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(12) **United States Patent**
Kiani

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(54) **SEPSIS MONITOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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(22) Filed: **May 3, 2011**

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Related U.S. Application Data

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(60) Provisional application No. 60/800,629, filed on May 15, 2006.

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

(52) **U.S. Cl.**
USPC **600/301**; 600/323; 600/324

(58) **Field of Classification Search**
USPC 600/300, 301, 324, 500, 508, 529, 323; 128/900
See application file for complete search history.

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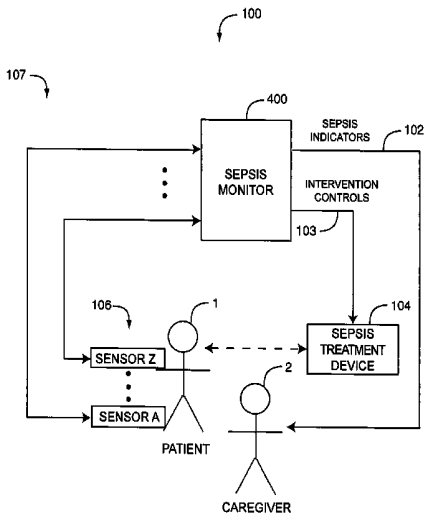
(57) **ABSTRACT**

Sensors are attached to a living being so as to generate corresponding sensor signals. A monitor is in communications with the sensors so as to derive physiological parameters responsive to the sensor signals. Predetermined limits are applied to the physiological parameters. At least one indicator responsive to the physiological parameters and the predetermined limits signal the onset of a sepsis condition in the living being.

11 Claims, 6 Drawing Sheets



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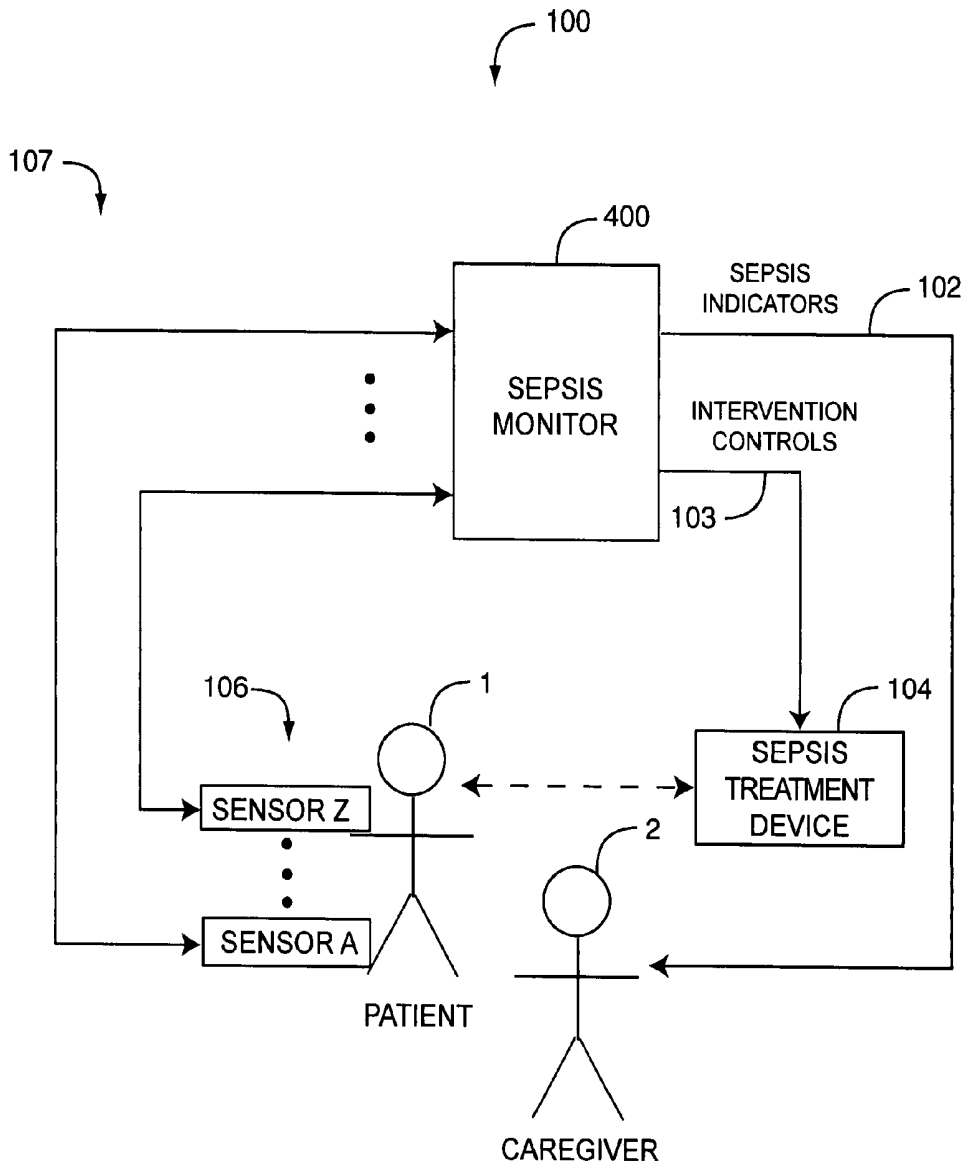
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SENSOR A
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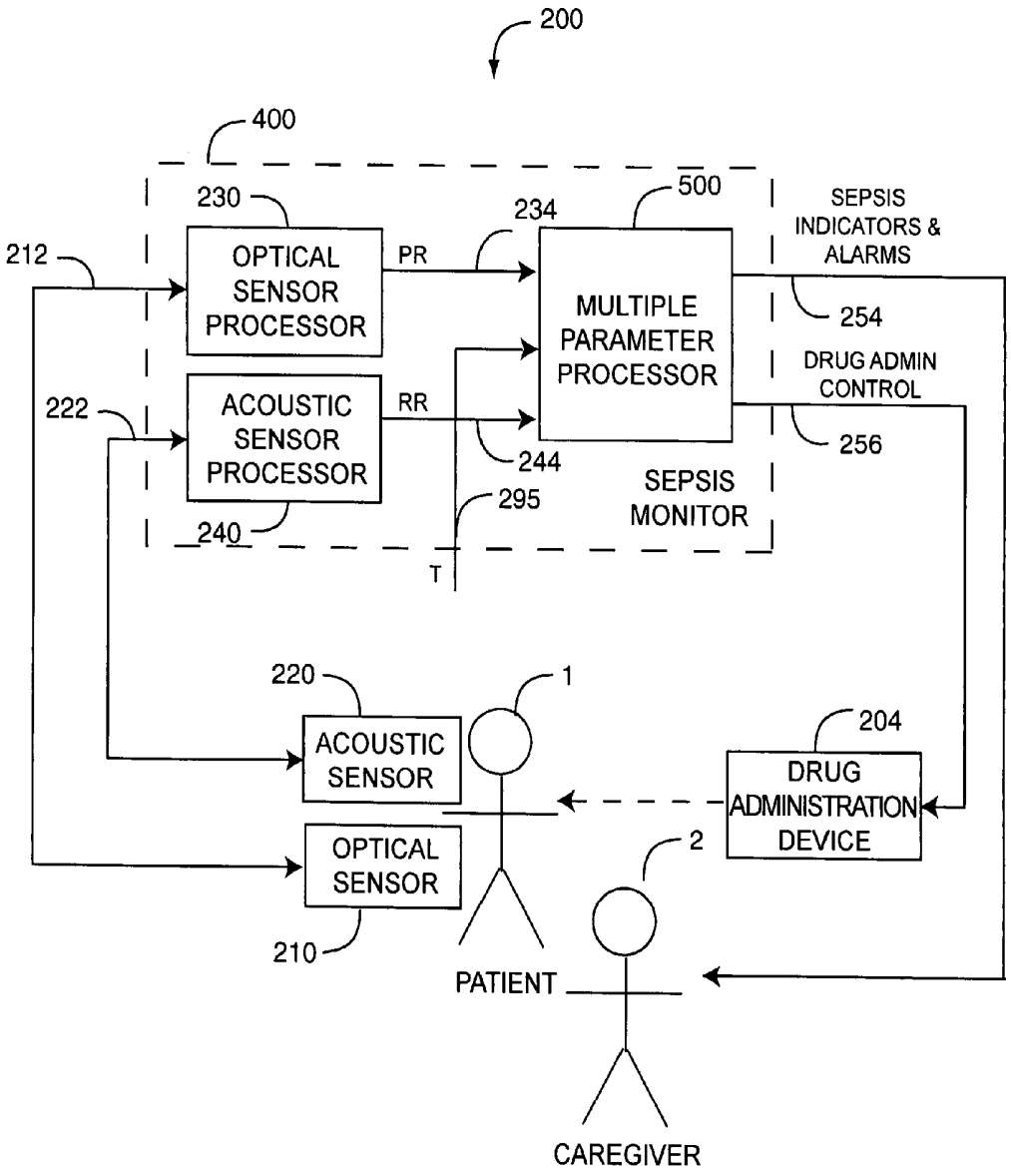
2
PATIENT
CAREGIVER

