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(54) **USE OF EXTERNAL RESPIRATORY THERAPY DEVICE TO DETECT CARDIAC ELECTRICAL ACTIVITY**

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(76) Inventors: **Jeffrey E. Stahmann**, Ramsey, MN (US); **Jesse W. Hartley**, Lino Lakes, MN (US); **Kent Lee**, Shoreview, MN (US); **Quan Ni**, Shoreview, MN (US)

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Correspondence Address:
HOLLINGSWORTH & FUNK, LLC
8009 34th Avenue South, Suite 125
Minneapolis, MN 55425

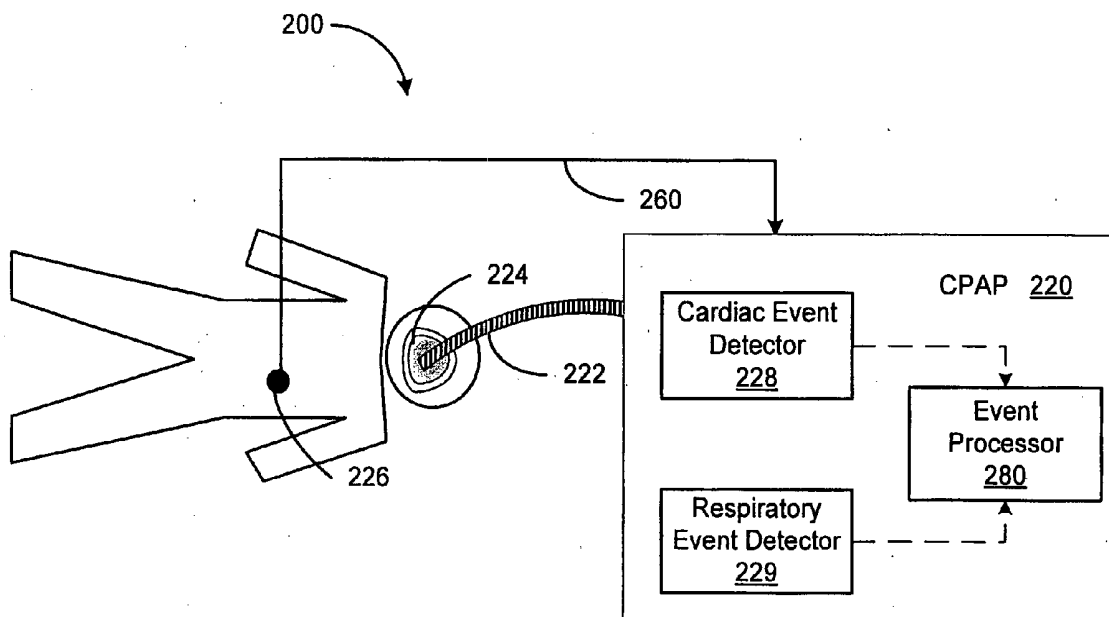
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(63) Continuation of application No. 10/922,351, filed on Aug. 19, 2004, now Pat. No. 7,364,547.

(57) **ABSTRACT**

Methods and systems provide an integrated approach to respiratory and cardiac monitoring, diagnosis and/or therapy. A medical system includes one or more cardiac electrodes coupled to an external respiratory therapy device. The cardiac electrodes sense cardiac electrical activity that is used to generate an electrocardiogram (ECG) signal. Cardiac events, such as arrhythmia, myocardial infarction and/or ischemia, may be detected based on the sensed cardiac electrical activity.



