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(54) **SYSTEMS, APPARATUS, AND METHODS FOR DOCUMENTING CODE BLUE SCENARIOS**

(71) Applicant: **LOS ANGELES BIOMEDICAL RESEARCH INSTITUTE AT HARBOR-UCLA MEDICAL CENTER**, Torrance, CA (US)

(72) Inventor: **Ruey-Kang CHANG**, Diamond Bar, CA (US)

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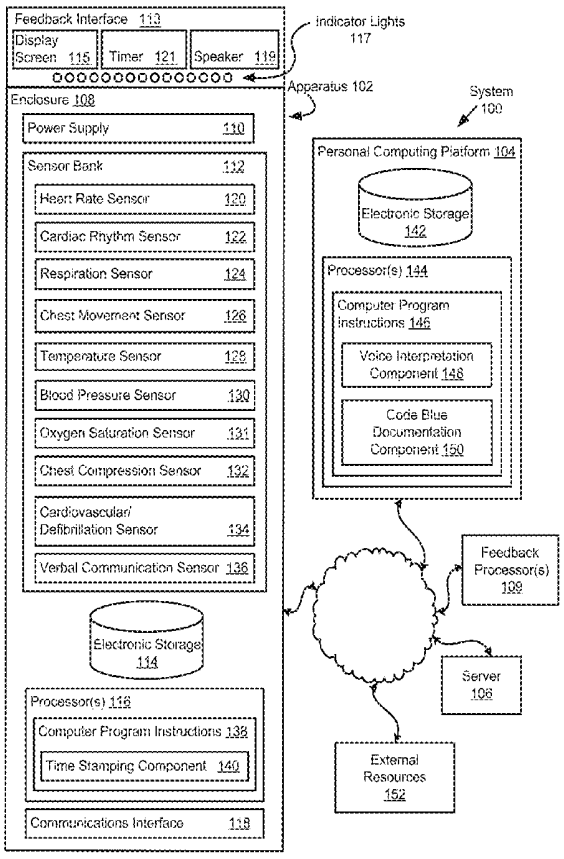
(57) **ABSTRACT**

An apparatus may be configured for providing feedback to caregivers during a code blue scenario when adhered to the chest of a subject undergoing resuscitation by sensing and transmitting information associated with the code blue scenario. Such information may include one or more of vital signs of the subject during resuscitation, information associated with chest movements of the subject during resuscitation, and audio information from an environment of the subject during resuscitation. One or more processors may generate real-time feedback for communication to the caregivers during the code blue scenario based on the sensed and transmitted information.



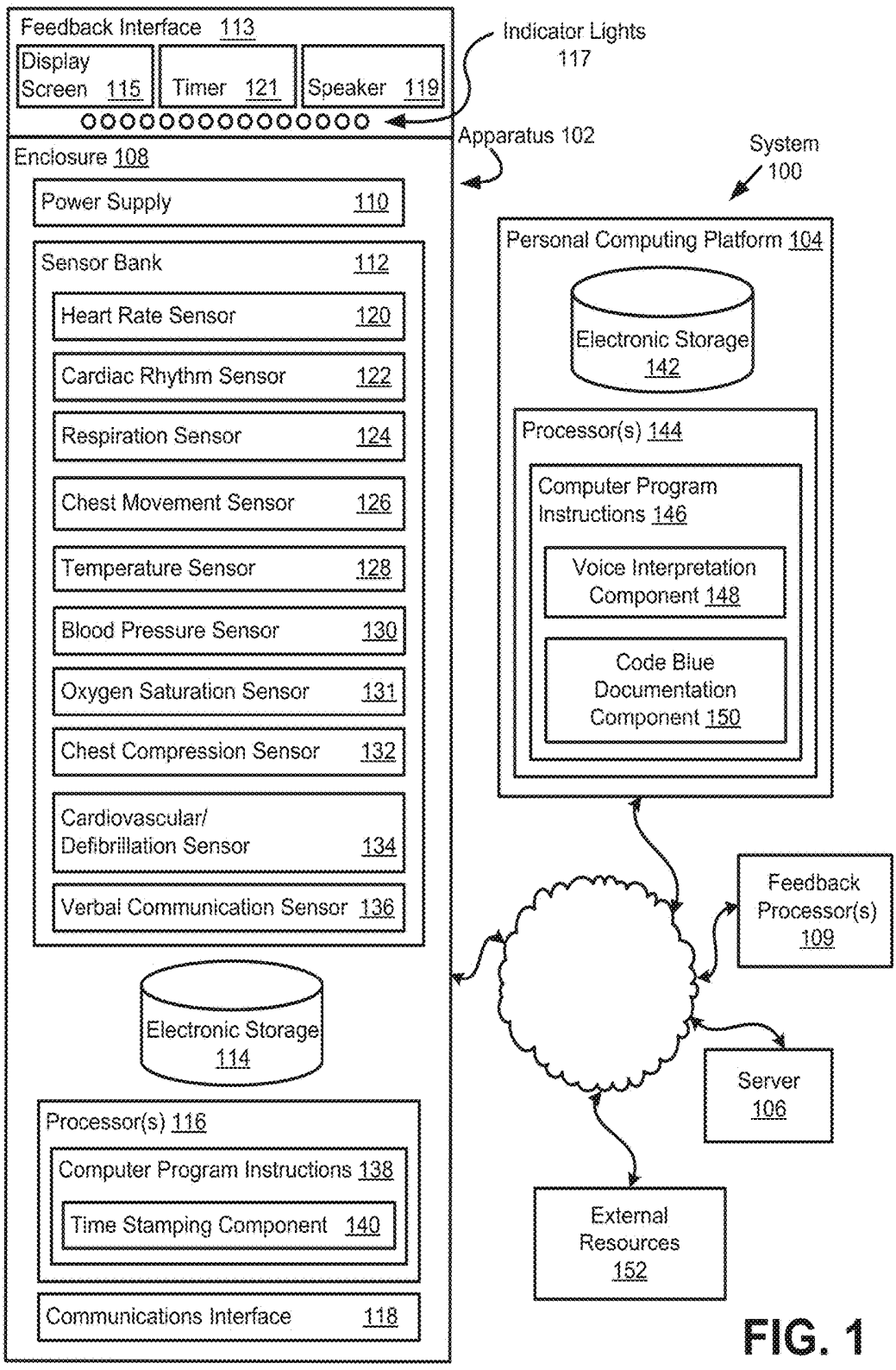

Feedback Interface 113
Display Screen 115
Timer 121
Speaker 119
Indicator Lights 117
Apparatus 102
System 100
Enclosure 108
Power Supply 110
Sensor Bank 112
Heart Rate Sensor 120
Cardiac Rhythm Sensor 122
Respiration Sensor 124
Chest Movement Sensor 126
Temperature Sensor 128
Blood Pressure Sensor 130
Oxygen Saturation Sensor 131
Chest Compression Sensor 132
Cardiovascular/ Defibrillation Sensor 134
Verbal Communication Sensor 136
Electronic Storage 114
Processor(s) 116
Computer Program Instructions 138
Time Stamping Component 140
Communications Interface 118
Personal Computing Platform 104
Electronic Storage 142
Processor(s) 144
Computer Program Instructions 146
Voice Interpretation Component 148
Code Blue Documentation Component 150
Feedback Processor(s) 109
Server 106
External Resources 152

FIG. 1

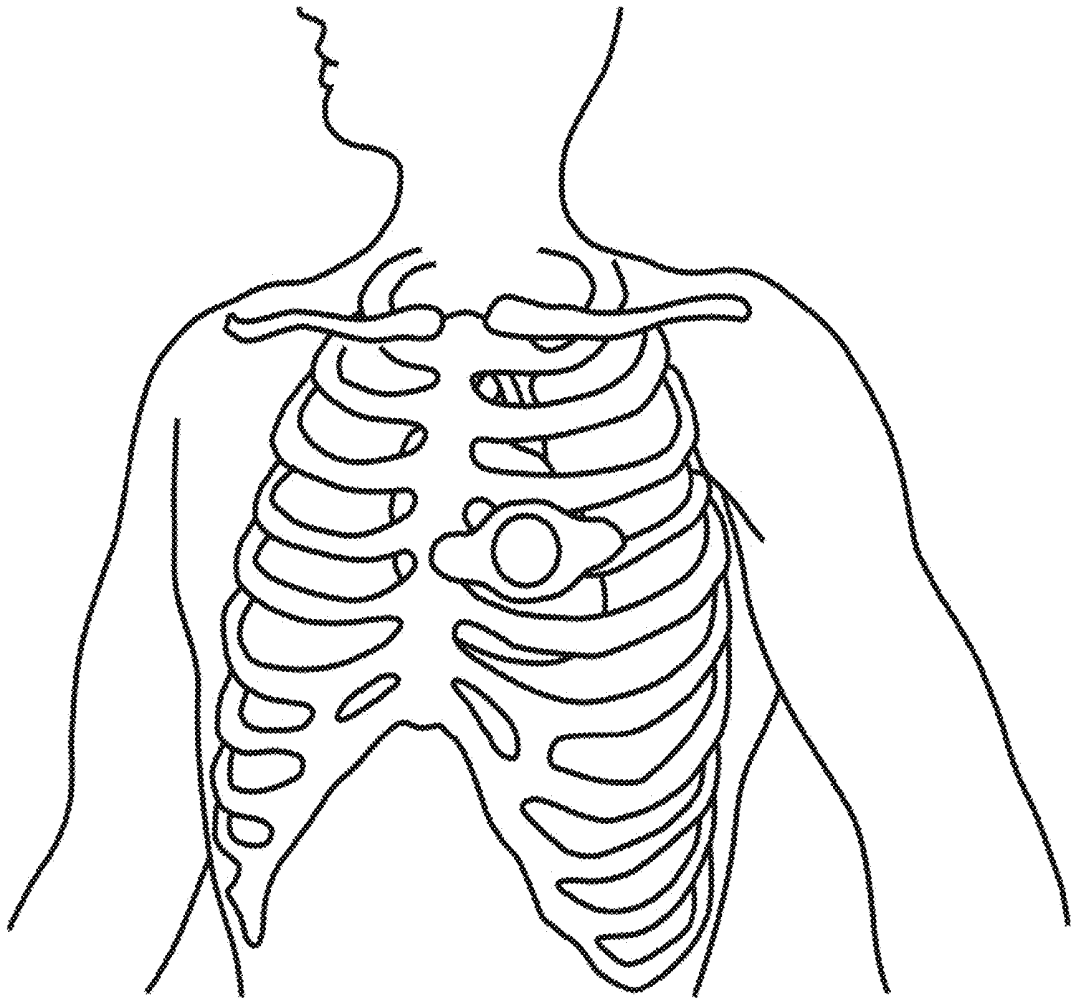


FIG. 2

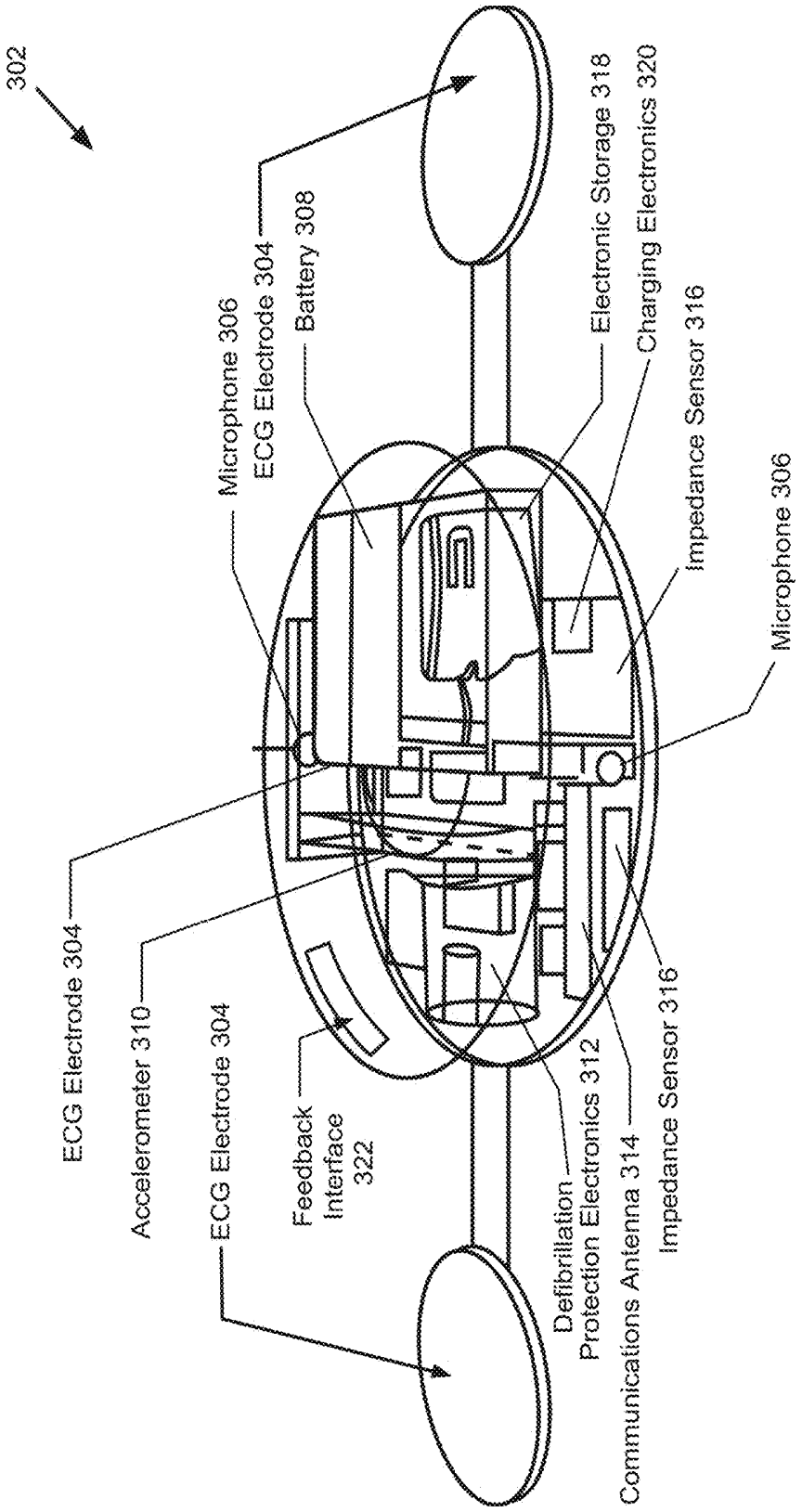

302
Microphone 306
ECG Electrode 304
Battery 308
Electronic Storage 318
Charging Electronics 320
Impedance Sensor 316
Microphone 306
ECG Electrode 304
Accelerometer 310
ECG Electrode 304
Feedback Interface 322
Defibrillation Protection Electronics 312
Communications Antenna 314
Impedance Sensor 316