FIG. 1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DRUG ADMIN CONTROL
256
222
ACOUSTIC SENSOR PROCESSOR
RR
244
SEPSIS MONITOR
295
240
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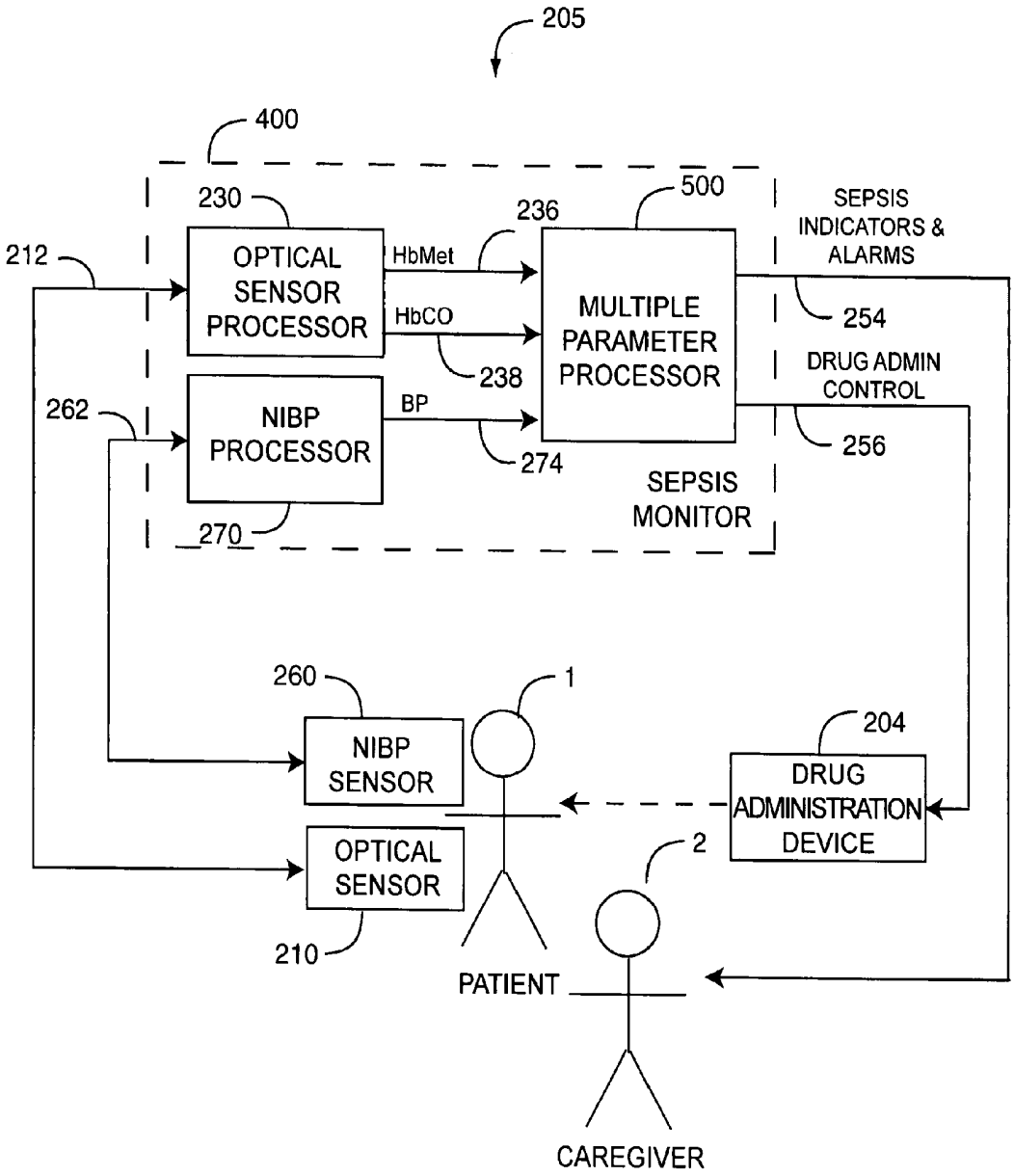
PATIENT
CAREGIVER