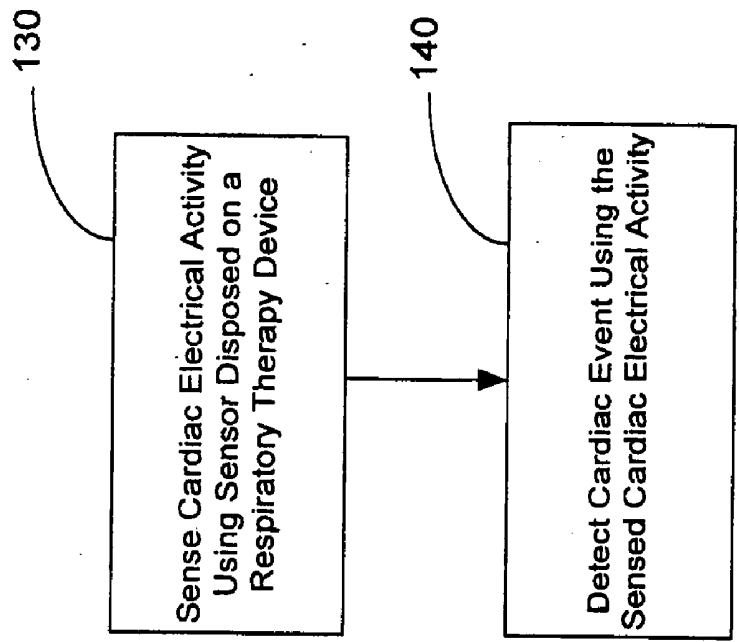


Figure 1B

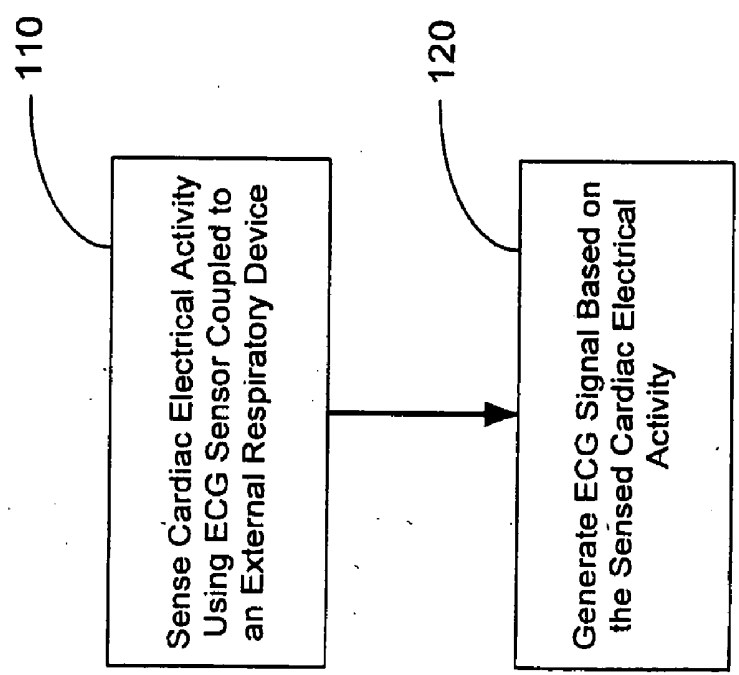


Figure 1A

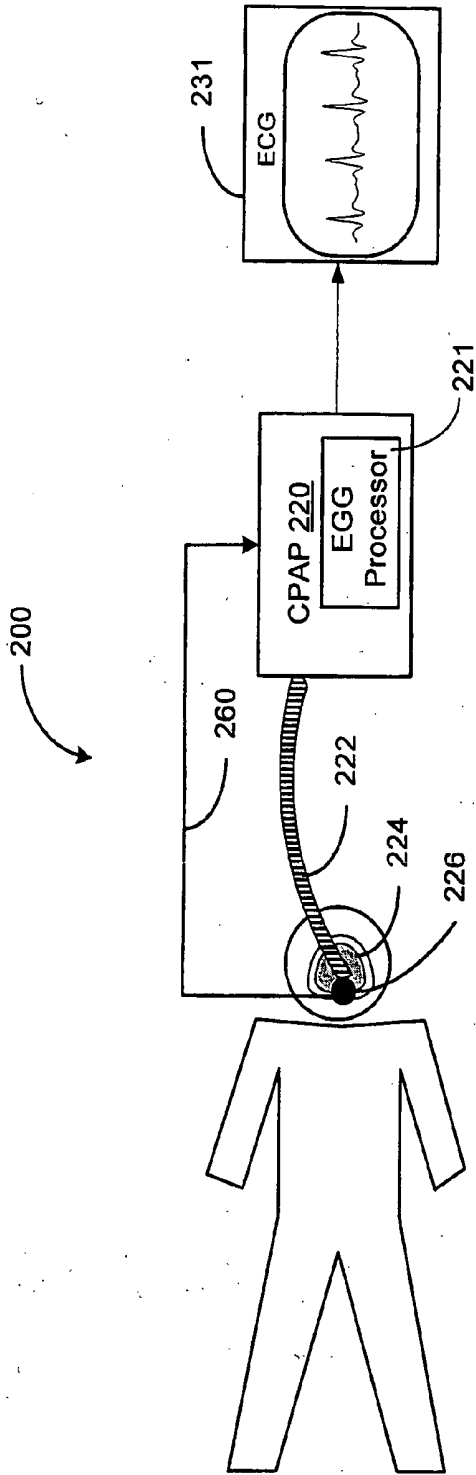


Figure 2A

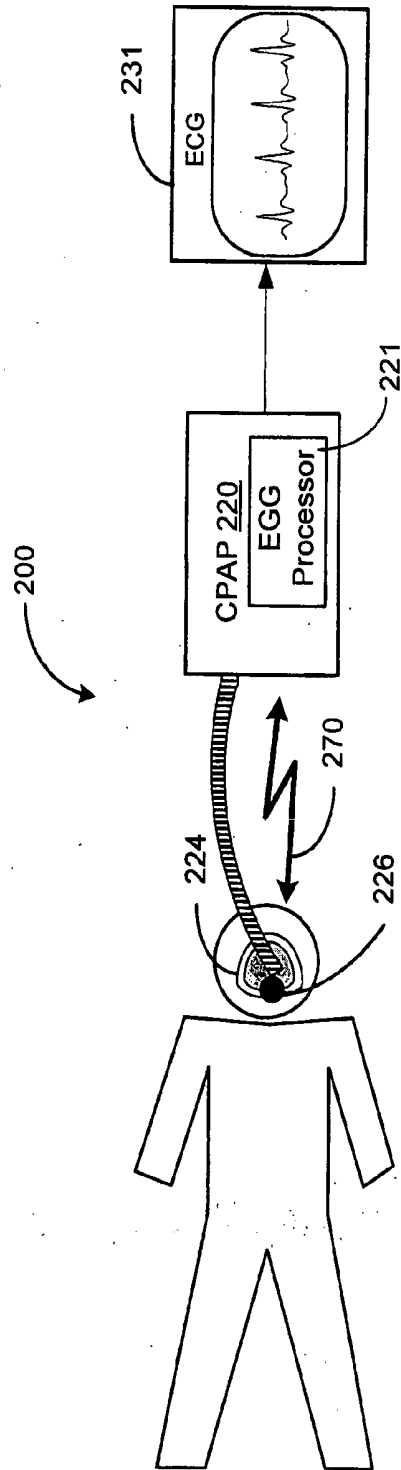


Figure 2B

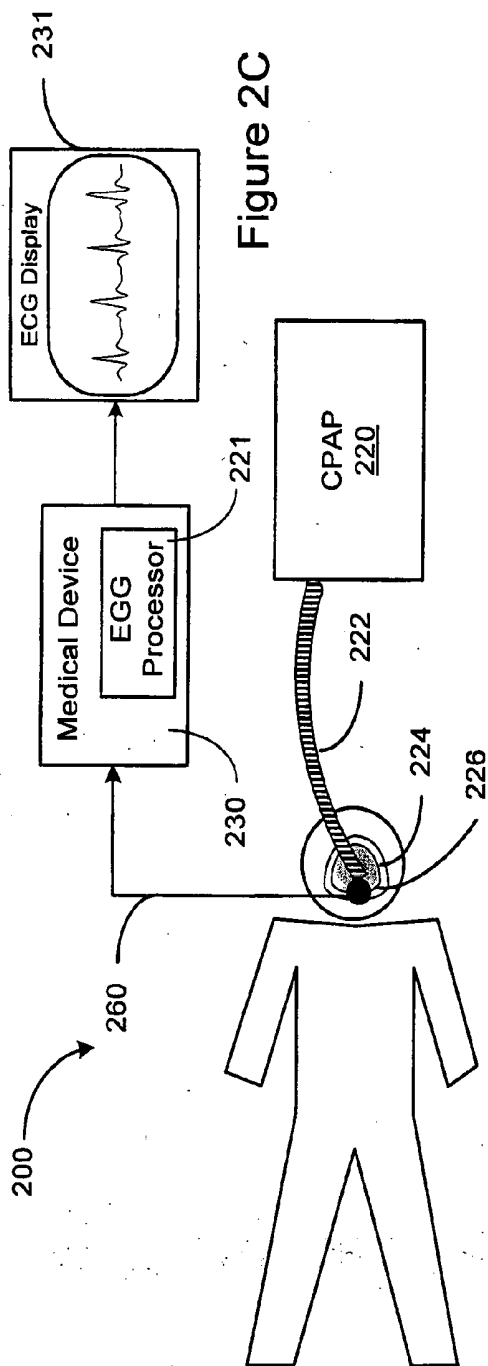


Figure 2C

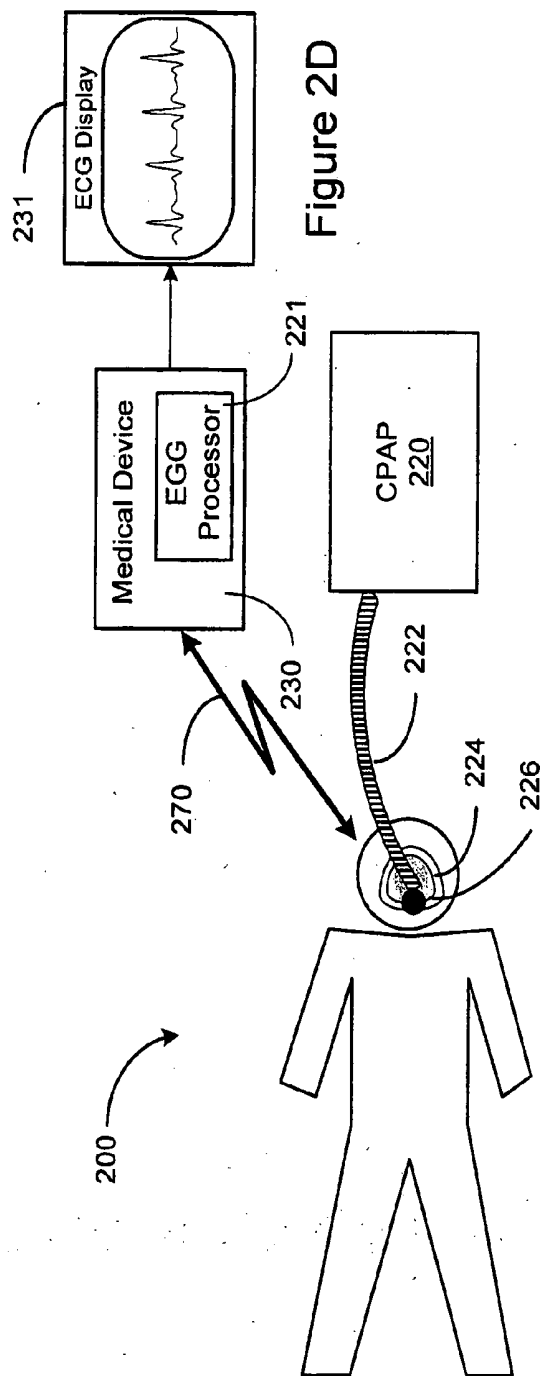


Figure 2D

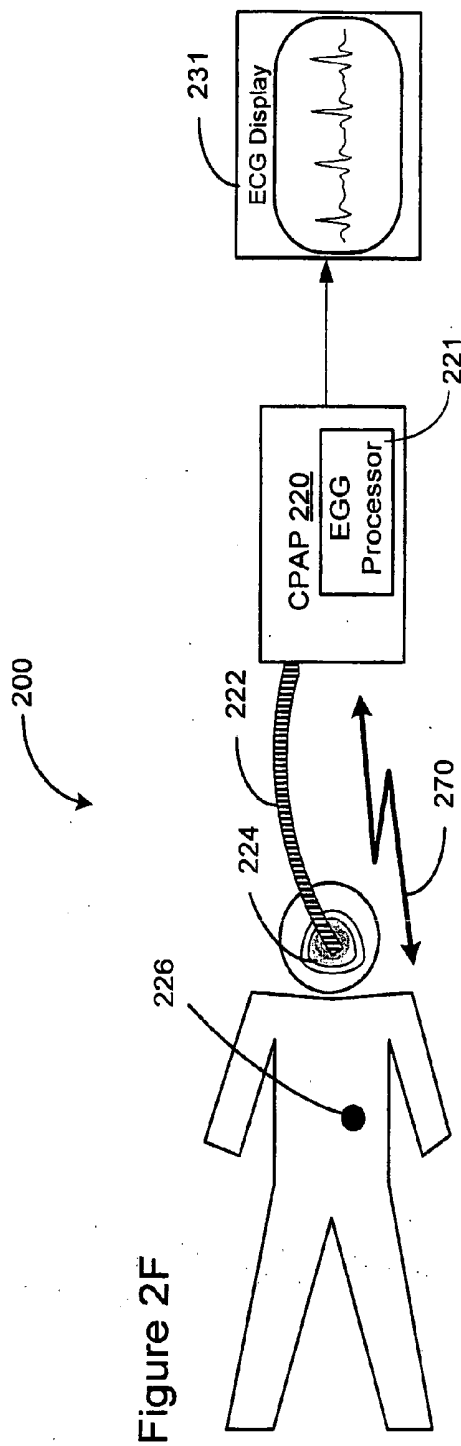
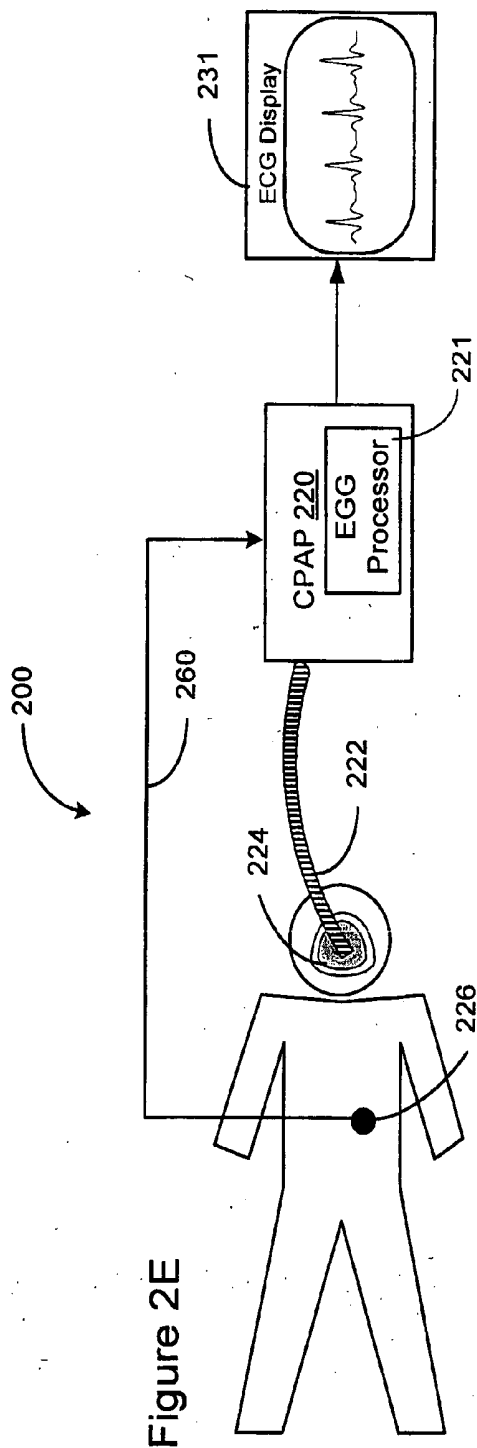