FIG. 3

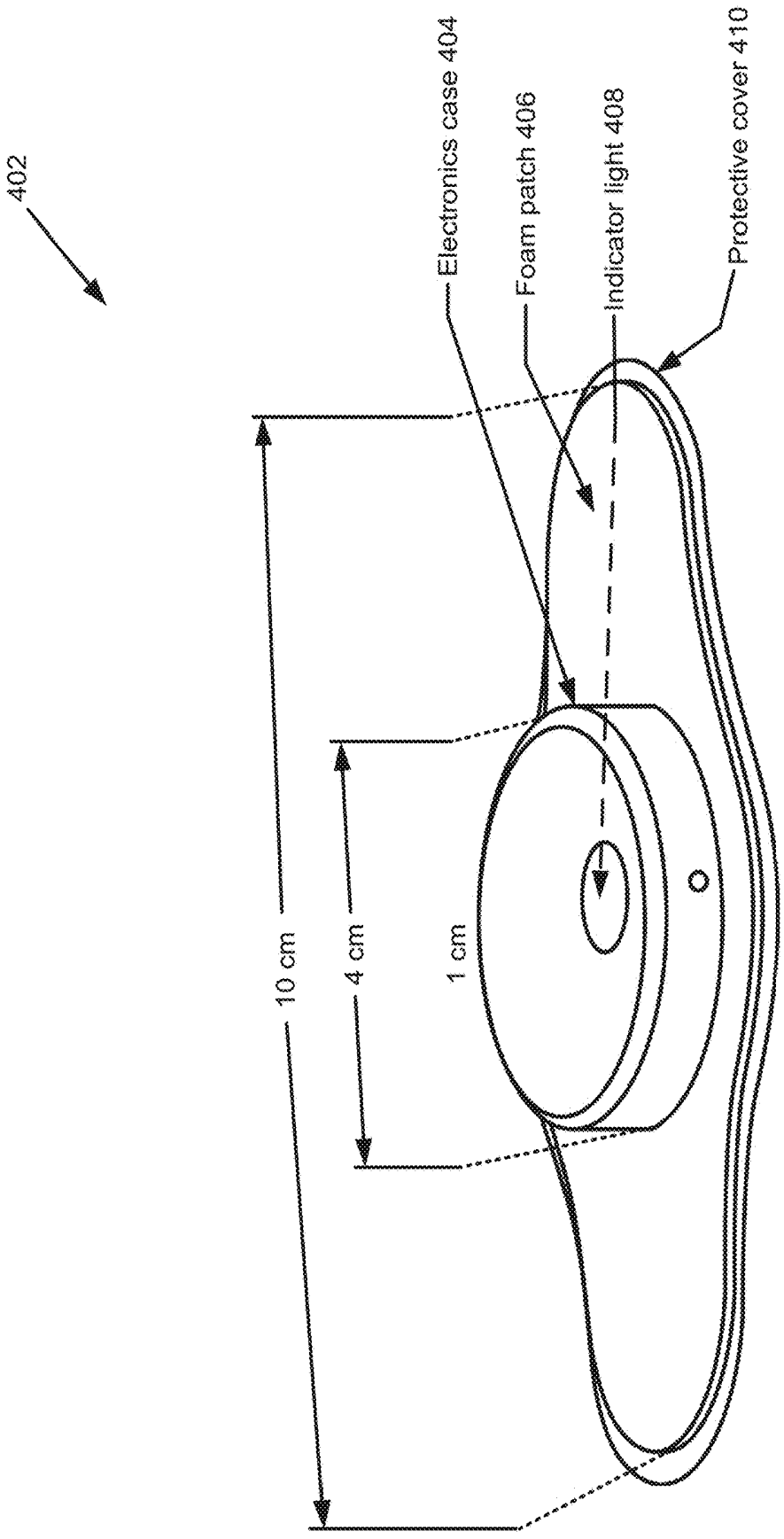

402
Electronics case 404
Foam patch 406
Indicator light 408
Protective cover 410
10 cm
4 cm
1 cm

FIG. 4

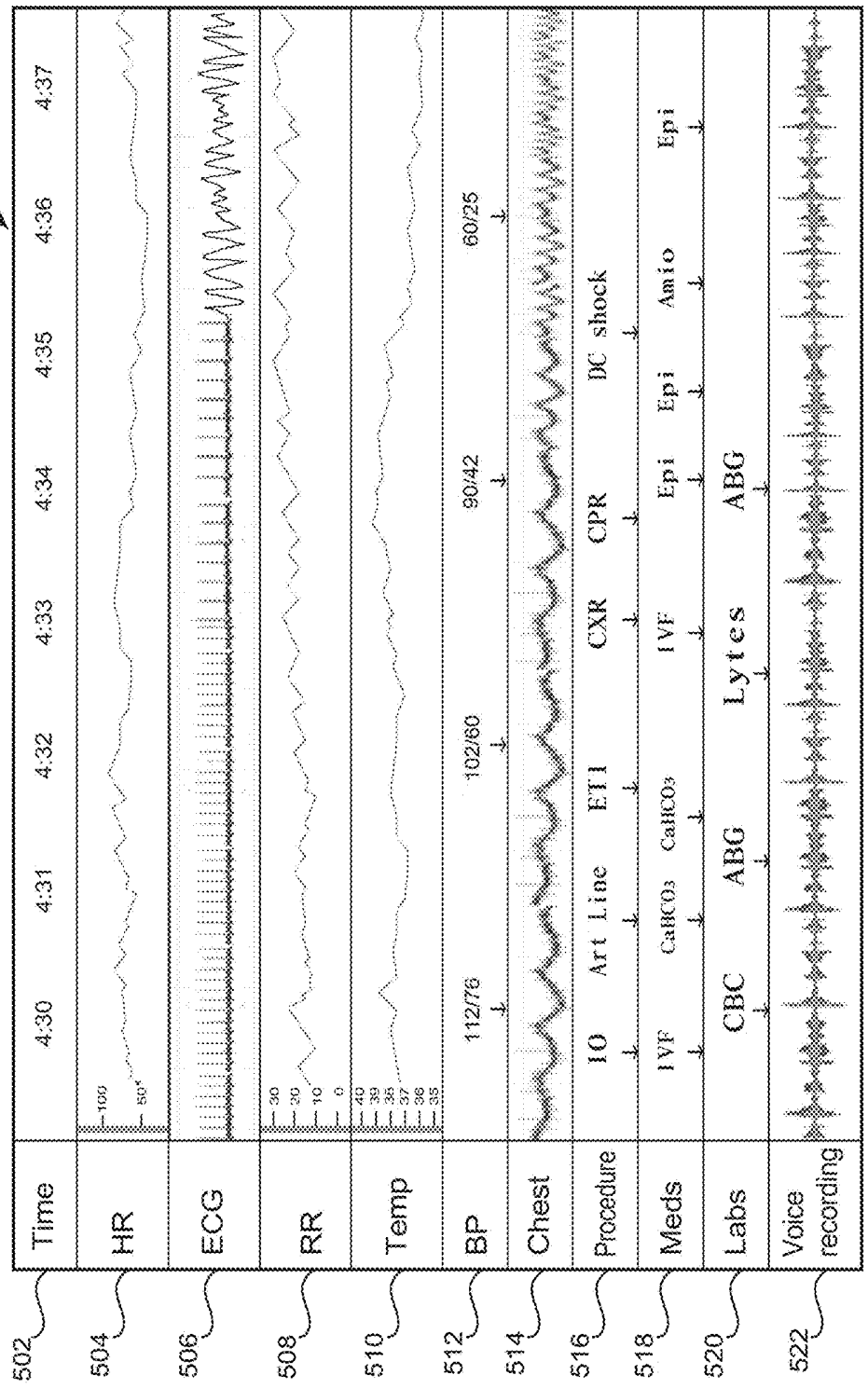

500
502
Time
4:30
4:31
4:32
4:33
4:34
4:35
4:36
4:37
504
HR
100
50
506
ECG
508
RR
30
20
10
0
510
Temp
40
39
38
37
36
35
512
BP
112/76
102/60
90/42
60/25
514
Chest
516
Procedure
IO
Art Line
ETT
CXR
CPR
DC shock
518
Meds
IVF
CaHCO3
CaHCO3
IVF
Epi
Epi
Amio
Epi
520
Labs
CBC
ABG
Lytes
ABG
522
Voice recording

FIG. 5

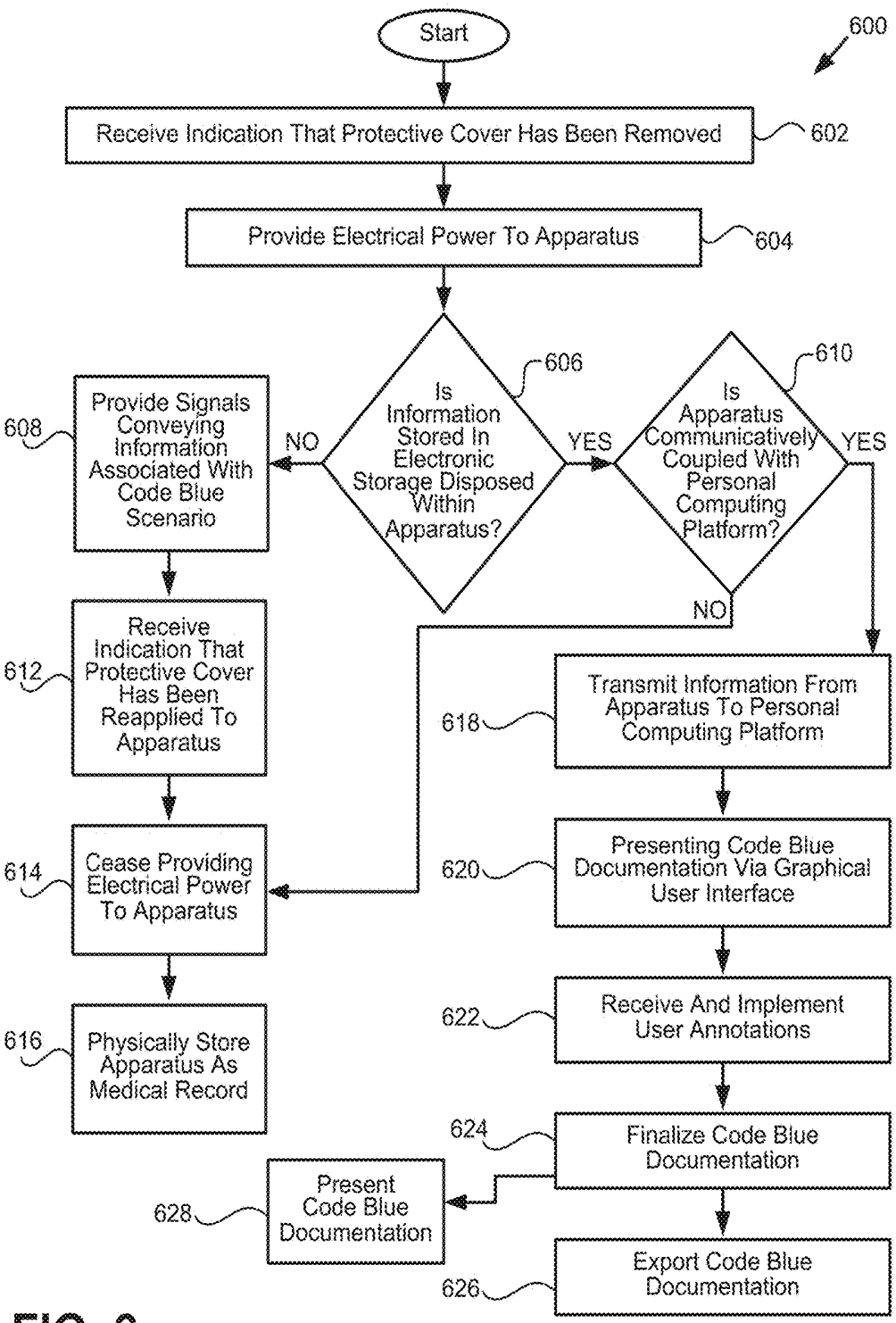

Start
600
Receive Indication That Protective Cover Has Been Removed
602
Provide Electrical Power To Apparatus
604
Is Information Stored In Electronic Storage Disposed Within Apparatus?
606
NO
YES
Provide Signals Conveying Information Associated With Code Blue Scenario
608
Is Apparatus Communicatively Coupled With Personal Computing Platform?
610
YES
NO
Receive Indication That Protective Cover Has Been Reapplied To Apparatus
612
Transmit Information From Apparatus To Personal Computing Platform
618
Cease Providing Electrical Power To Apparatus
614
Presenting Code Blue Documentation Via Graphical User Interface
620
Physically Store Apparatus As Medical Record
616
Receive And Implement User Annotations
622
Finalize Code Blue Documentation
624
Present Code Blue Documentation
628
Export Code Blue Documentation
626

