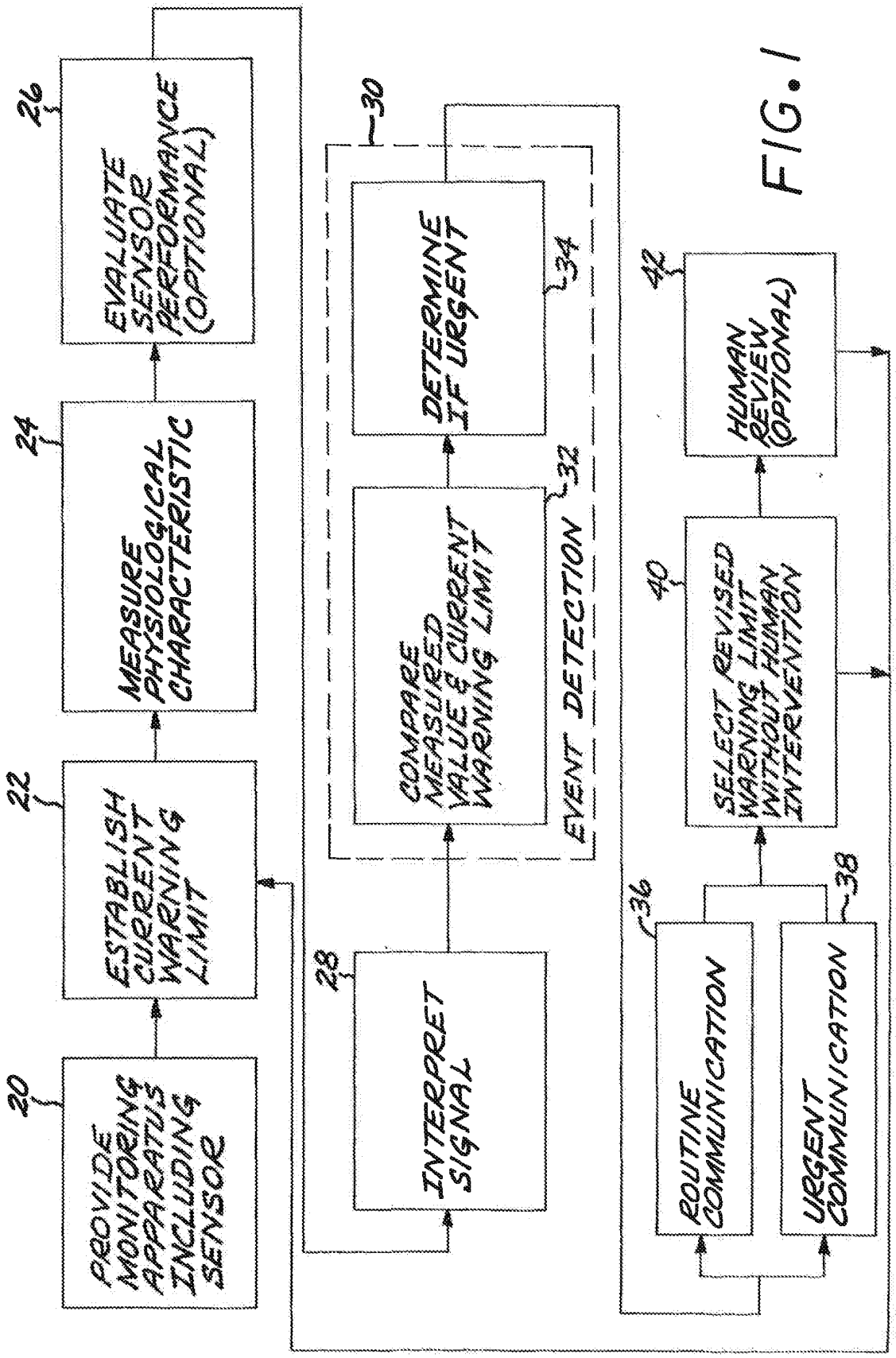
20
PROVIDE MONITORING APPARATUS INCLUDING SENSOR
22
ESTABLISH CURRENT WARNING LIMIT
24
MEASURE PHYSIOLOGICAL CHARACTERISTIC
26
EVALUATE SENSOR PERFORMANCE (OPTIONAL)
28
INTERPRET SIGNAL
30
EVENT DETECTION
32
COMPARE MEASURED VALUE & CURRENT WARNING LIMIT
34
DETERMINE IF URGENT
36
ROUTINE COMMUNICATION
38
URGENT COMMUNICATION
40
SELECT REVISED WARNING LIMIT WITHOUT HUMAN INTERVENTION
42
HUMAN REVIEW (OPTIONAL)