Figure 2G

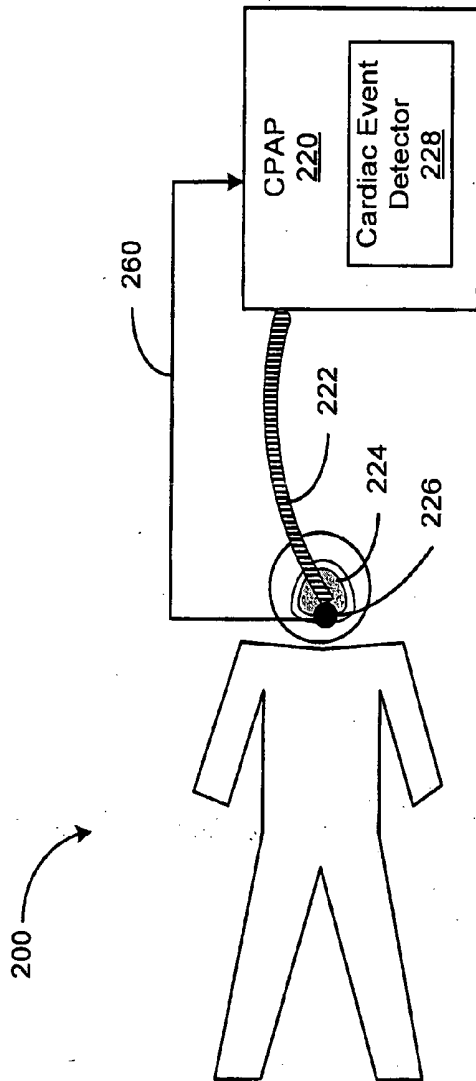


Figure 2H

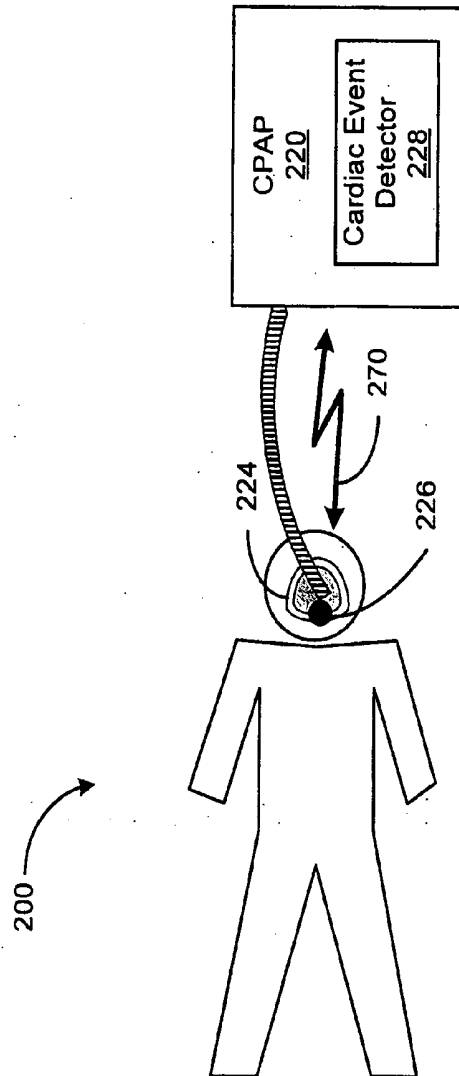


Figure 2I

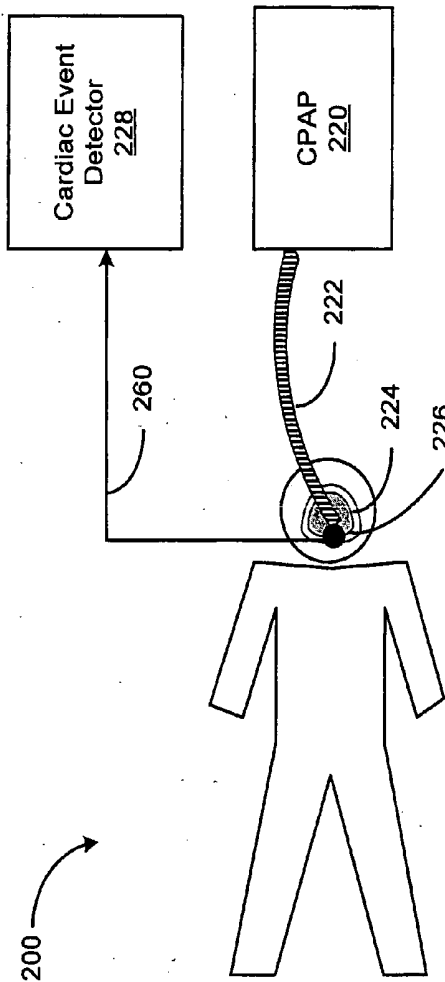
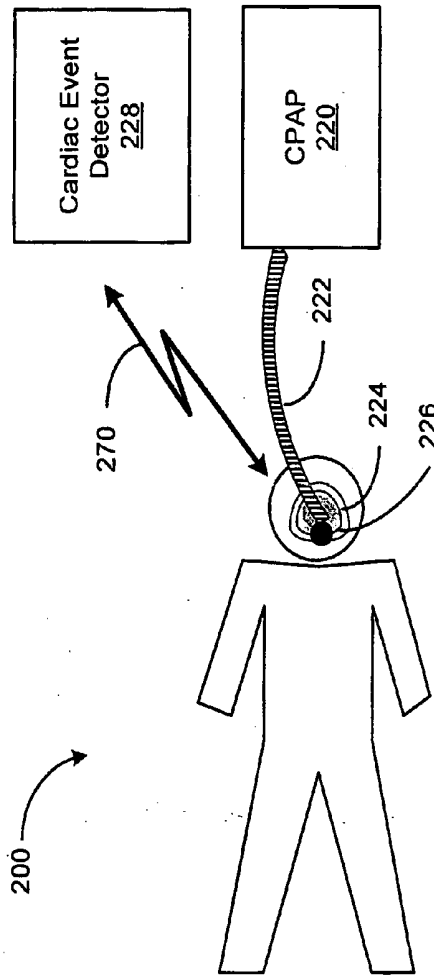