FIG. 6

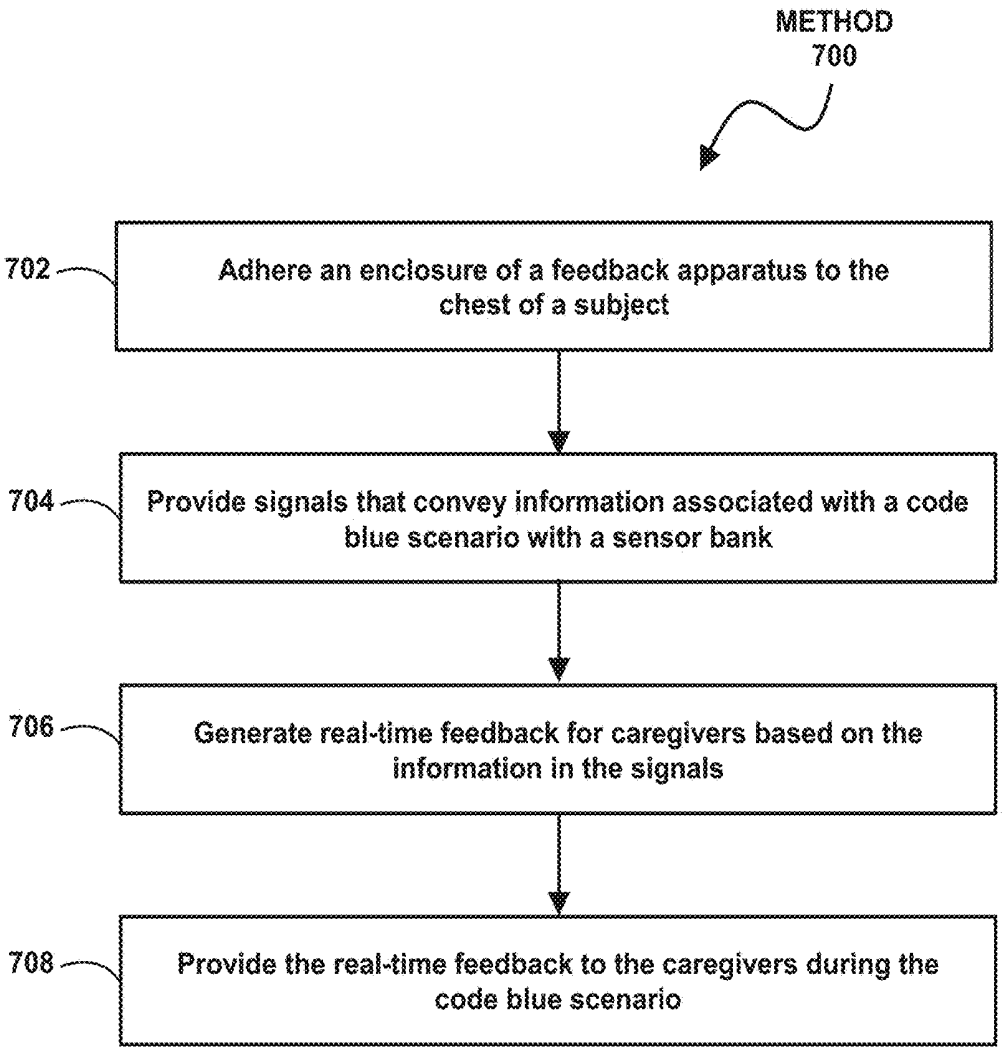

METHOD
700
702
Adhere an enclosure of a feedback apparatus to the chest of a subject
704
Provide signals that convey information associated with a code blue scenario with a sensor bank
706
Generate real-time feedback for caregivers based on the information in the signals
708
Provide the real-time feedback to the caregivers during the code blue scenario

FIG. 7

SYSTEMS, APPARATUS, AND METHODS FOR DOCUMENTING CODE BLUE SCENARIOS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation in part of U.S. patent application Ser. No. 15/669,449 filed on Aug. 4, 2017, which is a continuation of U.S. patent application Ser. No. 14/245,858 filed on Apr. 4, 2014, both entitled "SYSTEMS, APPARATUS, AND METHODS FOR DOCUMENTING CODE BLUE SCENARIOS" and both incorporated herein by reference in their entireties.

FIELD OF THE DISCLOSURE

[0002] This disclosure relates to systems, apparatus, and methods for documenting a code blue scenario in which a subject is undergoing resuscitation.

BACKGROUND

[0003] Patient safety is one of the most important challenges facing today's healthcare. There are approximately 2.5 million deaths in the U.S. each year, about a third of which occur in acute care hospitals. Unless there are "do-not-resuscitate" advanced directives in place, patients who die in a hospital most likely have undergone one or more resuscitation attempts known as "code blue." Code blue is used by hospitals to describe a scenario in which a patient with cardiac or respiratory arrest requires stat medical intervention (i.e., resuscitation). Medical errors occur in healthcare every day. In code blue scenarios, medical errors may be likely to occur, which can cost lives. Common errors in cardiopulmonary resuscitation (CPR) may include slow chest compression rates, shallow chest compression depths, hyperventilation, long pauses in CPR before shock delivery, delivery of electrical defibrillation for nonshockable rhythms, medication errors, failure to follow resuscitation guidelines (e.g., advanced cardiovascular life support (ACLS), pediatric advanced life support (PALS), and/or other guidelines), and/or other errors.

[0004] Studies have found conventional paper-based documentation practices of code blue scenarios may be inaccurate, often misreporting intervention delivery times, missing their delivery entirely, and/or making other documentation errors. Paper-based code blue records may commonly have missing time data, include use of multiple timepieces for recording time data during the same event, and convey a wide variation in coherence and precision of clocking devices. For example, the documentation of time in emergency events has been shown to vary significantly, by as much as nineteen minutes, depending on which clocking devices are used. Furthermore, incomplete and inaccurate documentation of code blue scenarios are frequently a source for medicolegal disputes.

SUMMARY

[0005] Exemplary implementations may provide feedback (e.g., coaching) to caregivers during a code blue scenario, as well as complete and accurate documentation of code blue scenarios, which may facilitate quality improvement of resuscitation in practice, enhance in patent safety, and protect healthcare professionals against lawsuits. Some implementations provide an electronic apparatus for providing feedback to caregivers and complete documentation of code blue scenarios. This apparatus may be referred to as a "BlueBox." According to one implementation, the apparatus may include a five by ten centimeter elongated patch configured to be placed next to the mid-sternum on the left. Other configurations are contemplated. The apparatus may be configured to provide feedback to caregivers related to, as well as provide complete capture of, all code blue events including vital signs of a subject (e.g., a patient or other individual undergoing resuscitation), cardiac rhythm, verbal orders, execution of the orders, chest compression, cardioversion/defibrillation, procedures, medications, labs, and/or other events. The apparatus may enhance the safety of subjects undergoing CPR. The apparatus may provide electronic code blue records that can be useful for electronic medical record (EMR) documentation, education, and quality improvement.

[0006] The apparatus may include multiple sensors embedded in a micro-electronics platform. The sensors may include electrocardiogram (ECG) sensors, one or more accelerometers (e.g., a tri-axial accelerometer), a temperature sensor, an impendence sensor, one or more acoustic sensors, one or more sensors configured for detecting oxygen saturation (SpO_2) (e.g., pulse oximeter sensors), and/or other sensors. In some implementations, all of the sensors may be integrated into a volume with a four centimeter diameter and eight millimeter thickness. Feedback may be given, and vital signs and audio information may be simultaneously recorded with corresponding time stamps and/or other information. Security measures may be implemented to protect the recorded information. An enclosure and contact surface of the apparatus may be designed to withstand pressure from chest compressions and/or voltages from cardioversion and defibrillation.

[0007] An "electronic code blue sheet" and/or feedback user interface may be provided to display the feedback, and/or the code blue events recorded by the apparatus. In accordance with some implementations, the user interface may be provided by an app suitable for one or more platforms including Apple iOS™ platform, Android™ platform, Microsoft Windows™, and/or other platforms. The app may run on one or more computing platforms associated with a caregiver, a medical facility and/or other medical providers, medical equipment in the environment where the code blue events occur, and/or other computing platforms. The app may receive information from sensors of the apparatus, retrieve information recorded by the apparatus, receive and/or retrieve information from a server and/or other processing devices, and/or perform other operations via a wireless connection, and automatically display the feedback, the code blue events chronologically with time stamps, and/or other information, in some implementations. The user interface may provide zoomable views of the feedback, the vital signs, and/or other information. The user interface may facilitate communication of audio instructions, playback of other audio information, and/or other operations. In some implementations, a trained transcriptionist may annotate additional events, such as procedures and medications, based on the voice recordings. This annotation may be performed automatically with the aid of voice recognition technology, in some implementations. The electronic code blue sheet may be exported (e.g., as a portable document file (PDF) and/or other electronic document for-

mats) so that the code blue sheet can be printed for paper medical record, or for uploading to EMR.

[0008] One aspect of the disclosure relates to an apparatus configured to provide feedback to caregivers during a code blue scenario. The apparatus may comprise an enclosure, a sensor bank, a feedback interface, one or more processors, and/or other components. The enclosure may be adhered to a chest of a subject undergoing resuscitation. The enclosure may be configured to withstand compressive forces applied to the subject's chest from chest compressions during resuscitation. Components disposed within the enclosure may be protected from mechanical damage, electrical shock, and/or other conditions. The sensor bank may be at least partially disposed within the enclosure. The sensor bank may be configured to provide signals conveying information associated with the code blue scenario. The information may include vital signs of the subject during resuscitation, information associated with chest movements of the subject during resuscitation, audio information from an environment surrounding the subject during resuscitation, and/or other information. The feedback interface may be coupled with the enclosure. The feedback interface may be configured to provide real-time feedback to the caregivers during the code blue scenario. The real-time feedback may comprise a recommendation to begin resuscitation, adjustments that should be made to ongoing resuscitation, and/or other feedback. The one or more processors may be operatively coupled with the sensor bank and the feedback interface, one or more computing platforms, and/or other components. The one or more processors may be configured by computer program instructions to generate the real-time feedback based on the information in the signals from the sensor bank. In some implementations, the feedback may be provided by one or more components of the feedback interface, the user interface provided by the app described above, and/or other components.

[0009] In some implementations, the feedback interface may comprise one or more of a display screen, one or more indicator lights, a speaker, components for communication with one or more computing platforms, and/or other components. The feedback interface may be configured to provide the real-time feedback to the caregivers via one or more of the display screen, the one or more indicator lights, the speaker, the app running on the one or more computing platforms, and/or the other components. In some implementations, the feedback interface may include a timer. The timer may be activated responsive to one or both of the apparatus being removably adhered to the subject's chest or an adhesive cover being removed from the enclosure.

[0010] In some implementations, the real-time feedback may comprise adjustments that should be made to ongoing resuscitation such as recommended changes to one or more of a compression rate, a compression depth, a pause between compressions, or a compression interval of cardiopulmonary resuscitation (CPR) chest compressions performed on the subject during the code blue scenario. In some implementations, generating the real-time feedback based on the information in the signals from the sensor bank may comprise determining time elapsed since collapse of the subject. The time elapsed since collapse may be determined responsive to the information in the signals from the sensor bank indicating ventricular fibrillation and no respiratory movement, and/or other information. In some implementations, the real-time feedback may comprise a recommendation to begin chest compressions on the subject. In some implementations, the real-time feedback may comprise a recommendation to shock or defibrillate the subject. In some implementations, the real-time feedback may comprise a recommendation to inject the subject with epinephrine.

[0011] Another aspect of the disclosure relates to a method for providing feedback to caregivers during a code blue scenario with a feedback apparatus. The apparatus may comprise an enclosure, a sensor bank, a feedback interface, one or more processors, and/or other components. The method may comprise adhering the enclosure to a chest of a subject undergoing resuscitation. The enclosure may be configured to withstand compressive forces applied to the subject's chest from chest compressions during resuscitation. Components disposed within the enclosure may be protected from mechanical damage, electrical shock, and/or other conditions. The sensor bank may be at least partially disposed within the enclosure. The method may comprise providing, with the sensor bank, signals conveying information associated with the code blue scenario. The information may include vital signs of the subject during resuscitation, information associated with chest movements of the subject during resuscitation, audio information from an environment surrounding the subject during resuscitation, and/or other information. The feedback interface may be coupled with the enclosure. The method may comprise providing, with the feedback interface, real-time feedback to the caregivers during the code blue scenario. The real-time feedback may comprise a recommendation to begin resuscitation, adjustments that should be made to ongoing resuscitation, and/or other feedback. The one or more processors may be operatively coupled with the sensor bank and the feedback interface. The one or more processors may be configured by computer program instructions. The method may comprise generating, with the one or more processors, the real-time feedback based on the information in the signals from the sensor bank.

[0012] In some implementations, the feedback interface may comprise one or more of a display screen, one or more indicator lights, a speaker, components for communication with one or more computing platforms, and/or other components. The method may comprise providing the real-time feedback to the caregivers via one or more of the display screen, the one or more indicator lights, the speaker, the app described above, and/or the other components. In some implementations, the feedback interface may include a timer. The method may comprise activating the timer responsive to one or both of the apparatus being removably adhered to the subject's chest or an adhesive cover being removed from the enclosure.