FIG. 2A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DRUG ADMIN CONTROL
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NIBP PROCESSOR
BP
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SEPSIS MONITOR
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PATIENT
CAREGIVER

FIG. 2B

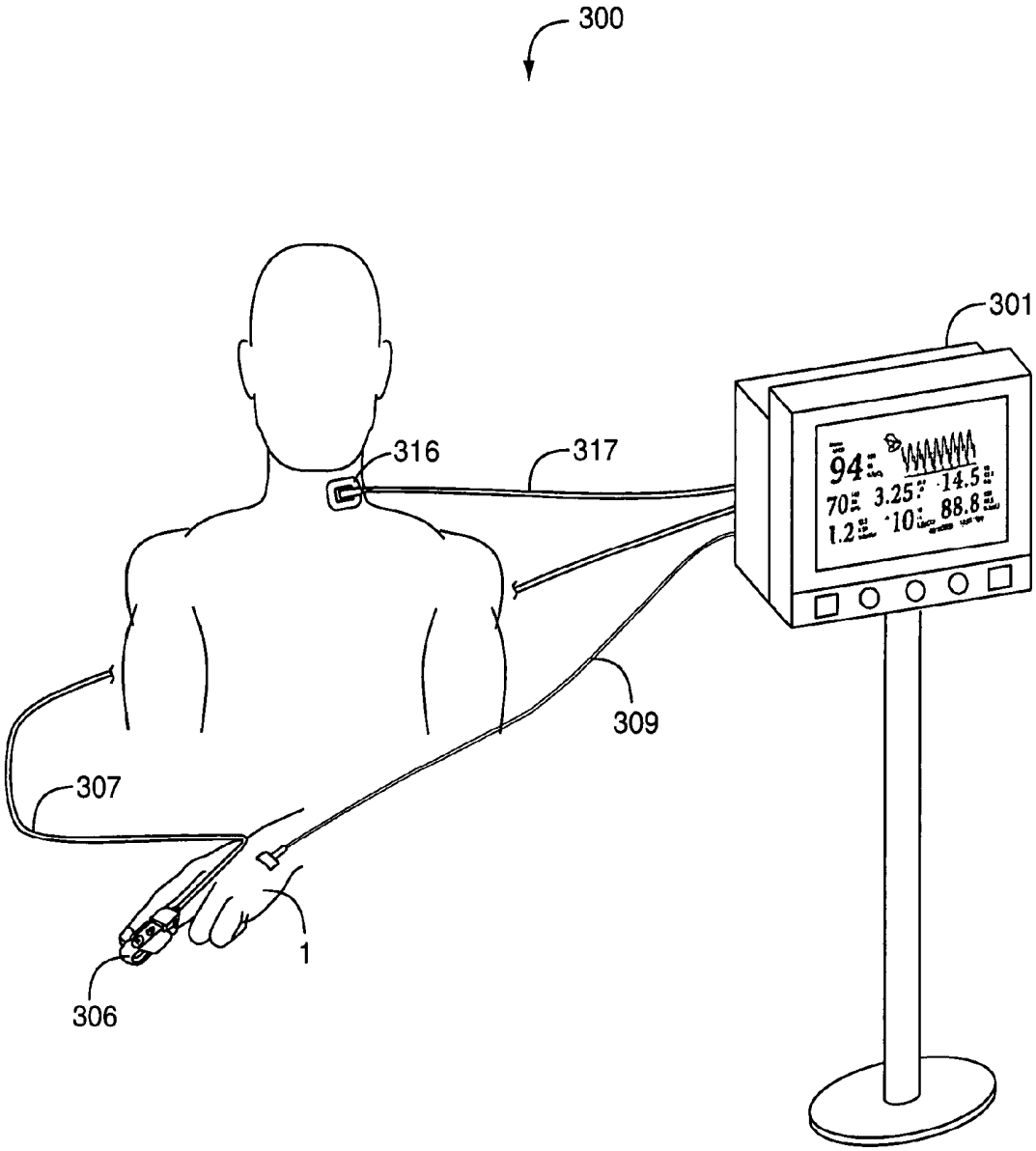

FIG. 3

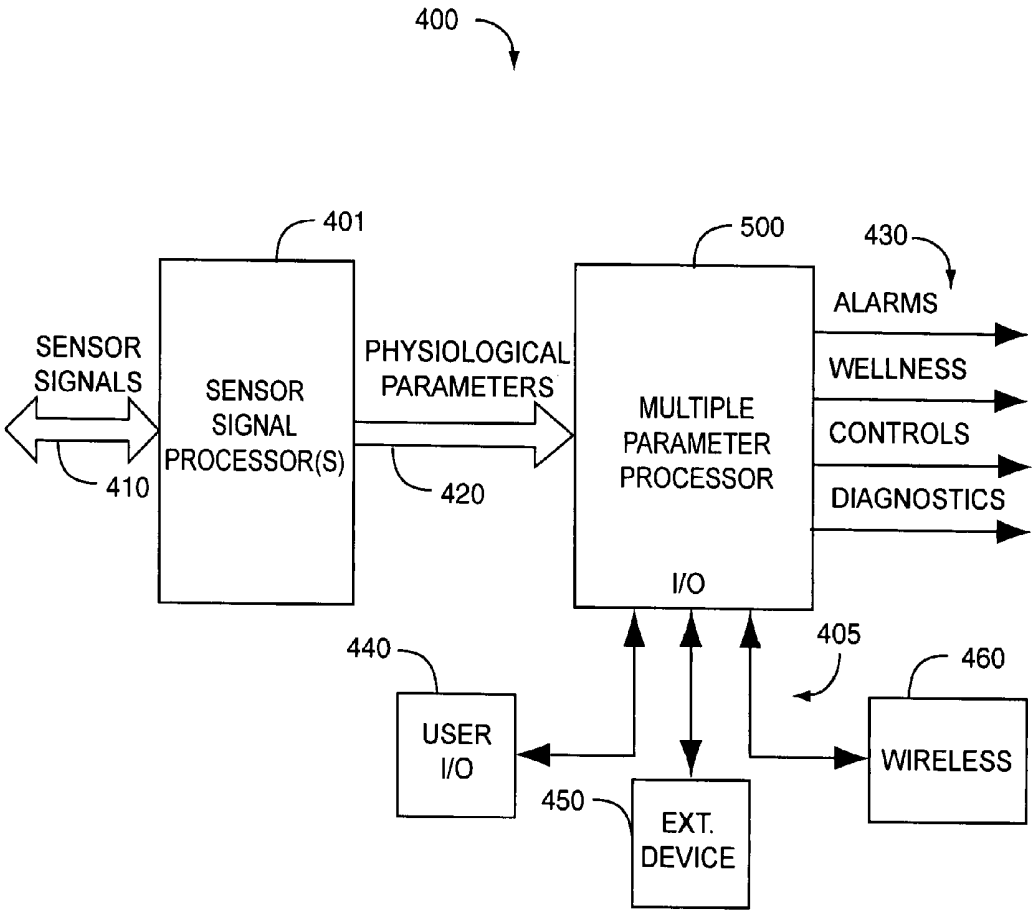
400
401
SENSOR SIGNALS
SENSOR SIGNAL PROCESSOR(S)
410
PHYSIOLOGICAL PARAMETERS
420
500
MULTIPLE PARAMETER PROCESSOR
I/O
430
ALARMS
WELLNESS
CONTROLS
DIAGNOSTICS
405
440
USER I/O
450
EXT. DEVICE
460
WIRELESS

FIG. 4

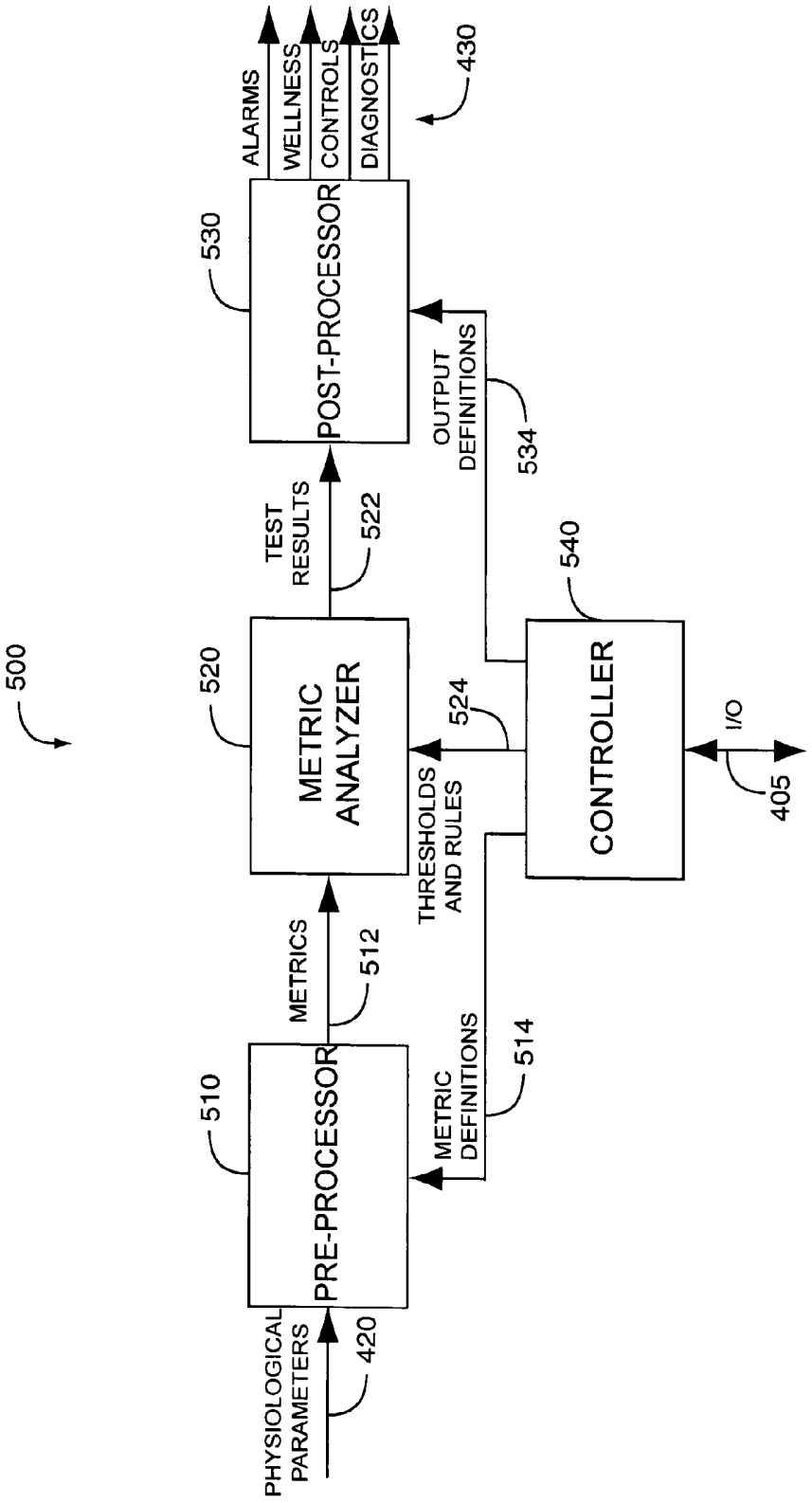
500
PHYSIOLOGICAL PARAMETERS
420
PRE-PROCESSOR
510
METRICS
512
METRIC DEFINITIONS
514
METRIC ANALYZER
520
TEST RESULTS
522
THRESHOLDS AND RULES
524
POST-PROCESSOR
530
OUTPUT DEFINITIONS
534
CONTROLLER
540
I/O
405
ALARMS
WELLNESS
CONTROLS
DIAGNOSTICS
430

FIG. 5

SEPSIS MONITOR

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority benefit under 35 U.S.C. §120 to, and is a continuation of U.S. patent application Ser. No. 11/803,936, filed May 15, 2007 entitled "Sepsis Monitor," which claims priority benefit under 35 U.S.C. §119 (e) from U.S. Provisional Application No. 60/800,629, filed May 15, 2006, entitled "Septic Shock Monitor." The present application also incorporates the foregoing disclosures herein by reference.