Figure 2J



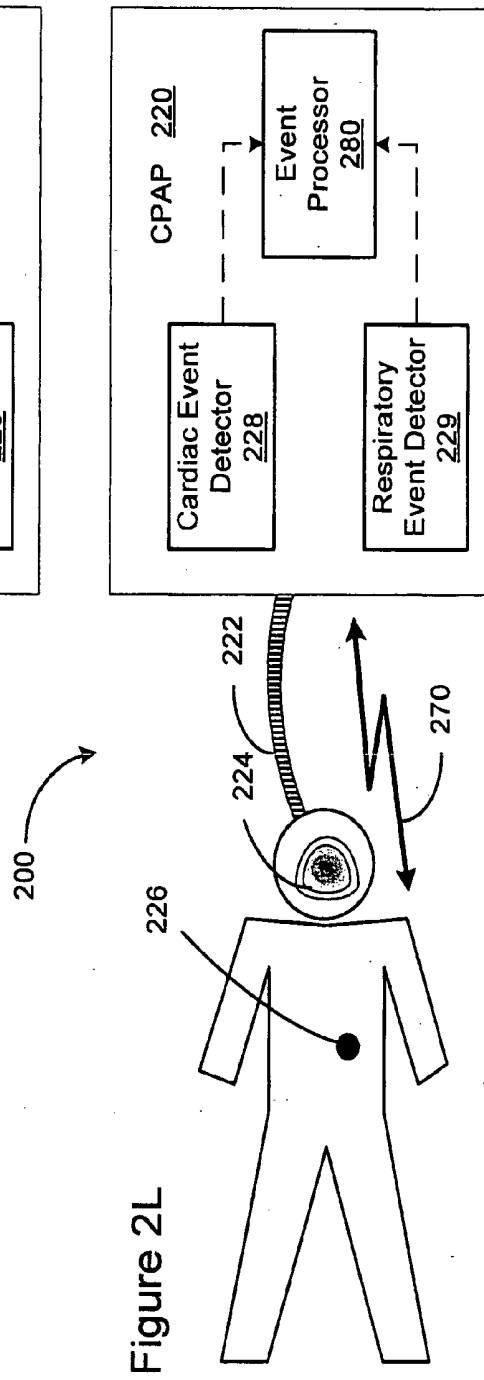
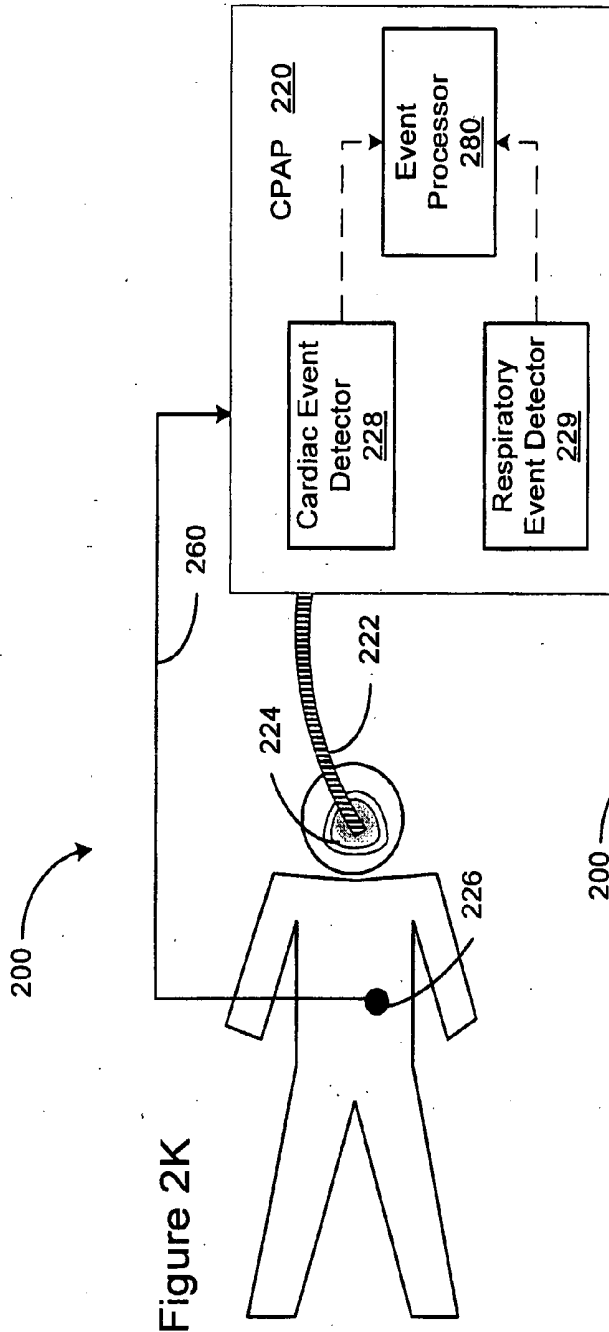


Figure 2M

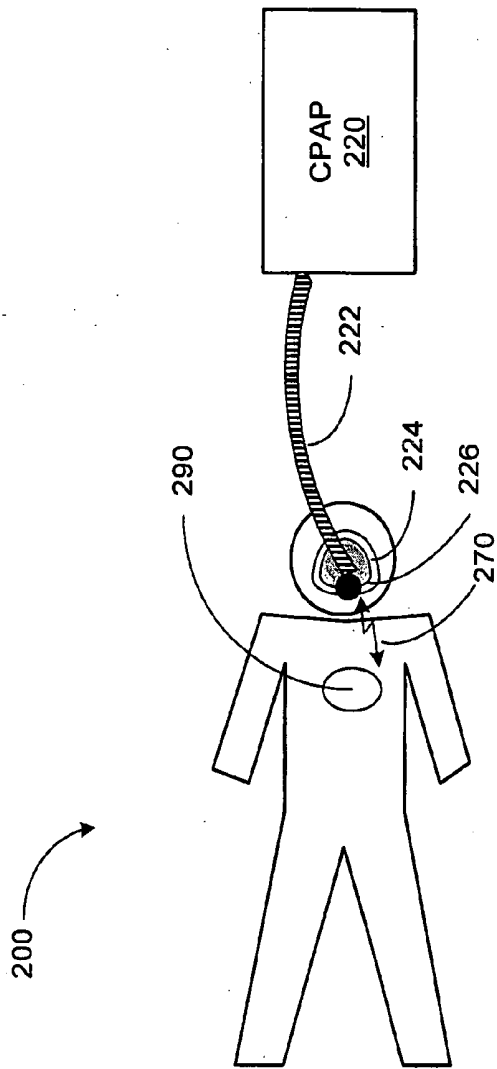
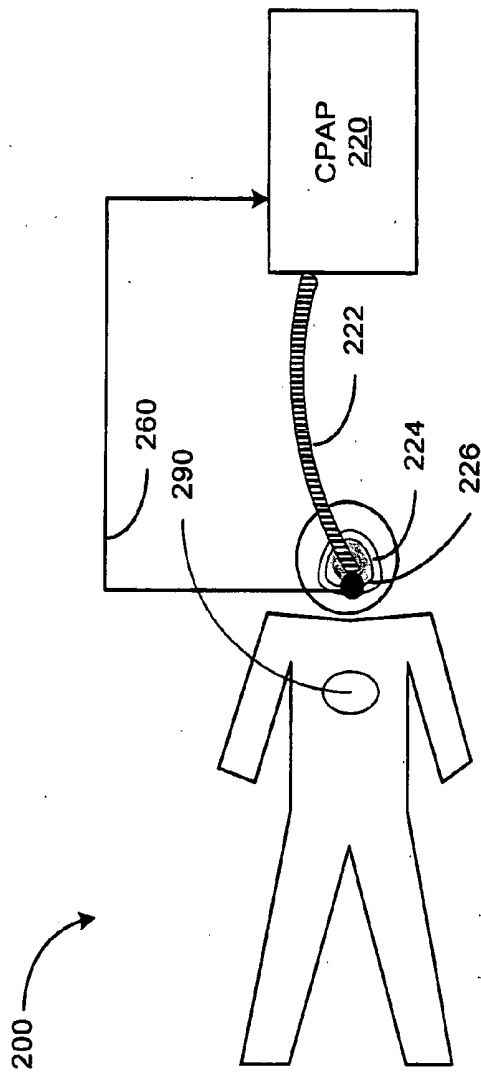