[0013] In some implementations, the real-time feedback may comprise adjustments that should be made to ongoing resuscitation such as recommended changes to one or more of a compression rate, a compression depth, a pause between compressions, or a compression interval of cardiopulmonary resuscitation (CPR) chest compressions performed on the subject during the code blue scenario. In some implementations, generating the real-time feedback based on the information in the signals from the sensor bank may comprise determining time elapsed since collapse of the subject. The time elapsed since collapse may be determined responsive to the information in the signals from the sensor bank indicating ventricular fibrillation and no respiratory movement, and/or other information. In some implementations,

the real-time feedback may comprise a recommendation to begin chest compressions on the subject. In some implementations, the real-time feedback may comprise a recommendation to shock or defibrillate the subject. In some implementations, the real-time feedback may comprise a recommendation to inject the subject with epinephrine.

[0014] Another aspect of the disclosure relates to an apparatus configured for documenting a code blue scenario when adhered to the chest of a subject undergoing resuscitation. The apparatus may comprise an enclosure and a sensor bank. The enclosure may be configured to withstand compressive forces applied to the subject's chest during resuscitation of the subject such that components disposed within the enclosure are protected from mechanical damage. The sensor bank may be at least partially disposed within the enclosure. The sensor bank may be configured to provide signals conveying information associated with a code blue scenario. The information may include vital signs of the subject during resuscitation and audio information from an environment surrounding the subject during resuscitation.

[0015] Another aspect of the disclosure relates to a system configured for documenting code blue scenarios. The system may comprise one or more physical processors configured to receive information from an apparatus configured for documenting a code blue scenario when adhered to the chest of a subject undergoing resuscitation by sensing and transmitting information associated with the code blue scenario. The information may include vital signs of the subject during resuscitation and audio information from an environment of the subject during resuscitation. The one or more physical processors may be disposed at a location other than the apparatus. The one or more processors may be further configured to execute computer program instructions. The computer program instructions may comprise a code blue documentation component configured to provide code blue documentation that conveys information related to the vital signs of the subject during resuscitation and the audio information from the environment of the subject during resuscitation.

[0016] Another aspect of the disclosure relates to a method for documenting code blue scenarios. The method may comprise receiving, using one or more physical processors, vital sign information associated with vital signs of a subject during resuscitation in a code blue scenario. The vital sign information may be received from an apparatus configured to be adhered to the chest of the subject when the code blue scenario begins. The method may comprise receiving, using one or more physical processors, audio information from an environment surrounding the subject during resuscitation. The audio information may be received from the apparatus. The method may comprise providing, using one or more physical processors, code blue documentation that conveys information related to the resuscitation performed on the subject. The code blue documentation may be based on both the vital sign information and the audio information.

[0017] These and other features, and characteristics of the present technology, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention. As used in the specification and in the claims, the singular form of "a", "an", and "the" include plural referents unless the context clearly dictates otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. **1** illustrates a system configured to provide feedback to caregivers during code blue scenarios, as well as document the code blue scenarios, in accordance with one or more implementations.

[0019] FIG. **2** illustrates an exemplary positioning of an apparatus configured for providing feedback during, and documenting, a code blue scenario when adhered to the chest of a subject undergoing resuscitation, in accordance with one or more implementations.

[0020] FIG. **3** illustrates an electronics hardware footprint and configuration of the apparatus, in accordance with one or more implementations.

[0021] FIG. **4** illustrates an exemplary enclosure of the apparatus, in accordance with one or more implementations.

[0022] FIG. **5** illustrates a graphical user interface presenting code blue documentation, in accordance with one or more implementations.

[0023] FIG. **6** illustrates a method for documenting code blue scenarios, in accordance with one or more implementations.

[0024] FIG. **7** illustrates a method for providing feedback to caregivers with a feedback apparatus during a code blue scenario, in accordance with one or more implementations.

DETAILED DESCRIPTION

[0025] FIG. **1** illustrates a system **100** configured for providing feedback to caregivers during code blue scenarios, as well as documenting code blue scenarios, in accordance with one or more implementations. The feedback (e.g., coaching) provided to caregivers during a code blue scenario, as well as complete and accurate documentation of code blue scenarios, may facilitate quality improvement of resuscitation in practice, enhance in patent safety, and protect healthcare professionals against lawsuits. The system **100** may provide complete documentation for code blue scenarios, which may be useful for EMR integration, medical education, quality improvement, medicolegal purposes, and/or other purposes. The system **100** may provide standardized code blue documentation that is complete and operator-independent, thus improving quality of care and protecting patient safety. According to some implementations, system **100**, with its capacity to provide feedback and capture most or all events in code blue scenarios, may provide much needed assistance to healthcare professionals who lead code blue teams (e.g., anesthesiologists, intensivists, emergency physicians, and/or other healthcare professionals).

[0026] Components of system **100** may continuously record important vital parameters of a subject undergoing CPR, procedures such as chest compression and defibrillation, and all verbal communications among the code blue team members such as orders, responses, medications, lab results, and/or other verbal communications. Proper documentation of code blue scenarios may facilitate detailed reviews of CPR events for quality improvement, thus

enhancing patent safety. Proper documentation may protect healthcare professionals against lawsuits which might otherwise be due to incomplete or inaccurate documentation. Properly documenting care in a patient's medical records is essential and, in the event of a lawsuit, provides evidence that the care that was provided met professional standards.

[0027] In one exemplary implementation, system **100** may include an apparatus shaped as a disk having a diameter of four centimeters and a thickness of one centimeter, housed in a ten by five centimeter patch shaped as a big Band-Aid. The apparatus may be configured to be placed on the left mid chest, over the fourth intercostal space between the left sternal border and left nipple, at the beginning of a code blue scenario. There may be no control buttons or other mechanisms on the apparatus. Instead, the apparatus may power on and begin recording responsive to a protective cover being removed. This may be achieved using a magnetic switch, according to some implementations. The apparatus may power off and stop recording responsive to the apparatus being removed from the subject. The apparatus may be configured to prevent unauthorized removal of any internal memory and/or tampering with recorded information.

[0028] As depicted in FIG. **1**, system **100** may include an apparatus **102**, a personal computing platform **104**, a server **106**, one or more feedback processors **109**, and/or other components. The apparatus **102** may be configured for providing feedback to caregivers during code blue scenarios, as well as documenting code blue scenarios when adhered to the chest of a subject undergoing resuscitation. FIG. **2** illustrates an exemplary positioning of an apparatus that is the same or similar to apparatus **102**, in accordance with one or more implementations. The position of apparatus **102** depicted in FIG. **2** is not intended to be limiting as other positions are contemplated and are within the scope of the disclosure. For example, in some implementations, the position may be at a different location of the subject or covering a different shape or size area on the subject than that depicted in FIG. **2**.

[0029] Referring again to FIG. **1**, apparatus **102** may include an enclosure **108**. The enclosure **108** may be configured to withstand compressive forces applied to the subject during resuscitation such that components disposed within enclosure **108** are protected from mechanical damage (e.g., breaking or otherwise becoming unable to operate properly due to receipt of compressive forces). The enclosure **108** may be configured to withstand electrical conditions (e.g., high voltages) resulting from defibrillation being performed on the subject such that component disposed within enclosure **108** are protected from electrical and/or magnetic damage (e.g., shorting or otherwise becoming unable to operate properly due to exposure to certain electrical conditions). The enclosure **108** may have an adhesive applied to an external portion of enclosure **108** to facilitate removably adhering to the subject's chest. The apparatus **102** may be prepared with a removable cover or film **111** that protects the adhesive on enclosure **108**, and exposes the adhesive when removed.

[0030] FIG. **3** illustrates an electronics hardware footprint and configuration **302** of apparatus **102**, in accordance with one or more implementations. The electronics hardware footprint and configuration **302** may include are area in which one or more components of apparatus **102** are disposed. As depicted in FIG. **3**, electronics hardware footprint and configuration **302** may include one or more of ECG electrodes **304**, microphones **306**, a battery **308**, an accelerometer **310**, defibrillation protection electronics **312**, communications antenna **314**, impedance sensors **316**, electronic storage **318**, charging electronics **320**, a feedback interface **322**, and/or other components. In some implementations, there may be no physical buttons, physical switches, or plug-style ports associated with electronics hardware footprint and configuration **302**. In some implementations, electronics hardware footprint and configuration **302** may include one or more indicator lights configured to convey feedback or a status of apparatus **100** (e.g., on, off, recording, not recording, and/or other statuses). In some embodiments, feedback interface **322** may include a display screen, one or more indicator lights, a speaker, one or more components (e.g., Bluetooth and/or other communication components) configured to communicate real-time and/or near real-time feedback to the caregivers during a code blue scenario via one or more computing platforms remote from the apparatus **102**, and/or other electronic components configured to provide feedback to caregivers during a code blue scenario.

[0031] Other configurations for electronics hardware footprint and configuration **302** are contemplated. The positions of various components on electronics hardware footprint and configuration **302** may vary according to different implementations. The shape and/or size of electronics hard ware footprint and configuration **302** depicted in FIG. **3** are not intended to be limiting as other shapes and/or sizes are contemplated and are within the scope of the disclosure. For example, in some implementations, the shape of electronics hardware footprint and configuration **302** may be more complex (e.g., more constituent shapes, curves, or angles) or less complex (e.g., less constituent shapes, curves, or angles) than that depicted in FIG. **3**. In addition, there may be more or less sensor positions at the same or different locations on electronics hardware footprint **302**. The size of electronics hardware footprint and configuration **302** may vary according to various factors includes a subject size (e.g., adult versus child), sensors sizes, and/or other factors.

[0032] FIG. **4** illustrates an exemplary enclosure **402** of apparatus **102**, in accordance with one or more implementations. The enclosure **402** may be similar to or the same as enclosure **108** described in connection with FIG. **1**. The enclosure **402** may be configured to enclose some or all of electronics hardware footprint and configuration **302** (see FIG. **3**). As depicted in FIG. **4**, enclosure **402** may include one or more of an electronics case **404**, a foam patch **406**, an indicator light **408**, a removable protective cover **410**, and/or other components. The enclosure **402** may be made in whole or in part of one or more of acrylic, foam, plastic, metal, resin, and/or other materials. Pressure used for chest compressions may be up to **125** pounds. As such, enclosure **402** may be configured to withstand twenty or more pounds per square inch (PSI), or about 150 or more pounds of total force, according to some implementations. The enclosure **402** may include a hydrogel at a surface configured to contact skin on the subject. Such hydrogel may facilitate measurements by one or more of ECG sensors, temperature sensors, and/or other sensors. A surface of enclosure **402** may be configured to be adhered to skin of the subject. The removable protective cover **410** may cover an adhesive that facilitates adhesion by enclosure **402** to the subject. In some implementations, a magnetic switch (not depicted) may be included in enclosure **402** and be configured such that,

responsive to a user removing the disposable cover and/or placing apparatus **102** on the subject, apparatus **102** may be powered on and/or collecting information associated with a code blue scenario.

[0033] Other configurations for enclosure **402** are contemplated. The shape and/or size of enclosure **402** depicted in FIG. **4** are not intended to be limiting as other shapes and/or sizes are contemplated and are within the scope of the disclosure. For example, in some implementations, the shape of enclosure **402** may be more complex (e.g., more constituent shapes, curves, or angles) or less complex (e.g., less constituent shapes, curves, or angles) than that depicted in FIG. **4**. The size of enclosure **402** may vary according to various factors includes a subject size (e.g., adult versus child), sensors sizes, and/or other factors.

[0034] Referring again to FIG. **1**, apparatus **102** may include one or more of a power supply **110**, a sensor bank **112**, a feedback interface **113**, electronic storage **114**, one or more processors **116**, a communications interface **118**, and/or other components.

[0035] The power supply **110** may be disposed within enclosure **108**. The power supply **110** may be configured to provide electrical power to one or more components of apparatus **102**. The power supply **110** may be configured to provide electrical power to one or more components of apparatus **100** responsive to one or both of apparatus **100** being removably adhered to a subject's chest or an adhesive cover being removed from enclosure **108**. The power supply **110** may include one or more of a battery, a capacitor, and/or other power supplies. The power supply **110** may be replaceable. According to various implementations, power supply **110** may be rechargeable using a conductive wire line in or an inductive wireless mechanism.

[0036] The sensor bank **112** may be at least partially disposed within enclosure **108**. The sensor bank **112** may be configured to provide signals conveying information associated with a code blue scenario. The information may include vital signs of the subject during resuscitation and/or audio information from an environment surrounding the subject during resuscitation. The audio information from the environment may include voice commands issued during resuscitation of the subject. The audio information from the environment may include a vocal indication of a vital sign (e.g., blood pressure, whether or not the subject has a pulse, etc.) of the subject during resuscitation.

[0037] In some implementations, sensor bank **112** may include one or more of a heart rate sensor **120**, a cardiac rhythm sensor **122**, a respiration sensor **124**, a chest movement sensor **126**, a temperature sensor **128**, a blood pressure sensor **130**, an oxygen saturation (SpO_2) sensor **131**, a chest compression sensor **132**, a cardioversion and/or defibrillation sensor **134**, a verbal communication sensor **136**, and/or other components.

[0038] The heart rate sensor **120** may be configured to provide a signal conveying information associated with a heart rate of the subject during resuscitation. By way of non-limiting example, the signal from heart rate sensor **120** may facilitate determining and/or presenting a heart rate of the subject, indications of when the subject's heart beats, and/or other information associated with the subjects heart function. In some implementations, heart rate sensor **120** may include one or more ECG sensors.

[0039] The cardiac rhythm sensor **122** may be configured to provide a signal conveying information associated with a cardiac rhythm of the subject during resuscitation. By way of non-limiting example, the signal from the cardiac rhythm sensor **122** may facilitate determining and/or presenting the subject's cardiac rhythm as shown by ECG, various types of arrhythmias (e.g., ventricular fibrillation), and/or other information associated with the subject's cardiac rhythm. In some implementations, cardiac rhythm sensor **122** may include one or more ECG sensors.