BACKGROUND OF THE INVENTION

Sepsis is a serious medical condition caused by the body's response to an infection. The source of the infection can be any of a number of places throughout the body. Bacterial infections are the most common cause of sepsis, but sepsis can also be caused by fungal, parasitic, or viral infections. Toxins produced by an untreated or inadequately treated infection circulate in the bloodstream causing damage, for example, to the brain, heart, lungs, kidneys and liver. Severe sepsis can result in septic shock, a medical emergency in which the organs and tissues of the body are not receiving an adequate flow of blood.

SUMMARY OF THE INVENTION

The signs and symptoms of sepsis may be subtle. The unacceptably low survival rate of severe sepsis indicates that current patient identification strategies may be lacking. For example, conventional patient monitors give insufficient advance warning of deteriorating patient health or the onset of potentially serious physiological conditions resulting from sepsis. Advantageously, a sepsis monitor noninvasively measures patient condition so as to provide caregivers with an advanced warning or prediction of the onset sepsis. A sepsis monitor may also be configured to provide automatic intervention or treatment of sepsis.

SIRS (systemic inflammatory response syndrome) refers to the systemic activation of the body's immune response, such as from sepsis. SIRS is manifested by, for example, the presence of more than one of a temperature greater than 38° C. or less than 36° C.; a heart rate greater than 90 beats/min.; and a respiration rate greater than 20 breaths/min. Thus, in an embodiment, a sepsis monitor is responsive to more than one of pulse rate, respiration rate and temperature.

Sepsis also results in large amounts of nitrous oxide (NO) released into the blood. It has been shown that NO functions, in part, as a killer molecule that is activated by immune cells. The overproduction of NO during sepsis induces excessive vascular relaxation and a profound hypotension that is also a characteristic feature of sepsis. NO interacts rapidly with hemoglobin to form methemoglobin (HbMet). Thus, HbMet can function as a marker for NO generation in patients with sepsis. Further, endogenously produced CO functions as a messenger molecule as part of a complex cascade of mediators resulting from sepsis. A portion of the endogenous CO is exhaled and a portion is present as carboxyhemoglobin (HbCO). Thus, in an embodiment, a sepsis monitor is responsive to one or more of HbCO, HbMet and blood pressure.

In an embodiment, sepsis monitoring is based upon one or more physiological parameters and associated parameter limits, trends, patterns and variability, alone or in combination. The physiological parameters may include: blood parameters derived from an optical sensor including one or more of oxygen saturation ($Sp0_2$), pulse rate, HbCO and HbMet; respiration rate (RR) derived from an acoustic sensor or a capnography sensor, as examples; noninvasive blood pressure (NIBP) derived from a blood pressure sensor, such as an inflatable cuff and corresponding acoustic sensor, a continuous NIBP(CNIBP) measurement device or an intelligent cuff inflation (ICI) device, to name a few; and temperature manually measured or derived from a thermistor or other temperature transducer.

One aspect of a sepsis monitor is sensors attached to a living being so as to generate corresponding sensor signals. A monitor is in communications with the sensors so as to derive physiological parameters responsive to the sensor signals. Predetermined limits are applied to the physiological parameters. At least one indicator responsive to the physiological parameters and the predetermined limits signal the onset of a sepsis condition in the living being.

Another aspect of a sepsis monitor is identifying physiological parameters indicative of an onset of a sepsis condition in a living being. Sensor signals are generated that are responsive to the physiological parameters. The physiological parameters are computed from the sensor signals. Predetermined rules are applied to the physiological parameters so as to determine the onset of the sepsis condition. An indicator signals the potential existence and likely nonexistence of the sepsis condition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a general block diagram of a sepsis monitoring system;

FIGS. **2**A-B are detailed diagrams of sepsis monitoring system embodiments;

FIG. **3** is an illustration of a sepsis monitoring system embodiment;

FIG. **4** is a general block diagram of a sepsis monitor incorporating a multiple parameter processor; and

FIG. **5** is a detailed block diagram of a multiple parameter processor embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** illustrates a sepsis monitoring system **100** having one or more sensors **106** generating sensor signals **107** in response to physiological states of a living being, such as a patient **1**. A sepsis monitor **400** processes the sensor signals **107** and generates sepsis indicators **102** or intervention controls **103** or both, in response. In an open-loop configuration, one or more sepsis indicators **102** are observed by a caregiver **2**, who administers treatment in response. Alternatively, or in addition, the caregiver **2** initiates, pauses, halts or adjusts the settings of a sepsis treatment device **104** in response to the sepsis indicators **102**. In an embodiment, the sepsis indicators **102** signal one or more of a prediction of the onset of sepsis, a sepsis condition, a prediction of the onset of septic shock and a septic shock condition. In a closed-loop configuration, the sepsis treatment device **104** is responsive to one or more intervention controls **103** so as to affect the treatment of the patient **1**, including, for example, initiating, pausing, halting or adjusting the dosage of administered drugs. In an embodiment, the intervention controls **103** are responsive to one or more of a prediction of the onset of sepsis, a sepsis condition, a prediction of the onset of septic shock and a septic shock condition.

As shown in FIG. **1**, the sepsis treatment device **104** may be a drug infusion device, a medical gas inhalation device or a ventilation device to name a few. Drug infusion device and gas inhalation device control is described in U.S. patent application Ser. No. 11/654,904, filed Jan. 17, 2007, entitled Drug Administration Controller and incorporated by reference herein. Closed loop respirator control is described in U.S. patent application Ser. No. 11/585,678, filed Oct. 23, 2006, entitled Robust Ventilator Control and incorporated by reference herein.

As shown in FIG. **1**, sensors **106** provide noninvasive measurements and include, for example, an optical sensor attached to a tissue site, such as a fingertip, for measuring one or more blood parameters. Noninvasive sensors **106** may also include acoustic sensors, blood pressure cuffs, ECG or EEG electrodes, CO_2 measuring capnography sensors and temperature sensors to name but a few. The sepsis monitor **400** is responsive to sensors signals **107** so as to generate parameter measurements, which may include SpO_2, pulse rate, perfusion index, perfusion variability index, HbCO, HbMet, total hemoglobin, fractional saturation, glucose, cyanide, respiration rate, blood pressure, CO_2, bilirubin, lung volume, cardiac output, temperature, consciousness and hydration measures, among other parameters. Such parameters may be measured intermittently or continuously. Although sensors **106** are described above with respect to noninvasive technologies, sensors **106** may be invasive or noninvasive. Invasive measurements may require a person to prepare a blood or tissue sample, which is then processed by an instrument or testing device, with the result read from the instrument or device and manually entered into the sepsis monitor **400**.