Figure 2N



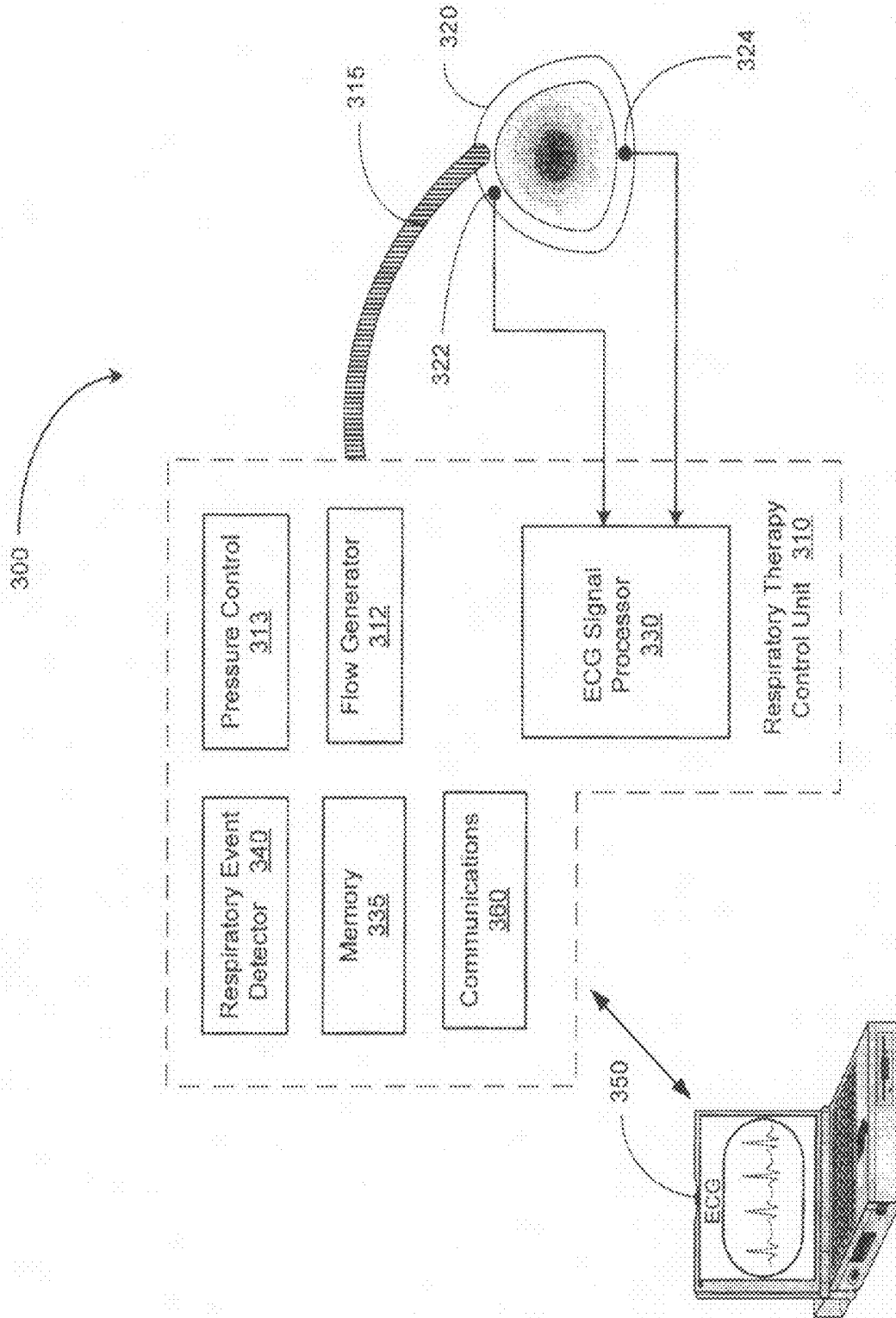


Figure 3A

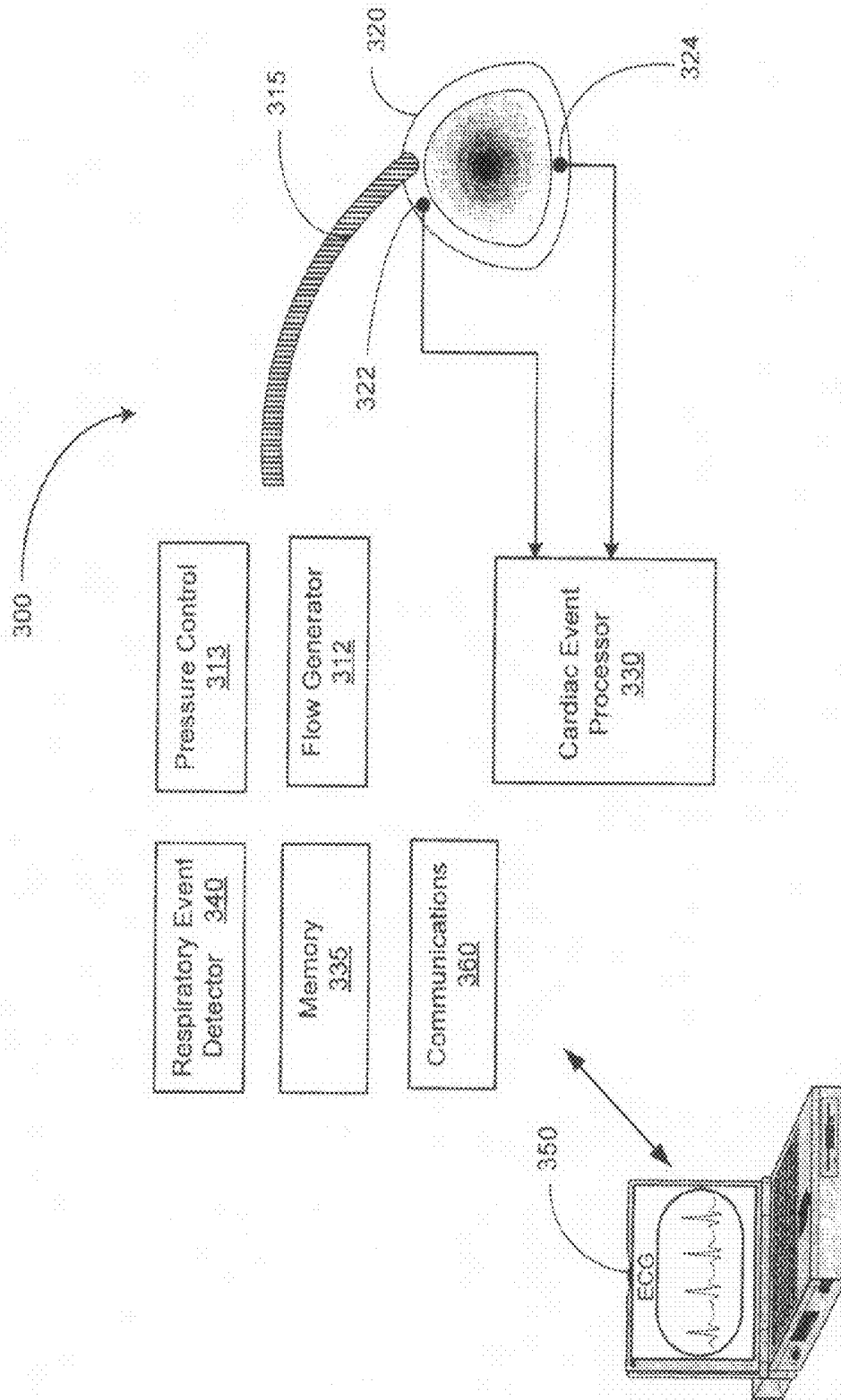


Figure 3B

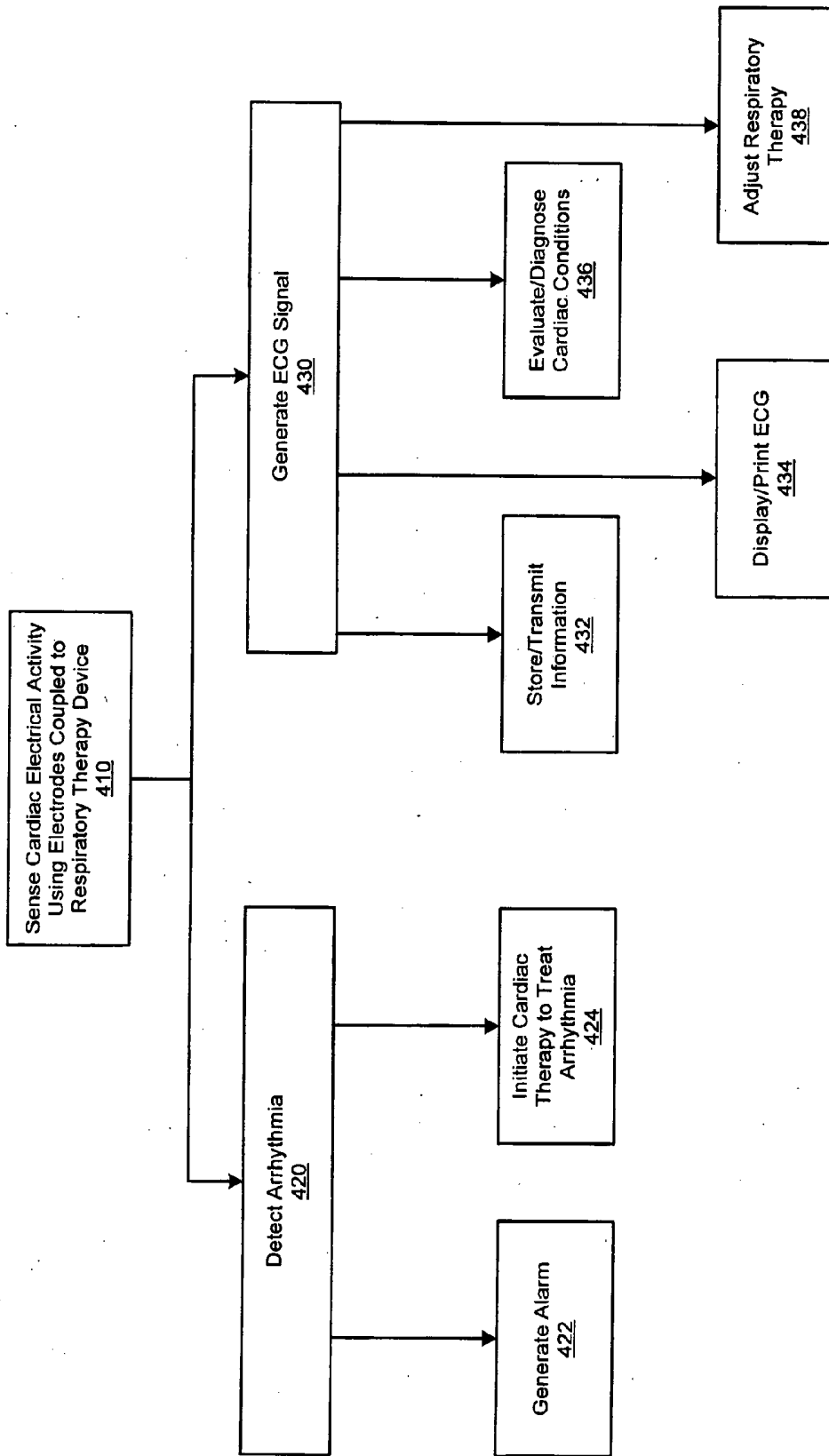


Figure 4

**USE OF EXTERNAL RESPIRATORY
THERAPY DEVICE TO DETECT CARDIAC
ELECTRICAL ACTIVITY**

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 10/922,351, filed on Aug. 19, 2004, which claims the benefit of Provisional Patent Application Ser. No. 60/504,356, filed on Sep. 18, 2003, to which Applicant claims priority under 35 U.S.C. §120 and 35 U.S.C. §119(e), respectively, and which are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

[0002] The present invention relates generally to methods and systems for detecting cardiac electrical activity using electrodes coupled to an external respiratory therapy device.