[0040] The respiration sensor **124** may be configured to provide a signal conveying information associated with a respiration of the subject during resuscitation. By way of non-limiting example, the signal from respiration sensor **124** may facilitate determining and/or presenting the subject's respiration rate, the subject's respiration volume, an indication of when the subject breaths, an indication of when a positive pressure ventilation was performed on the subject, an indication of how many positive pressure ventilations have been performed on the subject, an indication of a volume associated with positive pressure ventilations, and/or other information associated with the subject's breathing. In some implementations, respiration sensor **124** may include an impedance sensor.

[0041] The chest movement sensor **126** may be configured to provide a signal conveying information associated with chest movements caused by artificial respiration provided to the subject during resuscitation. By way of non-limiting example, the signal from chest movement sensor **126** may facilitate determining and/or presenting an indication of when an artificial breath was provided to the subject, and/or other information associated with artificial respiration provided to the subject. In some implementations, chest movement sensor **126** may include one or more accelerometers.

[0042] The temperature sensor **128** may be configured to provide a signal conveying information associated with a temperature of the subject during resuscitation. By way of non-limiting example, the signal provided by temperature sensor **128** may facilitate determining and/or presenting an indication of the subject's core temperature, the subject's surface temperature, a temperature of an environment surrounding the subject, a change in a temperature, and/or other information associated with temperature. In some implementations, temperature sensor **128** may include one or more of a thermometer, a thermistor, a thermocouple, and/or other temperature sensor.

[0043] The blood pressure sensor **130** may be configured to provide a signal conveying information associated with a blood pressure of the subject during resuscitation. In some implementations, blood pressure sensor **130** may be configured to receive a signal conveying information associated with a blood pressure of the subject during resuscitation from an external source. For example, blood pressure sensor **130** may receive a signal from a sphygmomanometer or blood pressure sensor (not depicted) that is separate and distinct from apparatus **102**. As such, blood pressure sensor **130** may be communicatively coupled with a sphygmomanometer or blood pressure sensor. In some implementations, blood pressure sensor **130** may include a microphone configured to record verbal announcements of the subject's blood pressure.

[0044] The oxygen saturation sensor **131** may be configured to provide a signal conveying information associated with an oxygen saturation of the subject's blood. By way of non-limiting example, the signal provided by oxygen satu-

ration sensor **131** may facilitate determining and/or presenting an indication of a saturation of peripheral oxygen (SpO_2) associated with the subject.

[0045] The chest compression sensor **132** may be configured to provide a signal conveying information associated with chest compressions performed on the subject during resuscitation. By way of non-limiting example, the signal provided by chest compression sensor **132** may facilitate determining and/or presenting an indication of when a chest compression was performed on the subject, an amount of force applied to the subject by a chest compression, a displacement (depth) of the subject's chest cause by a chest compression, a rate of successive chest compressions, a pause in successive chest compressions, and/or other information associated with chest compressions performed on the subject. In some implementations, chest compression sensor **132** may include one or more accelerometers.

[0046] The cardioversion and/or defibrillation sensor **134** may be configured to provide a signal conveying information associated with cardioversion procedures and/or defibrillation procedures performed on the subject during resuscitation. By way of non-limiting example, the signal provided by cardioversion and/or defibrillation sensor **134** may facilitate determining and/or presenting an indication of when cardioversion procedures and/or defibrillation procedures were performed on the subject, an amount of energy associated with cardioversion procedures and/or defibrillation procedures performed on the subject, duration of the energy, synchronized versus unsynchronized, subject's response to a cardioversion procedure and/or a defibrillation procedure, and/or other information associated with cardioversion procedures and/or defibrillation procedures. The cardioversion and/or defibrillation sensor **134** may be communicatively coupled to a cardioversion and/or defibrillation device. The cardioversion and/or defibrillation sensor **134** may be configured to sense electrical currents applied to the subject. The cardioversion and/or defibrillation sensor **134** may include one or more of an ECG sensor, an accelerometer, a microphone, and/or other sensors.

[0047] The verbal communication sensor **136** may be configured to provide a signal conveying information associated with verbal communication among the caregiver members of the code blue team, a response from a caregiver to an inquiry by apparatus **102** and/or feedback processor **109** (described below) in an environment of the subject during resuscitation, and/or other information. The verbal communication sensor **136** may include one or more of a microphone, an acoustic-to-electric transducer, and/or other sensor configured to sense audio information.

[0048] The feedback interface **113** may be coupled to, formed by, formed in, or otherwise attached to enclosure **108**. In some implementations, the feedback interface **113** may be the same as or similar to feedback interface **322** (shown in FIG. **3** and described herein). In some implementations, the feedback interface **113** may include one or more components of communications interface **118** and/or have other components. The feedback interface **113** may comprise one or more of a display screen **115**, one or more indicator lights **117** (which may or may not include the indicator light **408** described above), a speaker **119**, and/or other components. The feedback may be provided to the caregivers via one or more of the display screen **115**, the one or more indicator lights **117**, the speaker **119**, via personal computing platform **104**, and/or other computing platforms, and/or other components.

[0049] In some embodiments, the feedback interface **113** may be at least partially formed in, on, or by a surface of enclosure **108** that is visible to the caregivers (e.g., a surface that is not adhered to the subject), and/or other surfaces. For example, the feedback interface **113** may be formed on a surface of enclosure **108** opposite a surface including a protective cover and/or adhesive of the system **100**, on an edge surface of enclosure **108** visible to caregivers, and/or other surfaces. In some embodiments, one or more portions of the feedback interface **113** may be formed on different surfaces of enclosure **108**. For example, the display screen **115**, the speaker **119**, and/or one or more indicator lights **117** may be formed on a larger surface of enclosure **108** opposite the protective cover, and one or more other indicator lights, and/or other components may be formed on a smaller edge surface of enclosure **108**. It should be noted that this description of the feedback interface **113** is not to be considered limiting. The feedback interface **113** may or may not include all of the components listed above (e.g., the feedback interface **113** may comprise only indicator lights **117** and the speaker **119**, only the indicator lights **117**, only the display screen **115**, only communications components of communications interface **118**, etc.), and individual components may be located anywhere in, on, or otherwise coupled to enclosure **108** that allows the system **100** to function as described herein.

[0050] Feedback interface **113** may be configured to provide real-time and/or near real-time feedback to the caregivers during a code blue scenario. In some embodiments, the feedback may be provided in textual and/or graphical form via the display screen **115**, via an app running on personal computing platform **104**, and/or other components. In this example, the feedback may be provided by displaying textual instructions, displaying pictures and/or other images, and/or displaying other information. Displaying pictures and/or other images may include displaying annotated pictures or images that instruct (e.g., via arrows and/or other notations in the pictures and/or images) caregivers to perform specific actions, and/or other displays.

[0051] In some implementations, the feedback may be provided by lighting one more indicator lights **117** of different colors, lighting one or more indicator lights **117** with different patterns and/or frequencies, and/or by providing other lighting (e.g., lighting virtual lights displayed by the app running on personal computing platform **104**). In this example, lights of different colors may correspond to different recommended actions, an intensity and/or other relative level of a recommended action (e.g., green means less intense, yellow means more intense, and red means most intense), and/or other information. A grid and/or other row(s) of lights may be lit in a specific shape or other pattern to indicate specific feedback. Lighting intensity (e.g., brightness) may be changed to indicate specific feedback. Indicator lights **117** may be controlled to blink or flash with specific patterns to indicate specific instructions.

[0052] In some implementations, the feedback may be provided by the speaker **119**, speakers included in personal computing platform **104**, and/or other sound generation components. In some implementations, the speaker **119**, for example, may provide verbal commands and/or other instructions for caregivers. For example, the speaker may

instruct a caregiver "begin CPR" or provide other commands. In some implementations, the speaker **119** may provide beeping sounds and/or other noises that correspond to specific actions, an intensity of the specific actions, and/or other information. For example, the speaker **119** may provide a first sound that indicates a caregiver should start CPR, and additional sounds that help the caregiver pace compressions. In this example, the speaker **119** may adjust an intensity (e.g., the volume) of the sounds to cause the caregiver to perform deeper or shallower compressions, or make other adjustments to the CPR provided.

[0053] In some implementations, the feedback interface **113** may be and/or include one or more components (e.g., communications interface **118**) configured to communicate real-time and/or near real-time feedback to the caregivers during a code blue scenario via one or more computing platforms (e.g., personal computing platform **104**) remote from the apparatus **102**. For example, the feedback interface **113** may be and/or include one or more components configured to communicate feedback to caregivers via one or more personal computing platforms **104**, one or more computing platforms associated with one or more items of medical equipment proximate to a location where a patient is undergoing resuscitation, one or more computing platforms configured to record and/or present medical records, one or more computing platforms associated with a medical services provider and/or care facility, and/or other computing platforms. For example, in some implementations, the feedback may be provided via Bluetooth components included in the feedback interface **113** linked to an iPad or other mobile device or computer. In some implementations, for example, the apparatus **102** itself may be able to process the analysis and provide feedback directly via one or more displays and/or indicators of the feedback interface **113** device (e.g., as described above). In some implementations, for example, the apparatus **102** may be coupled to a (e.g., cloud) server (e.g., server **106**, feedback processor **109**, etc.) and stream data to the server in real-time or near real-time, which may process received data, analyze results, and send them back to the apparatus **102** to show resuscitation recommendations. In some implementations, for example, the apparatus **102** may be coupled to the (e.g., cloud) server (e.g., server **106**, feedback processor **109**, etc.) and stream data to the server in real-time or near real-time, which may process received data, analyze results, and send them back to the personal computing platform **104** and/or other computing platforms to show resuscitation recommendations.

[0054] In some implementations, the feedback interface may include a timer **121**. The timer **121** may be a display and/or other indication (e.g., a specific number of lit indicator lights **117** that steadily increase over time) of an elapsed amount of time. In some implementations, the timer **121** may be activated responsive to one or both of the apparatus **102** being removably adhered to the subject's chest or an adhesive cover being removed from the enclosure **102**, for example. In some implementations, the timer **121** may be activated responsive to collapse of the subject, responsive to a start of CPR and/or other resuscitation operations, responsive to defibrillation, and/or responsive to other operations. In some implementations, as described below, the timer **121** may be activated by computer program instructions **138** and/or time stamping component **140**.

[0055] The processor(s) **116** may be disposed within enclosure **108**. The processor(s) **116** may be configured to execute computer program instructions **138**. The computer program instructions **138** may include a time stamping component **140** and/or other components. The time stamping component **140** may be configured to time stamp signals provided by sensor bank **112**, time stamp information conveyed by the signals provided by sensor bank **112**, time stamp feedback determined by feedback processors **109** and/or provided by feedback interface **113**, and/or other information. Such time stamps may facilitate chronological logging of code blue events including the feedback provided by the system **100**.

[0056] The electronic storage **114** may be disposed within enclosure **108**. The electronic storage **114** may be configured to store and provide access to information conveyed by the signals provided by sensor bank **112**, information determined by feedback processor **109**, and/or other information. According to some implementations, apparatus **102** may be assigned a unique serial number and a security code for accessing information stored by electronic storage **114**. To access the stored information using a given personal computing device (e.g., personal computing platform **104**), the given personal computing device may be required to be paired with apparatus **102** via a Bluetooth link and/or other communicative connection, in accordance with some implementations.

[0057] In some implementations, a patient's identifiers may be recorded by virtue of a user verbally identifying the patient's name, a hospital ID number, a date of birth, and/or other patient information. In some implementations, apparatus **102** may be configured to wirelessly retrieve information including patient information from other electronic medical devices. The apparatus **102** may be configured to obtain patient information by scanning visual marks (e.g., barcode, QR code, and/or other visual marks), by imaging the patient's ID band, by a keypad, and/or by other techniques.

[0058] The communications interface **118** may be disposed within enclosure **112**. The communications interface **118** may be configured to communicate with one or more other components of system **110** by wireless connections and/or wired connections. The communication interface **118** may be configured to transmit one or more of signals provided by sensor bank **112**, information conveyed by the signals provided by sensor bank **112**, information stored by electronic storage **114**, information received from feedback interface **113**, information received from processor(s) **116**, and/or other information. The communications interface **118** may be configured to receive information from one or more other components of system **100**. For example, the communications interface **118** may be configured to receive feedback (and/or information related to the feedback) determined by feedback processor **109**, transmit (e.g., via Bluetooth components, etc., as described herein) the information received from feedback processor **109** to personal computing platform **104** for communication to a caregiver, and/or perform other operations. In some implementations, the communications interface **118** may be configured to transmit received feedback to feedback interface **113** for provision to caregivers. According to some implementations, communications interface **118** may be compatible with one or more of a Bluetooth standard, a Wi-Fi standard, an ANT or ANT+ standard, a near-field standard, wireless data communication protocols, and/or other communications standards.

[0059] The feedback processor **109** may formed by and/or in one or more individual stand alone processors **109**, one or more servers **106**, one or more personal computing platforms **104**, the apparatus **102**, and/or other components of the system **100**. The feedback processor **109** may be configured to generate real-time and/or near real-time feedback for caregivers based on the information in the signals from the sensor bank **112** and/or other information. The real-time and/or near real-time feedback may comprise a recommendation to begin resuscitation, adjustments that should be made to ongoing resuscitation, and/or other feedback. In some implementations, the generated real-time and/or near real-time feedback may comprise recommendations that one or more actions taken by taken by the code blue caregiver team during the code blue scenario such as recommending one or more of chest compressions be performed on the subject during resuscitation, cardioversion procedures and/or defibrillation procedures be performed on the subject during resuscitation, medications be administered to the subject during resuscitation, endotracheal intubation be performed on the subject, artificial respiration be provided to the subject during resuscitation, vascular accesses (e.g., intravenous lines, intra-osseous lines, arterial lines, and/or other accesses) be created, surgical procedures be performed, laboratory tests be performed, and/or other actions be taken by the code blue caregiver team.