The sepsis monitor **400** may be a single instrument incorporating various hardware, software, circuits and code for processing sensor signals, deriving physiological parameters and processing those parameters to generate the indicators and controls described above. Alternatively, the sepsis monitor **400** may integrate one or more standalone instruments or plug-ins, each of which process specific sensor signals and derive particular physiological parameters. These may include blood parameter monitors, respiration rate monitors, blood pressure monitors, ECG and EEG monitors and capnometers, as a few examples.

In an embodiment, sensors **106** include a multiple wavelength optical sensor, such as described in U.S. patent application Ser. No. 11/376,013, filed Mar. 1, 2006 and entitled Multiple Wavelength Sensor Emitters; and the sepsis monitor **400** incorporates a patient monitor, such as described in U.S. patent application Ser. No. 11/367,033, filed Mar. 1, 2006 and entitled Noninvasive Multi-Parameter Patient Monitor, both patent applications assigned to Masimo Laboratories, Irvine, Calif. and both incorporated by reference herein.

In an embodiment, sensors **106** and measurement devices **108** include multiple wavelength sensors and corresponding noninvasive blood parameter monitors, such as Rainbow™ adhesive and reusable sensors and RAD-57™ and Radical-7™ monitors for measuring SpO_2, pulse rate, perfusion index, signal quality, HbCO and HbMet among other parameters. The Rainbow™ sensors and RAD-57™ and Radical-7™ monitors are available from Masimo Corporation, Irvine, Calif. In an embodiment, sensors **106** include a pulse oximetry sensor, such as described in U.S. Pat. No. 5,782,757 entitled Low Noise Optical Probes and the sepsis monitor **400** incorporates a pulse oximeter, such as described in U.S. Pat. No. 5,632,272 entitled Signal Processing Apparatus, both assigned to Masimo Corporation, Irvine, Calif. and both incorporated by reference herein. In other embodiments, sensors **106** also include any of LNOP® adhesive or reusable sensors, SofTouch™ sensors, Hi-Fi Trauma™ or Blue™ sensor all available from Masimo Corporation, Irvine, Calif. Further, the sepsis monitor **400** may also include any of Radical®, SatShare™, Rad-9™, Rad-5™, Rad-5v™ or PPO+™ Masimo SET® pulse oximeters all available from Masimo Corporation, Irvine, Calif.

In another embodiment, the sepsis monitor **400** and the sepsis treatment device **104** are incorporated within a single unit. For example, the sepsis monitor **400** and treatment device **104** may be incorporated within a single housing, or the devices may be separately housed but physically and proximately connected.

FIGS. **2**A-B illustrate sepsis monitoring system embodiments **200**, **205**. As shown in FIG. **2**A with respect to a system embodiment **200**, a sepsis monitor **400** is in communications with an optical sensor **210** and an acoustic sensor **220** attached to a patient **1**. An optical sensor processor **230** generates pulsatile-blood related parameters, such as pulse rate (PR) **234**, in response to optical sensor signals **212**. An acoustic sensor processor **240** generates body-sound related parameters **244**, such as respiration rate (RR), in response to acoustic sensor signals **222**. A temperature parameter **295** is generated via a temperature sensor or manually entered. A multiple parameter processor **500** processes the parameter measurements **234**, **244**, **295** alone or in combination and generates sepsis indicators and alarms **254** or drug administration controls **256**, or both, in response. An acoustic sensor is described in U.S. Pat. No. 6,661,161 entitled Piezoelectric Biological Sound Monitor with Printed Circuit Board and a corresponding respirator rate monitor is described in International App. No. PCT/CA2005/000536 and PUb. No. WO 2005/096931, filed Apr. 8, 2005, both applications incorporated by reference herein.

As shown in FIG. **2**B with respect to a system embodiment **205**, a sepsis monitor **400** is in communications with an optical sensor **210** and a NIBP sensor **260** attached to a patient **1**. An optical sensor processor **230** generates pulsatile-blood related parameters, such as such as HbCO **236** and HbMet **238** in response to optical sensor signals **212**. An NIPB processor **270** generates blood pressure (BP) parameters, in response to NIBP sensor signals **262**. A multiple parameter processor **500** processes the parameter measurements **236**, **238**, **274** alone or in combination and generates sepsis indicators and alarms **254** or drug administration controls **256**, or both, in response. A continuous NIBP (CNIBP) sensor and processor are described in U.S. Pat. No. 5,590,649 entitled Apparatus and Method for Measuring an Induced Perturbation to Determine Blood Pressure and an intelligent cuff inflation (ICI) sensor and processor are described in U.S. Pat. No. 5,785,659 entitled Automatically Activated Blood Pressure Measurement Device, both patents incorporated by reference herein.

Advantageously, the multiple parameter processor **500** is responsive to a combination of multiple physiological parameters to indicate sepsis so that an alert can be provided based upon these parameters. Further, the multiple parameter processor **500** responds not only to parameter limits but also to parameter trend information, parameter patterns and parameter variability, so as to reflect a patient condition over time. In an embodiment, sepsis indicators **254** include alarms and wellness indicators that indicate stages of sepsis from none, to the onset of sepsis, to severe sepsis and septic shock. These outputs, for example, provide a warning of a potential onset of sepsis at an early stage and can trigger alarms as sepsis symptoms progress. Further, drug administration control **256** controls the administration of drugs or alters drug doses in response to patient condition. In an embodiment, the multiple

parameter processor **500** compares parameter limits and rising or falling trends of the measurements **234**, **244**, **236**, **238**, **274**, **295** alone or in combination, with corresponding predetermined thresholds and generates indicators and alarms **254** or drug administration controls **256** in response. The comparisons utilize a rule-based metric analysis, as described in detail in respect to FIGS. **4-5**, below.