BACKGROUND OF THE INVENTION

[0003] The human body functions through a number of interdependent physiological systems controlled through various mechanical, electrical, and chemical processes. The metabolic state of the body is constantly changing. For example, as exercise level increases, the body consumes more oxygen and gives off more carbon dioxide. The cardiac and pulmonary systems maintain appropriate blood gas levels by making adjustments that bring more oxygen into the system and dispel more carbon dioxide. The cardiovascular system transports blood gases to and from the body tissues. The respiration system, through the breathing mechanism, performs the function of exchanging these gases with the external environment. Together, the cardiac and respiration systems form a larger anatomical and functional unit denoted the cardiopulmonary system.

[0004] Various disorders may affect the cardiovascular, respiratory, and other physiological systems. For example, heart failure is a clinical syndrome that impacts a number of physiological processes. Heart failure is an abnormality of cardiac function that causes cardiac output to fall below a level adequate to meet the metabolic demand of peripheral tissues. Heart failure is usually referred to as congestive heart failure (CHF) due to the accompanying venous and pulmonary congestion. Congestive heart failure may have a variety of underlying causes, including ischemic heart disease (coronary artery disease), hypertension (high blood pressure), and diabetes, among others.

[0005] Abnormal breathing patterns often occur in conjunction with congestive heart failure (CHF). A form of disordered breathing is known as periodic breathing (PB). In particular, a form of periodic breathing known as Cheyne-Stokes respiration (CSR) is commonly associated with poor prognosis when diagnosing CHF patients. Some studies have suggested that disordered breathing is related to a higher incidence of cardiac arrhythmia.

[0006] External breathing therapy may be prescribed for patients suffering from various types of breathing dysfunction. For example, positive airway pressure devices are often used to treat disordered breathing such as CSR and other types of disordered breathing. The positive airway pressure provided by the device acts as a pneumatic splint keeping the patient's airway open and reducing the severity and/or number of occurrences of disordered breathing events due to airway obstruction.

[0007] Effective approaches to monitoring and evaluating cardiac conditions in patients receiving therapy for respiratory disorders is desirable. The present invention fulfills these and other needs, and addresses other deficiencies of prior art implementations and techniques.

SUMMARY OF THE INVENTION

[0008] Various embodiments are directed to methods and systems for detecting cardiac electrical activity using an external respiratory therapy device. In accordance with one embodiment, a medical system includes one or more cardiac electrodes configured to sense cardiac electrical activity. The cardiac electrodes are coupled to an external respiratory therapy device. The cardiac electrical activity is used to generate an electrocardiogram (ECG) signal.

[0009] In accordance with another embodiment of the invention, a system includes sensors coupled to an external respiratory therapy device. The sensors are configured to sense electrical activity of a heart. A cardiac event detector is coupled to the one or more sensors and is configured to detect one or more cardiac events based on the sensed cardiac electrical activity.

[0010] Another embodiment of the invention involves a method for generating an electrocardiogram (ECG) signal. Cardiac electrical activity is sensed using one or more cardiac electrodes coupled to an external respiratory therapy device. The ECG signal is generated based on the sensed cardiac electrical activity.

[0011] A further embodiment involves detecting cardiac events. The method includes sensing cardiac electrical activity using one or more cardiac electrodes coupled to an external respiratory therapy device. The cardiac events are detected based on the sensed cardiac electrical activity.

[0012] The above summary of the present invention is not intended to describe each embodiment or every implementation of the present invention. Advantages and attainments, together with a more complete understanding of the invention, will become apparent and appreciated by referring to the following detailed description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIGS. 1A and 1B are flowcharts of methods involving the use of electrodes coupled to an external respiratory therapy device in accordance with embodiments of the invention;

[0014] FIGS. 2A-2D are block diagrams of external respiratory therapy devices having one or more electrodes mechanically coupled to the respiratory therapy mask assembly and used in connection with generating electrocardiogram (ECG) signals in accordance with embodiments of the invention;

[0015] FIGS. 2E-2F are block diagrams of external respiratory therapy devices having one or more electrodes communicatively coupled to the respiratory therapy device controller and used in connection with generating ECG signals in accordance with embodiments of the invention;

[0016] FIGS. 2G-2J are block diagrams of external respiratory therapy devices having one or more electrodes mechanically coupled to the respiratory therapy mask assembly and used in connection with detecting cardiac events in accordance with embodiments of the invention;

[0017] FIGS. 2K-2L are block diagrams of external respiratory therapy devices having one or more electrodes communicatively coupled to the respiratory therapy device controller and used in connection with detection of cardiac events in accordance with embodiments of the invention;

[0018] FIGS. 2M-2N are block diagrams of an external respiratory therapy device having cardiac electrodes communicatively coupled to an implantable medical device in accordance with embodiments of the invention;

[0019] FIG. 3A is a block diagram of an external respiratory therapy device including one or more electrodes mechanically coupled to the respiratory therapy mask assembly and a respiratory therapy controller incorporating an ECG signal processor in accordance with embodiments of the invention;

[0020] FIG. 3B is a block diagram of an external respiratory therapy device including one or more electrodes mechanically coupled to the respiratory therapy mask assembly and a respiratory therapy controller incorporating cardiac event detector in accordance with embodiments of the invention; and

[0021] FIG. 4 is a process flow diagram illustrating various optional processes that may be implemented using one or more electrodes coupled to an external respiratory therapy device.

[0022] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail below. It is to be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the invention is intended to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[0023] In the following description of the illustrated embodiments, references are made to the accompanying drawings which form a part hereof, and in which are shown by way of illustration, various embodiments by which the invention may be practiced. It is to be understood that other embodiments may be utilized, and structural and functional changes may be made without departing from the scope of the present invention.

[0024] Treatment of respiratory disorders may involve the use of an external respiratory therapy device. Respiratory therapy devices may include a respiratory mask assembly that fits over the patient's nose and/or face and directs a flow of gas to the patient. The mask assembly is connected through a tube to a control unit that controls the flow of air or other gas to the patient. Sensors on the mask, in the control unit, or elsewhere may facilitate control of the respiratory therapy delivered to the patient.

[0025] External respiratory therapy devices are often used to treat breathing disorders, such as sleep disordered breathing. Sleep apnea is a common form of sleep disordered breathing and is characterized by periods of interrupted breathing during sleep. Apnea and other types of disordered breathing may be caused blockage of the airway due to prolapse of soft tissue into the throat (obstructive apnea) and/or by derangement of the central nervous system signals controlling the breathing reflex. The cessation of breathing may occur repeatedly during sleep, sometimes hundreds of times a

night and sometimes for a minute or longer. Respiratory therapy for sleep disordered breathing typically involves the use of an external respiratory device during the night. The external respiratory therapy device delivers positive airway pressure to the patient. The positive air pressure acts as a pneumatic splint, keeping the patient's airway open and reducing episodes of disordered breathing.

[0026] Patient's suffering from respiratory disorders may concurrently experience cardiac dysfunction. Sleep apnea and cardiac arrhythmia are common comorbidities. Further, Cheyne-Stokes respiration is frequently observed in patients with congestive heart failure. Cheyne-Stokes respiration in congestive heart failure patients is associated with poor prognosis and may be used to track the progression of the disease. Cardiac arrhythmias have been associated with the hypoxia or autonomic arousal from sleep disordered breathing.

[0027] Although cardiac conditions and respiratory disorders are commonly found in combination, monitoring and/or treatment of the disorders is generally accomplished using separate medical devices. Respiratory disorders such as disordered breathing have traditionally been treated using the above-described external respiratory therapy devices. Monitoring cardiac conditions such as cardiac arrhythmia may be accomplished using a patient worn or carried monitor, for example, a Holter monitor, having electrodes attached to the patient's chest for detecting cardiac electrical activity. Cardiac conditions such as arrhythmia and congestive heart failure may also be monitored and/or treated using an implantable cardiac rhythm management (CRM) system.

[0028] The nightly use of an external respiratory therapy device by the patient provides an opportunity to detect and/or diagnose cardiac disorders in addition to respiration disorders. Embodiments of the invention involve the use of cardiac sensors used in cooperation with a respiratory therapy device. The cardiac sensors sense cardiac electrical activity used to generate an electrocardiogram signal. Further embodiments of the invention involve detecting cardiac arrhythmia based on the sensed cardiac electrical activity.

[0029] FIGS. 1A and 1B are flowcharts illustrating methods of using a cardiac electrical activity sensor disposed on a respiratory therapy device in accordance with embodiments of the invention. One or more electrodes are disposed 110, 130 on a respiratory therapy device in locations that facilitate sensing cardiac electrical activity. The electrodes may be positioned on a respiratory mask, mask strap, or in other locations of the respiratory therapy device from which cardiac signals can be sensed. In one embodiment, the sensed cardiac electrical activity is used 120 to generate an electrocardiogram (ECG) signal. In another embodiment, the sensed cardiac electrical activity signal is used 140 to detect arrhythmia.

[0030] FIGS. 2A-2F illustrate various embodiments for sensing cardiac activity and generating ECG signals using electrodes coupled to an external respiratory therapy device. In some embodiments, cardiac electrodes disposed on the mask of an external respiratory device sense cardiac signals. Circuitry coupled to the electrodes generates an ECG waveform. The ECG waveform generating circuitry coupled to the electrodes may be disposed on the mask, within the CPAP controller, or in another location.