[0060] By way of a non-limiting example, in some implementations, the feedback processor **109** may be configured such that the real-time feedback may comprise adjustments that should be made to ongoing resuscitation. Such adjustments may comprise recommended changes to one or more of a compression rate (e.g., compressions per minute), a compression depth (e.g., cm), a pause between compressions (e.g., sec), or a compression interval of cardiopulmonary resuscitation (CPR) chest compressions performed on the subject during the code blue scenario. For example, the rate and depth of chest compression may be detected based on output signals from the chest compression sensor **132**. The feedback processor **109** may be configured to determine whether the rate and/or depth of chest compression are within a predetermined amount of a target rate and/or depth of chest compression and/or meet other target criteria. In some implementations, the predetermined amount may be an absolute value, a percentage, and/or other predetermined amounts. In some implementations, the feedback processor **109** may be configured to determine whether the rate and/or depth of chest compression are within a predetermined amount of 10%, 20%, 50%, and/or other percentages of the target rate and/or depth of chest compression. In some implementations, responsive to the rate and/or depth being more than 20% (for example) different than the target rate and/or depth, the feedback processor **109** may cause the feedback interface **113** to provide feedback to the caregiver performing CPR. The feedback processor **109** may control the speaker **119**, the indicator lights **117**, and/or other components of the feedback interface **113** to provide feedback to the caregiver that causes the caregiver to adjust the way the caregiver is performing CPR on the subject. In some implementations, the target rate and/or depth of chest compression may be determined at manufacture of the system **100**, received and/or adjusted via input to the personal computing platform **104**, determined by the feedback processor **109** and/or other components based on information from the external resources **152** and/or other sources, determined by the server **106**, and/or determined in other ways.

[0061] In some implementations, generating the real-time feedback based on the information in the signals from the sensor bank may comprise determining time elapsed since a collapse of the subject. The time elapsed since a collapse may be determined to be at least some minimum amount of time. The feedback processor **109** may be configured to determine time elapsed since collapse responsive to the information in the signals from the sensor bank indicating ventricular fibrillation and no respiratory movement in the subject. In some implementations, this minimum amount of time may be about one minute. In some implementations, this minimum amount of time may be about two minutes. In some implementations, this minimum amount of time may be about three or more minutes.

[0062] In some implementations, the feedback processor **109** may be configured such that the real-time feedback may comprise a recommendation to begin chest compressions on the subject. The recommendation to begin chest compressions on the subject may be determined responsive to the time elapsed since collapse of the subject being at least one minute (for example) and/or another predetermined amount of time, the information in the signals from the sensor bank **112** indicating no respiratory movement, the information in the signals from the sensor bank **112** indicating no pulse in the subject, and/or other information. For example, the recommendation to begin chest compressions may be determined responsive to an ECG (e.g., part of sensor bank **112** as described herein) which shows ventricular fibrillation and respiration sensors (e.g., **124**) and/or chest movement sensors (e.g., **126**) that show no respiratory chest movement. In this example, the feedback processor **109** may cause the speaker **119** to ask a caregiver whether the subject has a pulse. If the caregiver responds that there is no pulse (detected by the verbal communication sensor **136**), the feedback processor **109** may control the speaker **119**, the indicator lights **117**, and/or other components of the feedback interface **113** to recommend beginning chest compressions.

[0063] In some implementations, the feedback processor **109** may be configured such that the real-time feedback may comprise a recommendation to shock or defibrillate the subject. The recommendation to shock or defibrillate the subject may be determined responsive to a time elapsed since a start of chest compressions being at least three minutes (for example) and/or another predetermined amount of time, the information in the signals from the sensor bank **112** indicating ventricular fibrillation, the information in the signals from the sensor bank **112** indicating no pulse in the subject, and/or other information. For example, after three minutes (for example) of chest compressions (e.g., as detected by the chest compression sensor **132**), an ECG rhythm may be detected (e.g., by the cardiac rhythm sensor **122**). Responsive to the ECG rhythm remaining Ventricular tachycardia (Vtach)/Ventricular fibrillation (Vfib), the feedback processor **109** may cause the speaker **119** to ask a caregiver whether the subject has a pulse or determine whether there is a pulse based on output signals from the heart rate sensor **120**. If the caregiver responds that there is no pulse (detected by the verbal communication sensor **136**) or if the output signals do not show a pulse, the feedback processor **109** may control the speaker **119**, the indicator

lights **117**, and/or other components of the feedback interface **113** to recommend shock or defibrillation.

[0064] In some implementations, the real-time feedback may comprise a recommendation to inject the subject with epinephrine. The recommendation to inject the subject with epinephrine may be determined responsive to a time elapsed since a start of chest compressions being at least five minutes (for example), the information in the signals from the sensor bank **112** indicating ventricular fibrillation, the information in the signals from the sensor bank **112** indicating no pulse in the subject, and/or other information. For example, after five minutes (for example) of chest compressions (e.g., as detected by the chest compression sensor **132**), an ECG rhythm may be detected (e.g., by the cardiac rhythm sensor **122**). Responsive to the ECG rhythm remaining Vtach/Vfib, the feedback processor **109** may cause the speaker **119** to ask a caregiver whether the subject has a pulse or determine whether there is a pulse based on output signals from the heart rate sensor **120**. If the caregiver responds that there is no pulse (detected by the verbal communication sensor **136**) or if the output signals do not show a pulse, the feedback processor **109** may control the speaker **119**, the indicator lights **117**, and/or other components of the feedback interface **113** to recommend injecting the subject with epinephrine.

[0065] In some implementations, the subject may be receiving positive pressure ventilation during the code blue scenario. In such implementations, the feedback processor **109** may be configured such that the real-time feedback may comprise a recommendation to adjust a ventilation pressure, a ventilation rate, and/or other ventilation parameters. The recommendation to adjust the ventilation pressure and/or the ventilation rate may be determined based on information in the signals from the sensor bank **112** related to a rate and depth of chest rise in the subject, and/or other information. For example, the rate and depth of chest rise may be detected based on output signals from the respiration sensor **124**, the chest movement sensor **126**, or other sensors. The feedback processor **109** may be configured to determine whether the rate and/or depth of chest rise are within a predetermined amount of a target rate and/or depth of chest rise and/or meet other target criteria. In some implementations, the predetermined amount may be an absolute value, a percentage, and/or other predetermined amounts (e.g., similar to those described above). In some implementations, responsive to the rate and/or depth being more than the predetermined amount different than the target rate and/or depth, the feedback processor **109** may cause the feedback interface **113** to provide feedback to the caregivers. The feedback processor **109** may control the speaker **119**, the indicator lights **117**, the display screen **115**, and/or other components of the feedback interface **113** to provide feedback to the caregiver that causes the caregiver to adjust the way the ventilation is provided to the subject. In some implementations, the target rate and/or depth of chest rise is determined at manufacture of the system **100**, received and/or adjusted via input to the personal computing platform **104**, determined by the feedback processor **109** and/or other components based on information from external resources **152** and/or other sources, determined by the server **106**, and/or determined in other ways.

[0066] In some implementations, the feedback processor **109** may be configured such that generating the real-time feedback based on the information in the signals from the sensor bank **112** may comprise a machine-learning and/or model based analysis of the information in the signals from the sensor bank **112**. The machine-learning and/or model based analysis may comprise determining which future actions taken by caregivers during resuscitation would improve a likelihood of recovery from the code blue scenario by the subject and/or determining other information. The machine learning and/or model based analysis may comprise generating the real-time feedback based on the predictions and/or other operations.

[0067] In some implementations, the machine learning and/or model based analysis may comprise a model based portion configured to reduce complexity by efficiently solving well-known parts of the analysis, and a machine learning portion configured to discover solutions. In some implementations, the model based portion may be used to determine whether certain target variables, such as chest compression rate and depth, are within or out of predetermined recommended parameter ranges. In some implementations, the model based portion may be augmented by deep machine learning. In some implementations, the machine learning and/or model based analysis may include training based on information from several individual patients (e.g., 100's, 1000's, and/or 100000's of patients).

[0068] In some implementations, the machine learning and/or model based analysis comprises an offline training mode during which the feedback processor **109** obtains training data comprising information from prior code blue scenarios including information from the sensor bank **112**, corresponding feedback provided to caregivers, corresponding outcome information for patients, and/or other information for training machine learning algorithms and/or other electronic models used in the analysis. In some implementations, the feedback processor **109** may be configured such that the machine learning and/or model based analysis is performed by one or more machine learning algorithms, one or more neutral networks, and/or other models. As an example, neural networks may be based on a large collection of neural units (or artificial neurons). Neural networks may loosely mimic the manner in which a biological brain works (e.g., via large clusters of biological neurons connected by axons). Each neural unit of a neural network may be connected with many other neural units of the neural network. Such connections can be enforcing or inhibitory in their effect on the activation state of connected neural units. In some embodiments, each individual neural unit may have a summation function which combines the values of all its inputs together. In some embodiments, each connection (or the neutral unit itself) may have a threshold function such that the signal must surpass the threshold before it is allowed to propagate to other neural units. These neural network systems may be self-learning and trained, rather than explicitly programmed, and can perform significantly better in certain areas of problem solving, as compared to traditional computer programs. In some embodiments, neural networks may include multiple layers (e.g., where a signal path traverses from front layers to back layers). In some embodiments, back propagation techniques may be utilized by the neural networks, where forward stimulation is used to reset weights on the "front" neural units. In some embodiments, stimulation and inhibition for neural networks may be more free-flowing, with connections interacting in a more chaotic and complex fashion.

[0069] As described herein, the machine learning and/or model based analysis may be performed by feedback processors **109** (e.g., stand alone devices, and/or included in the server **106**, the personal computing platform **104** (e.g., an iPad and/or other personal computing platforms), and/or other devices) and/or other components based on information transmitted from the apparatus **102**. Once analyzed, in some implementations, the personal computing platform **104** (e.g., iPad) may display the results and recommendations. Corresponding feedback information may be sent back to the apparatus **102** to be shown via indicator lights, and/or LCD screen, etc., communicated audibly, and/or communicated to a caregiver in other ways.

[0070] The personal computing platform **104** may include one or more of a smartphone, a tablet computer, a laptop computer, a desktop computer, and/or other personal computing platforms. In some implementations, the personal computing platform **104** may be associated with one or more individual caregivers. In some implementations, the personal computing platform **104** may be associated with a care facility and/or other entities that provide medical care. In some implementations, the personal computing platform **104** may be associated with a patient receiving resuscitation. The personal computing platform **104** may include one or more of electronic storage **142**, one or more processors **144**, and/or other components. The processor(s) **144** may be configured to execute computer program instructions **146**. The computer program instructions **146** may include one or more of a voice interpretation component **148**, a code blue documentation component **150**, and/or other components.

[0071] The voice interpretation component **148** may be configured to interpret one or more of a vital sign of the subject during resuscitation presented as a function of time, an action taken by a code blue team during the code blue scenario, and/or other information. The interpretation may be based on audio information from the environment surrounding the subject during resuscitation. The code blue team may include one or more healthcare providers, individual ones being assigned different roles and/or functions.

[0072] The code blue documentation component **150** may be configured to provide code blue documentation that conveys information related to the vital signs of the subject during resuscitation and the audio information from the environment surrounding the subject during resuscitation. The code blue documentation may include one or more of (1) one or more vital signs of the subject during resuscitation presented as a function of time, (2) one or more actions taken by a code blue team during the code blue scenario, the code blue team including one or more healthcare providers, (3) information based on the audio information from the environment of the subject during resuscitation presented as a function of time, and/or other information.

[0073] The one or more vital signs presented by the code blue documentation may include one or more of a heart rate of the subject during resuscitation, a cardiac rhythm of the subject during resuscitation, a respiration of the subject during resuscitation, chest movements of the subject with respiration during resuscitation, a temperature of the subject during resuscitation, a blood pressure of the subject during resuscitation, oxygen saturation (e.g., SpO_2) of the subject during resuscitation, and/or other information associated with vital signs.

[0074] The one or more actions taken by the code blue team during the code blue scenario may include one or more of chest compressions performed on the subject during resuscitation, cardioversion procedures and/or defibrillation procedures performed on the subject during resuscitation, medications administered to the subject during resuscitation, endotracheal intubation, artificial respiration provided to the subject during resuscitation, vascular accesses (e.g., intravenous lines, intra-osseous lines, arterial lines, and/or other accesses), surgical procedures, laboratory test results associated with the subject, results from point-of-care devices associated with the subject, and/or other information associated with actions taken by the code blue team. In some implementations, these actions may be responsive to feedback determined by feedback processor **109** and delivered by feedback interface **113** as described herein.

[0075] The information based on the audio information from the environment of the subject during resuscitation may include one or more of verbal commands issued by a leader of the code blue team, verbal responses to commands issued by a leader of the code blue team and/or a request for information as part of feedback determination by feedback processor **109**, chest compressions performed on the subject during resuscitation, cardioversion procedures and/or defibrillation procedures performed on the subject during resuscitation, verbal assessments of a status of the subject during resuscitation, verbal assessments of a vital sign of the subject during resuscitation, medications administered to the subject during resuscitation, endotracheal intubation and artificial respiration provided to the subject during resuscitation, vascular accesses (e.g., intravenous lines, intra-osseous lines, arterial lines, and/or other accesses), surgical procedures, laboratory test results associated with the subject, results from point-of-care devices associated with the subject, and/or other information associated with audio information from the environment surrounding the subject.

[0076] The code blue documentation may be provided and/or presented in various forms. In some implementations, the code blue documentation may be provided as an electronic document. By way of non-limiting example, the code blue documentation may be exported as a portable document file (PDF) or other electronic document format so that the code blue documentation can be printed for paper chart, or uploaded to an electronic medical record (EMR). The code blue documentation may be provided directly as an electronic medical record.