In one embodiment, the sepsis indicators **254** include a green indicator signaling a stable condition, a yellow indicator signaling a less stable condition or a potential sepsis onset and a red indicator signaling an unstable or severe sepsis condition. The indicators **254** may be, for example, various display LEDs emitting wavelengths of the appropriate colors. In an embodiment, a sepsis monitor **400** provides indicators **254** according to TABLES 1 and 2 below.

In an embodiment according to TABLE 1, below, if a patient's pulse rate (PR) and respiration rate (RR) are less than predetermined maximum limits and their body temperature is within a predetermined normal range, then the sepsis monitor **400** displays a green indicator. However, if more than one of pulse rate, respiration rate and body temperature are changing, where applicable changes in pulse rate and respiration rate are rate increases, then the sepsis monitor **400** displays a yellow indicator, signaling a potential onset of sepsis. If more than one of pulse rate, respiration rate and temperature become abnormal, including pulse rate and respiration rate above a predetermined limit and temperature outside of a predetermined range, then the sepsis monitor **400** displays a red indicator, signaling a potential sepsis condition.

TABLE 1

Rule-Based Monitor Outputs

RULE	OUTPUT
If PR < heart rate limit; RR < breathing rate limit; & T in normal range.	Then illuminate green indicator.
If PR rising > heart rate trend limit; RR rising > breathing rate trend limit; & T rising or fallina.	Then illuminate yellow indicator
If PR > heart rate limit; RR > breathing rate limit; & T outside normal range.	Then illuminate red indicator; Trigger audible alarm.

In an embodiment according to TABLE 2, below, if a patient's carboxyhemoglobin (HbCO), methemeglobin (HbMet) and blood pressure (BP) are normal, i.e. HbCO and HbMet less than predetermined maximum limits and BP greater than a predetermined minimum limit, then the sepsis monitor **400** displays a green indicator. However, if any of HbCO, HbMet and BP are changing, where applicable changes in HbCO and HbMet are increases and the applicable change in BP is a decrease, then the sepsis monitor **400** displays a yellow indicator, signaling a potential onset of sepsis. If any of HbCO, HbMet and BP change beyond predetermined limits, then the sepsis monitor **400** displays a red indicator, signaling a potential sepsis condition.

TABLE 2

Additional Rule-Based Monitor Outputs

RULE	OUTPUT
If HbCO < CO limit; HbMet < Met limit; & BP > blood pressure limit.	Then illuminate green indicator.

TABLE 2-continued

Additional Rule-Based Monitor Outputs

RULE	OUTPUT
If HbCO rising > CO trend limit; HbMet rising > Met trend limit or BP falling.	Then illuminate yellow indicator
If HbCO > HbCO limit threshold; HbMet > HbMet limit threshold; or BP < blood pressure limit.	Then trigger an alarm, such as An audible or a visual alert or both.

In other embodiments, a sepsis monitor **400** utilizes predetermined limits and ranges on any or all of PR, RR, T, HbCO, HbMet and BP to indicate no sepsis, a potential onset of sepsis or a sepsis condition, with green, yellow and red indicators or with other visual and audible indicators, displays and alarms. Other indicators, alarms, controls and diagnostics in response to various combinations of parameters and thresholds can be substituted for, or added to, the rule-based outputs illustrated in TABLES 1 and 2.

Other parameter measurements that may be input to the multiple parameter processor **500** include oxygen saturation (SpO_2) and perfusion index (PI) as derived from a pulse oximeter, EGG, EEG and $ETCO_2$, to name a few. All of these parameters may indicate real-time measurements and historical data such as measurement trends, patterns and variability. Signal quality measurements may also be input to the multiple parameter processor **500**. Pulse oximetry signal quality and data confidence indicators are described in U.S. Pat. No. 6,684,090 entitled Pulse Oximetry Data Confidence Indicator, a pattern recognition alarm indicator is described in U.S. Pat. No. 6,822,564 entitled Parallel Measurement Alarm Processor, both patents assigned to Masimo Corporation, Irvine, Ga. and incorporated by reference herein.

FIG. **3** illustrates a sepsis monitoring system **300** combining a sepsis monitor **400** (FIG. **1**) and a drug administration device **204** (FIGS. **2**A-B) into a drug infusion monitor **301**. The sepsis monitoring system **300** has an optical sensor **306** and a piezoelectric sensor **316** attached to a patient's body **1**. The optical sensor **306** detects pulsatile blood components and the piezoelectric sensor **316** detects tracheal sounds. The corresponding optical and acoustic sensor signals are transmitted to the drug infusion monitor **301** via an optical-sensor cable **307** and an acoustic-sensor cable **317**. The drug infusion monitor **301** generates blood parameter measurements such as PR, HbCO and HbMet and biological sound measurements such as respiration rate (RR) and processes the measurements to display sepsis indicators and administer corresponding treatments. In a particular embodiment, the drug infusion monitor **301** intravenously administers one or more drugs, such as recombinant activated protein C, to the patient **1** in doses and dose intervals so as to respond to varying stages of sepsis or the potential onset of sepsis and to transitions between less severe and more severe stages of sepsis.

FIG. **4** illustrates a sepsis monitor embodiment **400** having sensor signal processor(s) **401**, a multiple parameter processor **500**, sensor signal inputs **410** to the signal processor(s) **401** and monitor outputs **430** from the parameter processor **500**. Monitor outputs **430** may be sepsis alarms, wellness indicators, controls and sepsis diagnostics. Alarms may be used to alert medical personnel to a potential urgent or emergency medical condition in a patient under their care. Wellness indicators may be used to inform medical personnel as to patient condition stability or instability, such as a less urgent but potentially deteriorating medical state or condition. Diagnostics may be messages or other indicators used to assist medical personnel in diagnosing or treating a patient condi-

tion. Controls may be used to affect the operation of a medical treatment device, as described above, or other medical-related equipment.

In an embodiment, the multiple parameter processor **500** also has an input and output port (I/O) **405** that provides communications to the outside world. The I/O includes user I/O and external device communications to name a few. User I/O allows manual data entry and control. For example, a menu-driven operator display may be provided to allow entry of predetermined alarm thresholds. External device communications may include interfaces, networks or wireless communications to PCs, printers, chart recorders or displays to name a few.