[0031] In the illustrative examples presented herein, the external respiratory therapy device is configured as a continuous positive airway pressure (CPAP) device 220 including a controller 220, tubing 222, and respiratory mask apparatus

224. Any type of external respiratory therapy device other than CPAP can alternatively be used, such as bi-level positive airway pressure devices, auto titrating positive airway pressure devices, nebulizers, respirators, ventilators, and other external respiratory therapy devices. The CPAP controller **220** develops a positive air pressure that is delivered to the patient's airway through tubing **222** and mask assembly **224**. The positive airway pressure provided by the respiratory therapy device **200** acts as a pneumatic splint keeping the patient's airway open and reducing the severity and/or number of occurrences of disordered breathing due to airway obstruction.

[0032] A typical CPAP device delivers air pressure through a nasal mask worn by the patient. The application of continuous positive airway pressure keeps the patient's throat open, reducing or eliminating the obstruction causing apnea. Positive airway pressure devices may be used to provide a variety of respiration therapies, including, for example, continuous positive airway pressure (CPAP), bi-level positive airway pressure (bi-level PAP), proportional positive airway pressure (PPAP), auto-titrating positive airway pressure, ventilation, gas or oxygen therapies. Some positive airway pressure devices may also be configured to provide both positive and negative pressure, such that negative pressure is selectively used (and de-activated) when necessary, such as when treating Cheyne-Stokes breathing, for example. The term CPAP will be used herein as a generic term for any device using forms of positive airway pressure (and negative pressure when necessary), whether continuous or otherwise.

[0033] In some embodiments (FIGS. 2A-2D), the one or more cardiac electrodes **226** are mechanically coupled to the respiratory therapy device **200**. The electrodes **226** may be positioned on the mask assembly **224** of the external respiratory device **200**. For example, electrodes **226** may be positioned on the mask, mask strap, or other appropriate location on the mask assembly in a location that facilitates sensing cardiac electrical activity. The mask assembly **224** serves to hold the electrodes **226** in place while the external respiration therapy is delivered to the patient.

[0034] In some configurations, the electrodes **226** are coupled to an ECG processor **221** that uses the cardiac signals sensed by the electrodes **226** to generate an ECG waveform. The ECG processor **221** may be disposed, for example, within or on the CPAP controller unit. The electrodes **226** may be coupled to the ECG processor **221** through a wire lead **260**.

[0035] In some implementations, the ECG processor **221** may be positioned proximate the electrodes **226**, for example, on the respiratory mask assembly. This configuration facilitates generation of an ECG waveform that may be transmitted via a wireless communications link **270** to the CPAP controller **220** or other medical devices **230**.

[0036] The ECG waveform generated by the ECG processor **221** may be printed on a printing device, displayed on a display device **231**, stored in memory, and/or analyzed by circuitry disposed within the CPAP controller **220** and/or the cooperating medical device **230**.

[0037] If the patient uses the external respiratory therapy device regularly, for example each night, data acquisition via the electrodes **226** coupled to the external respiratory device **200** allows a significant amount of information about the patient's cardiac functioning to be collected during each sleep period. In some implementations, the cooperating medical device **230** may comprise a patient-worn or patient-carried device. In other implementations, the medical device **230**

may comprise an implantable device, for example, an implantable monitor or implantable therapy device.

[0038] In some embodiments (FIGS. 2C and 2D), the ECG processor **221** may be disposed within the medical device **230**. The medical device **230** may additionally include circuitry for storing and/or analyzing the ECG signals. Information about the ECG signals may be downloaded from the medical device **230** to an external device for display, analysis, or storage, for example.

[0039] In one configuration, the electrodes **226** may be communicatively coupled to the external device **230** through a wire lead **260**. In another configuration, additional circuitry, e.g., amplifiers and/or transmitter circuitry, may be used to provide a wireless link **270** between the cardiac electrodes **226** and the device **230**.

[0040] In some embodiments (FIGS. 2E and 2F), one or more cardiac electrodes **226** may be positioned on the patient's chest, or another location suitable for sensing cardiac electrical activity. The cardiac electrodes may be communicatively coupled to the external respiratory device **200**. For example, the sensors may be communicatively coupled to the CPAP controller **220** through a wire lead **260** (FIG. 2E). Alternatively, additional circuitry may be situated proximate the electrodes to facilitate communication with the CPAP controller **220** through a wireless communications link **270** (FIG. 2F).

[0041] FIGS. 2G-2L illustrate embodiments of the invention involving cardiac event detection using one or more cardiac electrodes **226** coupled to an external respiratory therapy device **200**. In some embodiments (FIGS. 2G-2J), the electrodes **226** are mechanically coupled to the respiratory mask apparatus **224**. The respiratory mask apparatus **224** serves as a support for the electrodes **226** positioning the electrodes against the patient's face to facilitate sensing cardiac electrical activity. The electrodes **226** are coupled to an external or implantable cardiac event detector **228** through wired **260** or wireless **270** connections. In some embodiments (FIGS. 2G and 2H), the cardiac event detector **228** is disposed within or on the CPAP controller **220** housing. In other embodiments (FIGS. 2I and 2J), cardiac event detector **228** circuitry is separate from the CPAP controller **220**.

[0042] FIGS. 2K and 2L illustrate embodiments of the invention wherein one or more cardiac electrodes **226** are positioned on the patient's chest or other location suitable for sensing cardiac electrical activity. The electrodes are coupled to a cardiac event detector **228** of an external respiratory therapy device **200**. The electrodes **226** may be coupled to the cardiac event detector **228** through a wire lead **260** or through a wireless connection **270**.

[0043] The CPAP device **220** may optionally include a respiratory event detector **229**. In accordance with one implementation, the respiratory event detector may be used to provide feedback for therapy control. For example, CPAP therapy may be initiated or adjusted based on the presence, absence, severity, frequency and/or duration of disordered breathing events detected by the respiratory event detector.

[0044] If a respiratory event detector is included, the respiratory event detector and the cardiac event detector may be coupled to an event processor **280**. The event processor **280** may be used to detect physiological events, including events affecting one or more of the cardiac and pulmonary systems based on inputs from the cardiac and respiratory event detectors. The cardiac event detector, respiratory event detector and/or event processor may be employed to detect various

cardiac and/or respiratory dysfunctions, including, for example, bradycardia, tachycardia, including atrial tachyarrhythmia, ventricular tachyarrhythmia and ventricular fibrillation, myocardial ischemia, and/or myocardial infarction. The event processor may compare occurrences of respiratory and cardiac events including one or more of the timing, severity, type, and occurrence rate of the respiratory and cardiac events and detect the physiological events based on these and/or other factors.

[0045] The cardiac event detection circuitry illustrated, for example, in FIGS. 2I and 2J may be implemented in a patient carried or patient worn device, or in an implantable device such as a cardiac defibrillator or pacemaker.

[0046] FIG. 2M illustrates an embodiment of the invention wherein one or more cardiac electrodes 226, and circuitry used to establish a wireless communications link 270, are disposed on the CPAP mask assembly 224. In FIG. 2M, signals sensed by the cardiac electrodes are transmitted to an implantable device 290, bypassing the CPAP controller 220.

[0047] The implantable device 290 may comprise, for example, an implantable therapy device, such as an implantable electrical stimulation device or implantable drug pump. The implantable device may comprise an implantable monitor. In one implementation, the implantable device 290 may comprise an implantable pacemaker, defibrillator, cardioverter, cardiac resynchronizer, or other cardiac therapy devices that receives the ECG signals. In another implementation, the implantable device 290 may comprise an implantable loop recorder, such as a subcutaneous ECG recorder. The implantable device may include a cardiac event detector that analyzes the ECG signals to detect cardiac events including cardiac arrhythmia, ischemia, and/or myocardial infarction.

[0048] FIG. 2N illustrates an embodiment wherein the cardiac electrodes 226 are coupled to the CPAP device 220 through a wire lead. Signals received by the CPAP device 220 may be wirelessly transmitted to the implantable device 290 for storage, analysis or for other purposes.

[0049] FIGS. 3A and 3B are block diagrams of a medical system including an external respiratory therapy device that may be used in connection with sensing cardiac electrical activity. FIG. 3A illustrates an embodiment that directed to generating an electrocardiogram signal in accordance with the invention. FIG. 3B illustrates an embodiment that uses the sensed electrical cardiac activity to detect arrhythmia.

[0050] FIGS. 3A and 3B depict block diagrams of a CPAP device 300 having cardiac sensing capabilities in accordance with the present invention. The CPAP device includes a CPAP controller 310, tubing 315, and mask assembly 320. The CPAP controller unit may include a respiratory event detector 340 configured to detect disordered breathing episodes, such as sleep apnea and/or hypopnea. Detection of disordered breathing may be used to initiate or adjust respiratory therapy delivered to the patient.

[0051] The CPAP controller unit 310 includes flow generator 312 that pulls in air through a filter. The flow generator 312 is controlled by the pressure control circuitry 313 to deliver an appropriate air pressure to the patient. Air flows through tubing 315 coupled to the CPAP device 310 and is delivered to the patient's airway through the mask assembly 320. The CPAP controller 310 may be coupled through communications circuitry 360 to other computing devices 350, such as a programmer or patient management server to facilitate storage, evaluation and/or display of the cardiac information.