[0077] In some implementations, the feedback, the code blue documentation, and/or other information may be provided for presentation via portable computing platform **104**. FIG. **5** illustrates a graphical user interface **500** presenting code blue documentation, in accordance with one or more implementations. The graphical user interface **500** may be presented by personal computing platform **104**. The graphical user interface **500** may include one or more of a time field **502**, a heart rate field **504**, an ECG field **506**, a respiratory rate field **508**, a temperature field **510**, a blood pressure field **512**, an oxygen saturation field (SpO_2) (not depicted), a chest movement field **514**, a procedure field **516**, a medication field **518**, a labs field **520**, a voice recording field **522**, and/or other fields. The fields of graphical user interface **500** presented in FIG. **5** are intended to be illustrative. In some implementations, graphical user interface **500** may include one or more additional fields not described, and/or without one or more of the fields discussed. Addi-

tionally, the order and/or arrangement in which the fields of graphical user interface **500** are illustrated in FIG. **5** are not intended to be limiting.

[0078] The fields of graphical user interface **500** may be configured to convey various information. The time field **502** may be configured to convey time information associated with a code blue scenario. The time information may include a time of day, a time since the code blue scenario was initiated, a time since apparatus **102** was adhered to the subject, a time since subject collapse, a time since chest compressions were started, and/or other time information associated with the code blue scenario. The heart rate field **504** may be configured to convey the subject's heart rate as a function of time and/or other information associated with the subject's heart rate. The ECG field **506** may be configured to convey the subject's electrocardiogram as a function of time, cardiac rhythm, identifying arrhythmias, and/or other information associated with the subject's ECG. The respiratory rate field **508** may be configured to convey the subject's respiratory rate as a function of time and/or other information associated with the subject's breathing. The temperature field **510** may be configured to convey the subject's temperature as a function of time and/or other information associated with the subject's temperature. The blood pressure field **512** may be configured to convey the subject's blood pressure as a function of time and/or other information associated with the subject's blood pressure. The chest movement field **514** may be configured to convey the subject's chest movements as a function of time and/or other information associated with the subject's chest movements. The procedure field **516** may be configured to convey indications of performed procedures as a function of time, the nature or type of individual procedures, and/or other information associated with procedures performed on the subject. The medication field **518** may be configured to convey indications of provided medications as a function of time, the type and/or dosage of individual medications, and/or other information associate with medications provided to the subject during the code blue scenario. The labs field **520** may be configured to convey indications of performed labs (e.g., assays) as a function of time, the nature or type of individual labs, and/or other information related to labs associated with the code blue scenario. The voice recording field **522** may be configured to convey audio information recorded in the environment surrounding the subject during the code blue scenario. The audio information may be transcribed into text. The graphical user interface **500** may be configured to facilitate audible playback of audio information. In some implementations, graphical user interface **500** may be configured to facilitate zooming in and out of a graphical representation of audio information (e.g., zoom in to view one second of audio information, zoom out to fit the size of a screen, and/or other zoom configurations). In some implementations, graphical user interface **500** may be configured to convey a detailed analysis of chest compressions (e.g., rate, depth, pauses, and intervals). Onscreen calipers may be provided to measure time intervals between events and measure time intervals for one or more quality of care indicators.

[0079] In some implementations, one or more of these fields may be configured to display a real-time value for the parameter associated with a given field. For example, the heart rate field **504** may be configured to convey the subject's real-time heart rate. The respiratory rate field **508** may be configured to convey the subject's real-time respiratory rate. The temperature field **510** may be configured to convey the subject's real-time temperature. The blood pressure field **512** may be configured to convey the subject's real-time blood pressure. The chest movement field **514** may be configured to convey the subject's real-time chest movements. These examples are not intended to be limiting.

[0080] Turning back to FIG. **1**, in some implementations, apparatus **102**, personal computing platform **104**, server **106**, feedback processor **109**, and/or external resources **152** may be operatively linked via one or more electronic communication links. For example, such electronic communication links may be established, at least in part, via a network or connection such as the Internet, Wi-Fi, Bluetooth, and/or other networks or connections. It will be appreciated that this is not intended to be limiting, and that the scope of this disclosure includes implementations in which apparatus **102**, personal computing platform **104**, server **106**, feedback processor **109**, and/or external resources **152** may be operatively linked via some other communication media.

[0081] By way of non-limiting example, a given personal computing platform **104** may include one or more of a desktop computer, a laptop computer, a handheld computer, a tablet computing platform, a NetBook, a Smartphone, and/or other computing platforms.

[0082] Server **106** may include electronic storage, one or more processors, and/or other components. Server **106** may be configured to execute computer program instructions **138**, computer program instructions **146**, and/or other instructions. Server **106** may include communication lines, or ports to enable the exchange of information with a network and/or other computing platforms. Illustration of server **106** in FIG. **1** is not intended to be limiting. Server **106** may include a plurality of hardware, software, and/or firmware components operating together to provide the functionality attributed herein to server **106**. For example, server **106** may be implemented by a cloud of computing platforms operating together as server **106**.

[0083] External resources **152** may include sources of information, hosts and/or providers of medical information (e.g., EMR) outside of system **100**, external entities participating with system **100**, and/or other resources. In some implementations, some or all of the functionality attributed herein to external resources **152** may be provided by resources included in system **100**.

[0084] Electronic storage **114** and/or **142** may comprise non-transitory storage media that electronically stores information. The electronic storage media of electronic storage **114** and/or **142** may include one or both of system storage that is provided integrally (i.e., substantially non-removable) with a device (e.g., apparatus **102** or personal computing platform **104**) and/or removable storage that is removably connectable to the device (e.g., apparatus **102** or personal computing platform **104**), for example, a port (e.g., a USB port, a firewire port, etc.) or a drive (e.g., a disk drive, etc.). Electronic storage **114** and/or **142** may include one or more of optically readable storage media (e.g., optical disks, etc.), magnetically readable storage media (e.g., magnetic tape, magnetic hard drive, floppy drive, etc.), electrical charge-based storage media (e.g., EEPROM, RAM, etc.), solid-state storage media (e.g., flash drive, etc.), and/or other electronically readable storage media. Electronic storage **114** and/or **142** may include one or more virtual storage resources (e.g.,

cloud storage, a virtual private network, and/or other virtual storage resources). Electronic storage **114** and/or **142** may store software algorithms, information determined by a processor (e.g., processor(s) **109**, processor(s) **116**, and/or processor(s) **144**), information received from server **106**, information received from personal computing platforms **104**, information received from apparatus **102**, information received from feedback processor **109**, information received from external resources **152**, and/or other information that enables system **100** to function as described herein.

[0085] Processor(s) **116** may be configured to provide information processing capabilities in apparatus **102**. Processor(s) **144** may be configured to provide information processing capabilities in personal computing platform **104**. Feedback processor(s) **109** may be configured to provide information processing capabilities in and/or for either one of these devices, as well as for system **100** as a whole. As such, processor(s) **109**, **116**, and/or **144** may include one or more of a digital processor, an analog processor, a digital circuit designed to process information, an analog circuit designed to process information, a state machine, and/or other mechanisms for electronically processing information. Although processor(s) **109**, **116**, and **144** are shown in FIG. **1** as single entities, this is for illustrative purposes only. In some implementations, processor processor(s) **109**, **116**, and/or **114** may include a plurality of processing units. These processing units may be physically located within the same device, or processor(s) **109**, **116**, and/or **114** may represent processing functionality of a plurality of devices operating in coordination. For example, parts and/or all of feedback processor(s) **109** may be included in enclosure **108** of apparatus **102**, included in personal computing platform **104**, included in server **106**, and/or included in other components of the system **100**. The processor(s) **109**, **116**, and/or **114** may be configured to execute computer program instructions (e.g., computer program instructions **138** and/or **146**, and/or computer program instructions that facilitate generation of feedback for provision to caregivers) by software; hardware; firmware; some combination of software, hardware, and/or firmware; and/or other mechanisms for configuring processing capabilities on processor(s) **109**, **116**, and/or **114**. As used herein, the term "module" may refer to any component or set of components that perform the functionality attributed to the module. This may include one or more physical processors during execution of processor readable instructions, the processor readable instructions, circuitry, hardware, storage media, or any other components.

[0086] It should be appreciated that although computer program instruction components **140**, **148**, and **150** are illustrated in FIG. **1** as being implemented within a single processing unit, in implementations in which processor(s) **116** and/or **114** includes multiple processing units, one or more of components **140**, **148**, and/or **150** may be implemented remotely from the other components. The description of the functionality provided by the different components **140**, **148**, and/or **150** described herein is for illustrative purposes, and is not intended to be limiting, as any of components **140**, **148**, and/or **150** may provide more or less functionality than is described. For example, one or more of components **140**, **148**, and/or **150** may be eliminated, and some or all of its functionality may be provided by other ones of components **140**, **148**, and/or **150**. As another example, processor(s) **116** and/or **114** may be configured to execute one or more additional components that may perform some or all of the functionality attributed below to one of components **140**, **148**, and/or **150**.

[0087] FIG. **6** illustrates a method **600** for documenting code blue scenarios, in accordance with one or more implementations. The operations of method **600** presented below are intended to be illustrative. In some implementations, method **600** may be accomplished with one or more additional operations not described, and/or without one or more of the operations discussed. Additionally, the order in which the operations of method **600** are illustrated in FIG. **6** and described below is not intended to be limiting.

[0088] In some implementations, method **600** may be implemented in one or more processing devices (e.g., a digital processor, an analog processor, a digital circuit designed to process information, an analog circuit designed to process information, a state machine, and/or other mechanisms for electronically processing information). The one or more processing devices may include one or more devices executing some or all of the operations of method **600** in response to instructions stored electronically on an electronic storage medium. The one or more processing devices may include one or more devices configured through hardware, firmware, and/or software to be specifically designed for execution of one or more of the operations of method **600**.

[0089] At an operation **602**, an indication may be received conveying that a protective cover has been removed from an apparatus (e.g., apparatus **102**) configured to be adhered to the chest of a subject when the code blue scenario begins. In some implementations, operation **602** may be performed by processor(s) **116**.

[0090] At an operation **604**, electrical power may be provided to the apparatus. Operation **604** may be performed by power supply **110**, according to some implementations. According to various implementations, the electrical power may be provided responsive to the protective cover being removed and/or the apparatus being applied to the subject.

[0091] At an operation **606**, electronic storage (e.g., electronic storage **114**) disposed within the apparatus may be queried to determine whether information associated with a code blue scenario is stored in the electronic storage. In some implementations, operation **606** may be performed by processor(s) **116**. If the determination in operation **606** is positive, method **600** may proceed to an operation **608**. If the determination in operation **606** is negative, method **600** may proceed to an operation **610**.

[0092] At operation **608**, a sensor bank (e.g., sensor bank **112**) disposed in the apparatus begins providing signals conveying information associated with the code blue scenario, which form a basis for code blue documentation.

[0093] At an operation **612**, an indication may be received conveying that the protective cover has been reapplied to the apparatus. In some implementations, operation **612** may be performed by processor(s) **116**.

[0094] At an operation **614**, electrical power ceases to be provided to the apparatus. According to various implementations, the electrical power may cease to be provided responsive to the protective cover being reapplied to the apparatus and/or the apparatus being placed into a container.

[0095] At an operation **616**, the apparatus may be physically stored as a medical record.

[0096] Looking back to operation **610**, a determination may be made as to whether the apparatus is communica-

tively coupled with a personal computing platform (e.g., personal computing platform **104**). In some implementations, operation **610** may be performed by processor(s) **116** in conjunction with communications interface **118**. If the determination in operation **610** is negative, method **600** may proceed to operation **614**. If the determination in operation in operation **610** is positive, method **600** may proceed to operation **618**.

[0097] At operation **618**, information associated with the signals provided by the sensor bank may be transmitted from the apparatus to the personal computing platform. In some implementations, operation **618** may be performed by processor(s) **116** in conjunction with communications interface **118**.

[0098] At an operation **620**, the personal computing platform may display a graphical user interface (e.g., graphical user interface **500**) presenting code blue documentation. Operation **620** may be performed by processor(s) **144**, according to some implementations.

[0099] At an operation **622**, user annotations may be received by the personal computing platform and implemented in the code blue documentation. Operation **622** may be performed by processor(s) **144**, according to some implementations.

[0100] At an operation **624**, the code blue documentation may be finalized based on one or both of the information received from the apparatus and/or user annotations. Operation **624** may be performed by processor(s) **144**, according to some implementations.

[0101] At an operation **626**, the code blue documentation may be exported in an electronic document format (e.g., PDF). Operation **626** may be performed by processor(s) **144**, according to some implementations.

[0102] At an operation **628**, the code blue documentation may be presented for review of quality, educational purposes, and/or other purposes. Operation **628** may be performed by processor(s) **144**, according to some implementations.

[0103] FIG. **7** illustrates a method **700** for providing feedback to caregivers with a feedback apparatus during a code blue scenario, in accordance with one or more implementations. The system may comprise an enclosure, a sensor bank, a feedback interface, one or more processors, and/or other components. The one or more hardware processors may be configured by computer program instructions. The operations of method **700** presented below are intended to be illustrative. In some embodiments, method **700** may be accomplished with one or more additional operations not described, and/or without one or more of the operations discussed. Additionally, the order in which the operations of method **700** are illustrated in FIG. **7** and described below is not intended to be limiting.

[0104] In some embodiments, method **700** may be implemented in one or more processing devices (e.g., a digital processor, an analog processor, a digital circuit designed to process information, an analog circuit designed to process information, a state machine, and/or other mechanisms for electronically processing information). The one or more processing devices may include one or more devices executing some or all of the operations of method **700** in response to instructions stored electronically on an electronic storage medium. The one or more processing devices may include one or more devices configured through hardware, firmware, and/or software to be specifically designed for execution of one or more of the operations of method **700**.