FIG. 1

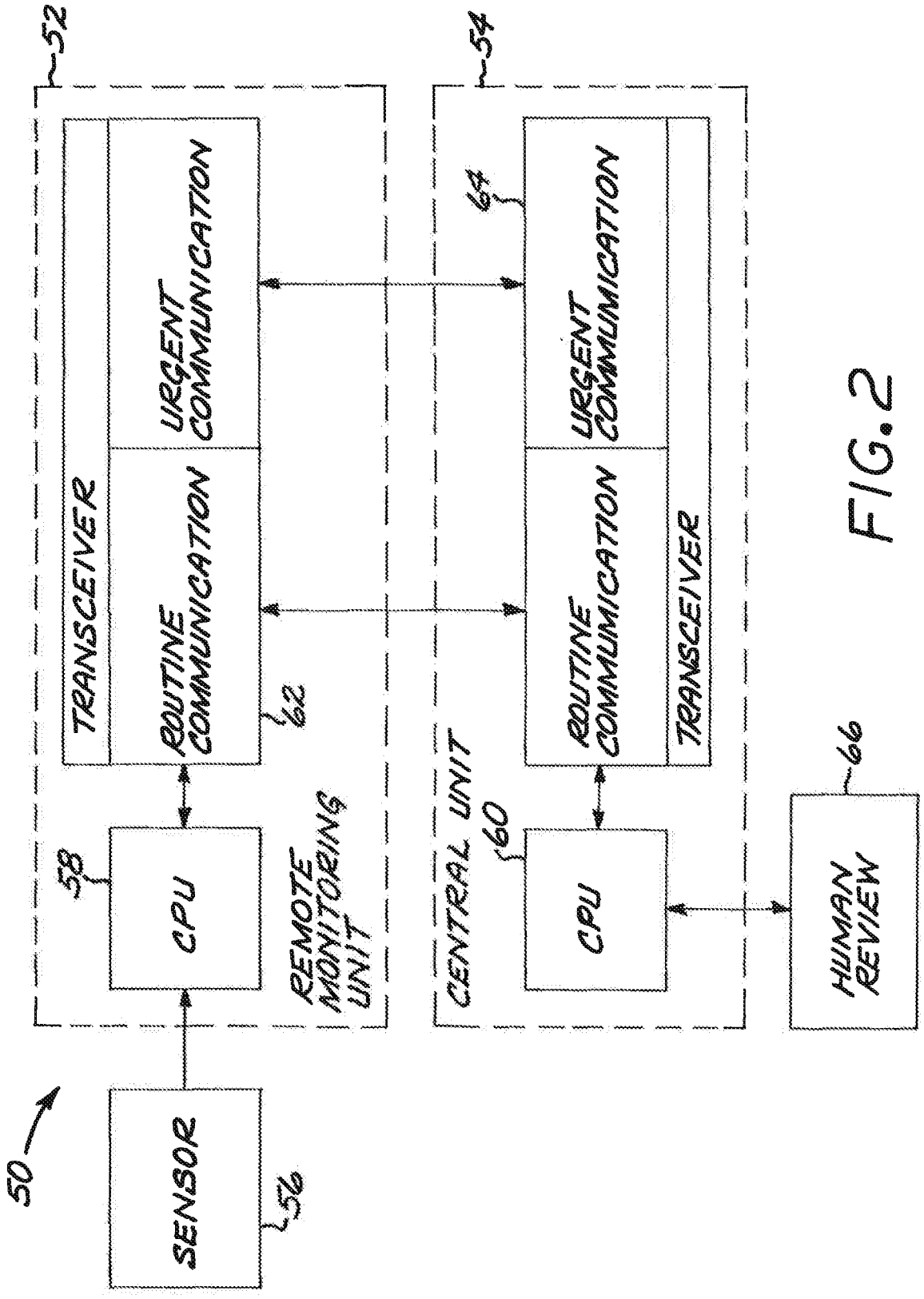
50
SENSOR
56
REMOTE MONITORING UNIT
52
TRANSCEIVER
ROUTINE COMMUNICATION
URGENT COMMUNICATION
62
58
CPU
CENTRAL UNIT
54
64
ROUTINE COMMUNICATION
URGENT COMMUNICATION
TRANSCEIVER
60
CPU
66
HUMAN REVIEW

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5959529 A **[0002] [0017]**
- US 5749907 A **[0006]**

专利名称(译)	自适应选择患者监测中的警告限值		
公开(公告)号	EP2298158B1	公开(公告)日	2016-11-30
申请号	EP2010178619	申请日	2002-04-22
申请(专利权)人(译)	CARDIONET INC.		
当前申请(专利权)人(译)	CARDIONET INC.		
[标]发明人	EGGERS PHILLIP N		
发明人	EGGERS, PHILLIP N		
IPC分类号	A61B5/00 A61B5/0245		
优先权	09/841153 2001-04-23 US		
其他公开文献	EP2298158A1		
外部链接	Espacenet		

摘要(译)

通过为患者的生理特征建立当前警告限制，为生理特征提供传感器，并使用传感器测量患者的生理特征的测量值来监测患者。响应于选择修改的警告限制提供和测量的至少一个步骤。然后，修订后的警告限制通常会替换当前的警告限制。当生理特征的测量值不在由当前警告限制定义的可接受范围内时，当前警告限制用于触发一些动作，

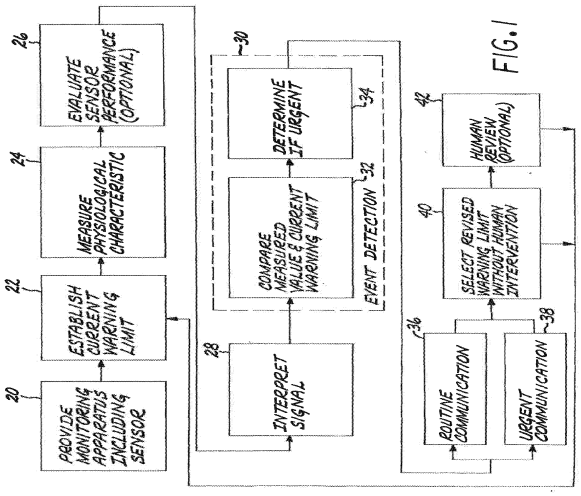

FIG. 1