[0052] In embodiments of the present invention, the mask apparatus 320 may comprise a nasal mask covering only the patient's nose. In other configurations the mask covers the patient's nose and mouth. One or more cardiac electrodes may be coupled to the CPAP device 300. For example, the one or more cardiac electrodes 322, 324 may be incorporated on the respiratory therapy mask 320. However, the one or more cardiac electrodes 322, 324 can be positioned in another location of the respiratory therapy device that facilitates acquisition of a cardiac signal. For example, electrodes 322 can be incorporated in a respiratory mask strap (not shown).

[0053] As illustrated in FIG. 3A, the cardiac electrodes 322, 324 are communicatively coupled to signal processing circuitry 330 within the CPAP controller 310. The cardiac activity information is used to generate an electrocardiogram signal. The ECG signal can be used by the CPAP control unit 310 to control the external respiratory therapy delivered to the patient. Additionally or alternatively, the ECG signal can be stored in memory 335, used to generate an ECG display or printout, and/or evaluated for diagnostic or therapeutic purposes.

[0054] FIG. 3B illustrates a block diagram of an embodiment of the invention that involves detection of cardiac arrhythmia. In this configuration, cardiac electrodes 322, 324 positioned on the respiratory mask 320, sense cardiac electrical activity. The electrodes 322, 324 are coupled to an arrhythmia detector 360 disposed within a housing of the respiratory therapy control unit 310. The cardiac event detector 360 uses the cardiac electrical activity sensed by the electrodes 322, 324 to detect cardiac events, such as bradycardia, ventricular tachyarrhythmia, ventricular fibrillation, and/or other arrhythmic events. In one implementation, the cardiac event detector 360 may evaluate the cardiac electrical activity to determine heart rate and detect arrhythmia based on heart rate. In another implementation, the arrhythmia detector 360 may analyze the morphology of the cardiac electrical activity signal and detect arrhythmia based on the morphology of the cardiac electrical activity signal. Other methods of arrhythmia detection are possible.

[0055] FIG. 4 illustrates various optional processes that may be facilitated using cardiac electrodes coupled to a respiratory therapy device. Cardiac electrical activity is sensed using electrodes coupled to an external respiratory therapy device 410. According to one aspect of the invention, the sensed cardiac activity may be used to detect arrhythmia 420. If arrhythmia is detected, an alarm may be generated 422, such as an audible or visual alarm. The alarm may include various tones or signals to indicate more than one type of arrhythmic condition, for example. In one implementation, the alarm may involve wireless communication with a remote device, such as a cell phone or pager, for example.

[0056] The sensed cardiac activity may be used to generate 430 an ECG signal. The ECG signal may be stored and/or transmitted 432 to a separate device. For example, the ECG signal may be transmitted to a patient management server for further analysis. The ECG waveform may be displayed 434 on a display device or printed. The ECG signal may be used to initiate cardiac therapy 424 to treat an arrhythmia.

[0057] Detected cardiac events and detected respiratory events may also be analyzed to determine relationships between cardiac and respiratory events. The results of this comparison may be displayed, stored, transmitted or used to modify cardiac or respiratory therapy.

[0058] Acquisition of ECG signals over a period of time may be used to trend cardiac conditions and/or diagnose **436** cardiac dysfunction, for example. Further, the ECG signals may be evaluated may be used to adjust **438** the patient's therapy, such as the external respiratory therapy delivered to the patient.

[0059] The ECG signal may be analyzed to detect morphological characteristics and/or cardiac timing measurements indicative of heart status including, for example, RR interval, PP interval, AV interval, PR interval, QT interval and/or ST elevation. The ECG signal may be used to determine statistics derived from heart rates, such as heart rate variability and various cardiac timing measurements, including RR timings and AV delay timing. Various cardiac events and/or other indications of heart status may be determined based on the ECG signal, including arrhythmia, myocardial ischemia, and/or other events. These analyses may be used to identify patient's cardiac condition and adjust therapy.

[0060] A number of the examples presented herein involve block diagrams illustrating functional blocks used for in accordance with embodiments of the present invention. It will be understood by those skilled in the art that there exist many possible configurations in which these functional blocks can be arranged and implemented. The examples depicted herein provide examples of possible functional arrangements used to implement the approaches of the invention. The components and functionality depicted as separate or discrete blocks/elements in the figures in general can be implemented in combination with other components and functionality. The depiction of such components and functionality in individual or integral form is for purposes of clarity of explanation, and not of limitation. It is also understood that the components and functionality depicted in the Figures and described herein can be implemented in hardware, software, or a combination of hardware and software.

[0061] Methods, devices, and systems in accordance with the present invention may incorporate one or more of the features, structures, methods, or combinations thereof described herein below. For example, a medical system may be implemented to include one or more of the features and/or processes described below. It is intended that such a method, device, or system need not include all of the features and functions described herein, but may be implemented to include one or more selected features and functions that provide unique structures and/or functionality.

[0062] Various modifications and additions can be made to the preferred embodiments discussed hereinabove without departing from the scope of the present invention. Accordingly, the scope of the present invention should not be limited by the particular embodiments described above, but should be defined only by the claims set forth below and equivalents thereof.

What is claimed is:

1. A method, comprising:

sensing cardiac electrical activity using one or more cardiac electrodes coupled to an external respiratory therapy device, the therapy device delivering external respiratory therapy to a patient;

generating, by circuitry disposed within the therapy device housing, an electrocardiogram (ECG) signal based on the sensed cardiac electrical activity;

collecting, in memory of the therapy device, information based at least in part on the ECG signal, the information spanning a period of multiple uses of the respiratory therapy device; and

trending cardiac conditions of the patient over the period of multiple uses based on the collected information.

2. The method of claim 1, further comprising controlling an implantable cardiac therapy device using the collected information.

3. The method of claim 1, wherein further comprising monitoring the cardiac progression of heart failure using the collected information.

4. The method of claim 3, further comprising treating the heart failure via an implantable device.

6. The method of claim 1, further comprising determining heart rate variability using the collected information.

7. The method of claim 1, further comprising:
detecting arrhythmia based on the cardiac electrical activity;

sensing patient respiration;

detecting respiratory events based on the patient respiration;

8. The method of claim 7, further comprising adjusting the respiratory therapy based on the detected respiratory events.

9. The method of claim 7, further comprising initiating cardiac therapy based on detection of arrhythmia.

10. The method of claim 1, further comprising:
sensing patient respiration;
detecting respiratory events based sensed respiration; and
detecting cardiac events based on the ECG signal.

11. The method of claim 10, further comprising controlling the patient external respiratory therapy based on the respiratory events and the cardiac events.

12. The method of claim 10, further comprising controlling an implantable cardiac therapy based on the respiratory events and the cardiac events.

controlling the respiratory therapy based on the detected cardiac events and the detected respiratory events.

13. A medical system, comprising:

an external respiratory therapy device configured to deliver an external respiratory therapy to a patient, the respiratory therapy device including:

a respiratory event detector configured to detect respiratory events;

control circuitry configured to adjust the respiratory therapy based on the detected respiratory events;

one or more cardiac electrodes configured to sense cardiac electrical activity;

circuitry, disposed within the respiratory therapy device housing, configured to generate an electrocardiogram (ECG) signal based on the sensed cardiac electrical activity;

a cardiac event detector configured to detect cardiac events based on the ECG signal;

memory circuitry, disposed within the respiratory therapy device housing, the memory circuitry configured to collect information based at least in part on the ECG signal, the collected information stored during each of multiple uses of the respiratory therapy device; and

a processor configured to analyze cardiac conditions of the patient over the period of multiple uses based on the collected information.

14. The medical system of claim **13**, wherein cardiac event detector is configured to detect arrhythmia.

15. The medical system of claim **13**, wherein processor is configured to develop a trend of one or more cardiac conditions related to heart failure.

16. The medical system of claim **13**, wherein the processor is configured to develop a trend of cardiac and respiratory conditions related to heart failure.

17. The medical system of claim **13**, wherein the processor is configured to determine relationships between the cardiac events and the respiratory events.

18. The medical system of claim **13**, wherein the processor is configured to monitor progression of heart failure based on the collected information.

19. The medical system of claim **13**, wherein the processor is configured to diagnose cardiac disorders and respiratory disorders based on the collected information.

20. The medical system of claim **13**, wherein the ECG signals are not used to control the respiratory therapy.

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专利名称(译)	使用外部呼吸治疗设备来检测心脏电活动		
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[标]申请(专利权)人(译)	STAHMANN JEFFREYê 哈特利JESSEW LEE KENT 倪泉		
申请(专利权)人(译)	STAHMANN JEFFREYê 哈特利JESSEW LEE KENT NI QUAN		
当前申请(专利权)人(译)	STAHMANN JEFFREYê 哈特利JESSEW LEE KENT NI QUAN		
[标]发明人	STAHMANN JEFFREY E HARTLEY JESSE W LEE KENT NI QUAN		
发明人	STAHMANN, JEFFREY E. HARTLEY, JESSE W. LEE, KENT NI, QUAN		
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摘要(译)

方法和系统提供呼吸和心脏监测，诊断和/或治疗的综合方法。医疗系统包括耦合到外部呼吸治疗设备的一个或多个心脏电极。心脏电极感测用于产生心电图 (ECG) 信号的心脏电活动。可以基于感测的心脏电活动检测心律失常，心肌梗塞和/或局部缺血等心脏事件。