FIG. **5** illustrates a sepsis monitor embodiment **500** having a pre-processor **510**, a metric analyzer **520**, a post-processor **530** and a controller **540**. The pre-processor **510** has inputs **420** that may be real-time physiological parameter measurements, historical physiological parameter measurements, signal quality measures or any combination of the above. The pre-processor **510** generates metrics **512** that may include historical or real-time parameter trends, detected parameter patterns, parameter variability measures and signal quality indicators to name a few. As examples, trend metrics may indicate if a physiological parameter is increasing or decreasing at a certain rate over a certain time, pattern metrics may indicate if a parameter is cyclical within a particular frequency range or over a particular time period, variability metrics may indicate the extent of parameter stability.

As shown in FIG. **5**, the metric analyzer **520** is configured to provide test results **522** to the post-processor based upon various rules applied to the metrics **512** in view of various thresholds **524**. As an example, the metric analyzer **520** may output an alarm trigger **522** to the post-processor **530** when a parameter measurement **503** increases faster than a predetermined rate. This may be expressed, as an example, by a rule that states "if trend metric exceeds trend threshold then trigger alarm." TABLE 1 and TABLE 2, above, illustrate sepsis monitor rules applied to metrics including PR, RR, T, HbCO, HbMet and BP parameters and trends.

Also shown in FIG. **5**, the post processor **530** inputs test results **522** and generates outputs **502** including alarms, wellness indictors, controls and diagnostics. Alarms may be, for example, audible or visual alerts warning of critical conditions that need immediate attention. Wellness indicators may be audible or visual cues, such as an intermittent, low-volume tone or a red/yellow/green light indicating a patient with a stable or unstable physiological condition, as examples. Controls may be electrical or electronic, wired or wireless or mechanical outputs, to name a few, capable of interfacing with and affecting another device. Diagnostics may indicate a particular patient condition, such as the potential onset of sepsis.

Further shown in FIG. **5**, the controller **540** interfaces with I/O **509**. In one embodiment, the I/O **509** provides predetermined thresholds, which the controller **540** transmits to the metric analyzer **520**. The controller **540** may also define metrics **514** for the pre-processor **510** and define outputs **534** for the post-processor **530**.

A sepsis monitor has been disclosed in detail in connection with various embodiments. These embodiments are disclosed by way of examples only and are not to limit the scope of the claims that follow. One of ordinary skill in art will appreciate many variations and modifications.

What is claimed is:

1. A patient monitoring method seeking to identify a sepsis condition in said patient, said method comprising:

noninvasively generating a plurality of sensor signals responsive to physiological parameters indicative of an onset of a sepsis condition in a said patient, at least one of said sensor signals responsive to the output of a noninvasive optical sensor;

electronically computing measurements for said physiological parameters from the sensor signals, said parameters including at least, pulse rate, temperature, and respiration;

said respiration parameter responsive to measurements taken by an acoustic sensor applied to the neck, and said pulse rate parameter responsive to measurements taken by a pulse oximeter applied to a digit;

applying a plurality of predetermined rules to the physiological parameters so as to determine the onset of the sepsis condition; and

indicating to an observer the potential existence of the sepsis condition.

2. The sepsis monitoring method according to claim **1** wherein the acoustic sensor detects tracheal sounds of the living being.

3. The sepsis monitoring method according to claim **2** wherein the applying comprises determining if the temperature is outside a predetermined range.

4. The sepsis monitoring method according to claim **3** wherein the applying comprises determining if the pulse rate and the respiration rate are greater than a plurality of predetermined limits.

5. The sepsis monitoring method according to claim **4** wherein the indicating comprises activating a first colored light to indicate nonexistence of a sepsis condition and a second colored light to indicate a potential existence of a sepsis condition.

6. The sepsis monitoring method according to claim **1** further comprising sending a control signal to a drug administration device intravenously in communications with the living being in response to the applying step so as to provide treatment for the sepsis condition.

7. A method of electronically monitoring signals indicative of a patient condition to determine when to warn a caregiver that said patient condition is indicative of sepsis, the method comprising:

outputting a first signal from a noninvasive optical sensor applied to a digit indicative of an absorption of light by body tissue of said patient, said first signal also indicative of one or more physiological parameters of said patient including a pulse rate;

outputting a second signal from a noninvasive acoustic sensor applied to an area of skin around a patient's throat where said second signal is indicative of acoustically sensed tracheal sounds;

outputting a third signal from a thermal sensor wherein the signal is indicative of a temperature of the patient;

electronically processing with a processor said first signal to output measurement values for said one or more physiological parameters including at least the pulse rate, processing with said processor said second signal to output measurement values for respiration, and processing with said processor said third single to output measurement values for said temperature;

electronically applying with said processor a plurality of predetermined rules to said measurement values; and

when said application of said rules indicates said patient condition is indicative that sepsis potentially exists, or that sepsis likely exists, outputting at least one of an audio or visual indication to said caregiver that sepsis

potentially exists, or that sepsis likely exists respectively according to the indication from the application of the rules.

8. The method according to claim **7**, wherein the audio or visual indication is a colored light.

9. The method according to claim **7**, further comprising sending a control signal to a drug administration device intravenously in communications with said patient, said control signal responsive to said indication of said sepsis, said device providing treatment for said sepsis.

10. The method of claim **7**, wherein the applying comprises determining if the pulse rate and the respiration rate are greater than a plurality of predetermined limits.

11. The method of claim **7**, wherein the applying comprising determining if the temperature is outside a normal range.

* * * * *

专利名称(译)	败血症监测		
公开(公告)号	US8663107	公开(公告)日	2014-03-04
申请号	US13/100172	申请日	2011-05-03
[标]申请(专利权)人(译)	Kiani曾MASSIê		
申请(专利权)人(译)	Kiani曾，MASSI E.		
当前申请(专利权)人(译)	CERCACOR LABORATORIES，INC.		
[标]发明人	KIANI MASSI E		
发明人	KIANI, MASSI, E.		
IPC分类号	A61B5/00		
CPC分类号	A61B2560/0276 A61B5/6826 A61B5/412 A61B5/6838 A61B5/08 A61B5/0205 A61B5/02455 A61B5/022 A61M5/1723 A61B5/14551 A61B5/082 A61B7/04		
优先权	60/800629 2006-05-15 US		
其他公开文献	US20110208018A1		
外部链接	Espacenet USPTO		

摘要(译)

传感器连接到生物上以产生相应的传感器信号。监视器与传感器通信，以便响应传感器信号导出生理参数。将预定限制应用于生理参数。响应于生理参数和预定限制的至少一个指示器指示生物体中败血症状况的发作。