[0105] At an operation **702**, the enclosure of the feedback apparatus may be adhered to the chest of a subject. In some implementations, the enclosure may be removably adhered to the skin of the subject's chest. The subject may be undergoing resuscitation. The enclosure may be configured to withstand compressive forces applied to the subject's chest from chest compressions during resuscitation of the subject. Components disposed within the enclosure may be protected from mechanical damage, electrical shock, and/or other conditions. The sensor bank may be at least partially disposed within the enclosure. The feedback interface may be coupled with the enclosure. Operation **702** may be performed by an enclosure the same as or similar to enclosure **108** (shown in FIG. **1** and described herein) according to some implementations.

[0106] At an operation **704**, signals that convey information associated with the code blue scenario may be provided. The information may include vital signs of the subject during resuscitation, information associated with chest movements of the subject during resuscitation, audio information from an environment surrounding the subject during resuscitation, and/or other information. In some implementations, operation **704** comprises generating, with a heart rate sensor of the sensor bank, a signal conveying information associated with a heart rate of the subject during resuscitation. In some implementations, operation **704** comprises generating, with a cardiac rhythm sensor of the sensor bank, a signal conveying information associated with a cardiac rhythm of the subject during resuscitation. In some implementations, operation **704** comprises generating, with a respiration sensor of the sensor bank, a signal conveying information associated with a respiration of the subject during resuscitation. In some implementations, operation **704** comprises generating, with a chest movement sensor of the sensor bank, a signal conveying information associated with chest movements caused by artificial respiration provided to the subject during resuscitation. In some implementations, operation **704** comprises generating, with a temperature sensor of the sensor bank, a signal conveying information associated with a temperature of the subject during resuscitation. In some implementations, operation **704** comprises generating, with a blood pressure sensor of the sensor bank, a signal conveying information associated with a blood pressure of the subject during resuscitation. In some implementations, operation **704** comprises generating, with an oxygen saturation sensor of the sensor bank, a signal conveying information associated with an oxygen saturation of the subject during resuscitation. In some implementations, operation **704** comprises generating, with a chest compression sensor of the sensor bank, a signal conveying information associated with chest compressions performed on the subject during resuscitation. In some implementations, operation **704** comprises generating, with a cardioversion and/or defibrillation sensor of the sensor bank, a signal conveying information associated with cardioversion procedures and/or defibrillation procedures performed on the subject during resuscitation. In some implementations, operation **704** comprises generating, with a verbal communication sensor of the sensor bank, a signal conveying information associated with verbal communication in an environment of the subject during resuscitation. Operation **704** may be performed by a sensor bank the same as or

similar to sensor bank **112** (shown in FIG. **1** and described herein) according to some implementations.

[0107] At an operation **706**, real time feedback for caregivers may be generated based on the information in the signals and/or other information. The real-time feedback may comprise a recommendation to begin resuscitation, adjustments that should be made to ongoing resuscitation, and/or other feedback. In some implementations, the real-time feedback may comprise adjustments that should be made to ongoing resuscitation. Such adjustments may comprise recommended changes to one or more of a compression rate, a compression depth, a pause between compressions, or a compression interval of cardiopulmonary resuscitation (CPR) chest compressions performed on the subject during the code blue scenario.

[0108] In some implementations, generating the real-time feedback based on the information in the signals from the sensor bank may comprise determining time elapsed since a collapse of the subject. The time elapsed since a collapse may be determined to be at least one minute (for example) responsive to the information in the signals from the sensor bank indicating ventricular fibrillation and no respiratory movement in the subject.

[0109] In some implementations, the real-time feedback may comprise a recommendation to begin chest compressions on the subject. The recommendation to begin chest compressions on the subject may be determined responsive to the time elapsed since collapse of the subject being at least one minute (for example), the information in the signals from the sensor bank indicating no respiratory movement, the information in the signals from the sensor bank indicating no pulse in the subject, and/or other information. In some implementations, the real-time feedback may comprise a recommendation to shock or defibrillate the subject. The recommendation to shock or defibrillate the subject may be determined responsive to a time elapsed since a start of chest compressions being at least three minutes (for example), the information in the signals from the sensor bank indicating ventricular fibrillation, the information in the signals from the sensor bank indicating no pulse in the subject, and/or other information. In some implementations, the real-time feedback may comprise a recommendation to inject the subject with epinephrine. The recommendation to inject the subject with epinephrine may be determined responsive to a time elapsed since a start of chest compressions being at least five minutes (for example), the information in the signals from the sensor bank indicating ventricular fibrillation, the information in the signals from the sensor bank indicating no pulse in the subject, and/or other information.

[0110] In some implementations, the subject may be receiving positive pressure ventilation during the code blue scenario. In such implementations, the real-time feedback may comprise a recommendation to adjust a ventilation pressure, a ventilation rate, and/or other ventilation parameters. The recommendation to adjust the ventilation pressure and/or the ventilation rate may be determined based on information in the signals related to a rate and depth of chest rise in the subject, for example.

[0111] In some implementations, generating the real-time feedback based on the information in the signals from the sensor bank may comprise a machine-learning analysis of the information in the signals from the sensor bank. The machine-learning analysis may comprise determining which future actions taken by caregivers during resuscitation would improve a likelihood of recovery from the code blue scenario by the subject. The machine learning analysis may comprise generating the real-time feedback based on the predictions and/or other operations. Operation **706** may be performed by one or more feedback processors the same as or similar to feedback processor **109** (shown in FIG. **1** and described herein) according to some implementations.

[0112] At an operation **708**, the real-time feedback may be provided to the caregivers during the code blue scenario. Operation **708** may be performed by a feedback interface the same as or similar to feedback interface **113** (shown in FIG. **1** and described herein) according to some implementations. The feedback interface may comprise one or more of a display screen, one or more indicator lights, a speaker, communications components, and/or other components. The real-time feedback may be provided to the caregivers via one or more of a computing platform located remotely from the enclosure, the display screen, the one or more indicator lights, the speaker, and/or the other components. In some implementations, the feedback interface may include a timer. In some implementations, the timer may be activated responsive to one or both of the apparatus being removably adhered to the subject's chest or an adhesive cover being removed from the enclosure, for example.

[0113] Although the present technology has been described in detail for the purpose of illustration based on what is currently considered to be the most practical and preferred implementations, it is to be understood that such detail is solely for that purpose and that the technology is not limited to the disclosed implementations, but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the appended claims. For example, it is to be understood that the present technology contemplates that, to the extent possible, one or more features of any implementation can be combined with one or more features of any other implementation.

What is claimed is:

1. An apparatus configured to provide feedback to caregivers during a code blue scenario, the apparatus comprising:

an enclosure adhered to a chest of a subject undergoing resuscitation, the enclosure configured to withstand compressive forces applied to the subject's chest from chest compressions during resuscitation of the subject such that components disposed within the enclosure are protected from mechanical damage;

a sensor bank at least partially disposed within the enclosure, the sensor bank being configured to provide signals conveying information associated with the code blue scenario, the information including vital signs of the subject during resuscitation, information associated with chest movements of the subject during resuscitation, and audio information from an environment surrounding the subject during resuscitation;

a feedback interface coupled with the enclosure, the feedback interface configured to provide real-time feedback to the caregivers during the code blue scenario, the real-time feedback comprising a recommendation to begin resuscitation, and/or adjustments that should be made to ongoing resuscitation; and

one or more processors operatively coupled with the sensor bank and the feedback interface, the one or more processors configured by computer program instruc-

tions to generate the real-time feedback based on the information in the signals from the sensor bank.

2. The apparatus of claim **1**, wherein the feedback interface comprises one or more of a display screen, one or more indicator lights, or a speaker, and wherein the feedback interface is configured to provide the real-time feedback to the caregivers via one or more of the display screen, the one or more indicator lights, or the speaker.

3. The apparatus of claim **1**, wherein the one or more processors are configured such that generating the real-time feedback based on the information in the signals from the sensor bank comprises a machine-learning analysis of the information in the signals from the sensor bank, the machine-learning analysis comprising determining which future actions taken by caregivers during resuscitation would improve a likelihood of recovery from the code blue scenario by the subject, and generating the real-time feedback based on the predictions.

4. The apparatus of claim **1**, wherein the enclosure is further configured to removably adhere to skin of the subject's chest.

5. The apparatus of claim **1**, wherein the one or more processors are configured such that the real-time feedback comprises adjustments that should be made to ongoing resuscitation, the adjustments comprising recommended changes to one or more of a compression rate, a compression depth, a pause between compressions, or a compression interval of cardiopulmonary resuscitation (CPR) chest compressions performed on the subject during the code blue scenario.

6. The apparatus of claim **1**, wherein the feedback interface includes a timer, and wherein the timer is activated responsive to one or both of the apparatus being removably adhered to the subject's chest or an adhesive cover being removed from the enclosure.

7. The apparatus of claim **6**, wherein the one or more processors are configured such that generating the real-time feedback based on the information in the signals from the sensor bank comprises determining time elapsed since collapse of the subject, the time elapsed since collapse determined to be at least one minute responsive to the information in the signals from the sensor bank indicating ventricular fibrillation and no respiratory movement.

8. The apparatus of claim **7**, wherein the one or more processors are configured such that the real-time feedback comprises a recommendation to begin chest compressions on the subject, the recommendation to begin chest compressions on the subject determined responsive to the time elapsed since collapse of the subject being at least one minute, the information in the signals from the sensor bank indicating no respiratory movement, and the information in the signals from the sensor bank indicating no pulse in the subject.

9. The apparatus of claim **8**, wherein the one or more processors are configured such that the real-time feedback comprises a recommendation to shock or defibrillate the subject, the recommendation to shock or defibrillate the subject determined responsive to a time elapsed since a start of chest compressions being at least three minutes, the information in the signals from the sensor bank indicating ventricular fibrillation, and the information in the signals from the sensor bank indicating no pulse in the subject.

10. The apparatus of claim **8**, wherein the one or more processors are configured such that the real-time feedback comprises a recommendation to inject the subject with epinephrine, the recommendation to inject the subject with epinephrine determined responsive to a time elapsed since a start of chest compressions being at least five minutes, the information in the signals from the sensor bank indicating ventricular fibrillation, and the information in the signals from the sensor bank indicating no pulse in the subject.

11. The apparatus of claim **1**, wherein the subject is receiving positive pressure ventilation during the code blue scenario, and wherein the one or more processors are configured such that the real-time feedback comprises a recommendation to adjust a ventilation pressure and/or a ventilation rate, the recommendation to adjust the ventilation pressure and/or the ventilation rate determined based on information in the signals related to a rate and depth of chest rise in the subject.

12. The apparatus of claim **1**, wherein the sensor bank includes:

a heart rate sensor configured to provide a signal conveying information associated with a heart rate of the subject during resuscitation;

a cardiac rhythm sensor configured to provide a signal conveying information associated with a cardiac rhythm of the subject during resuscitation;

a respiration sensor configured to provide a signal conveying information associated with a respiration of the subject during resuscitation;

a chest movement sensor configured to provide a signal conveying information associated with chest movements caused by artificial respiration provided to the subject during resuscitation;

a temperature sensor configured to provide a signal conveying information associated with a temperature of the subject during resuscitation;

a blood pressure sensor configured to provide a signal conveying information associated with a blood pressure of the subject during resuscitation;

an oxygen saturation sensor configured to provide a signal conveying information associated with an oxygen saturation of the subject during resuscitation;

a chest compression sensor configured to provide a signal conveying information associated with chest compressions performed on the subject during resuscitation;

a cardioversion and/or defibrillation sensor configured to provide a signal conveying information associated with cardioversion procedures and/or defibrillation procedures performed on the subject during resuscitation; and

a verbal communication sensor configured to provide a signal conveying information associated with verbal communication in an environment of the subject during resuscitation.

13. A method for providing feedback to caregivers with a feedback apparatus during a code blue scenario, the apparatus comprising an enclosure, a sensor bank, a feedback interface, and one or more processors configured by computer program instructions, the method comprising:

adhering the enclosure to a chest of a subject undergoing resuscitation, the enclosure configured to withstand compressive forces applied to the subject's chest from chest compressions during resuscitation of the subject such that components disposed within the enclosure are protected from mechanical damage, wherein the sensor

bank is at least partially disposed within the enclosure, and wherein the feedback interface is coupled with the enclosure;

providing signals with the sensor bank that convey information associated with the code blue scenario, the information including vital signs of the subject during resuscitation, information associated with chest movements of the subject during resuscitation, and audio information from an environment surrounding the subject during resuscitation;

generating real-time feedback for the caregivers based on the information in the signals from the sensor bank with the one or more processors, the real-time feedback comprising a recommendation to begin resuscitation, and/or adjustments that should be made to ongoing resuscitation; and

providing the real-time feedback to the caregivers during the code blue scenario with the feedback interface.

14. The method of claim **13**, wherein the feedback interface comprises one or more of a display screen, one or more indicator lights, or a speaker, and wherein the real-time feedback is provided to the caregivers via one or more of the display screen, the one or more indicator lights, or the speaker.

15. The method of claim **13**, wherein generating the real-time feedback based on the information in the signals from the sensor bank comprises a machine-learning analysis of the information in the signals from the sensor bank, the machine-learning analysis comprising determining which future actions taken by caregivers during resuscitation would improve a likelihood of recovery from the code blue scenario by the subject, and generating the real-time feedback based on the predictions.

16. The method of claim **13**, further comprising removably adhering the enclosure to skin of the subject's chest.

17. The method of claim **13**, wherein the real-time feedback comprises adjustments that should be made to ongoing resuscitation, the adjustments comprising recommended changes to one or more of a compression rate, a compression depth, a pause between compressions, or a compression interval of cardiopulmonary resuscitation (CPR) chest compressions performed on the subject during the code blue scenario.

18. The method of claim **13**, wherein the feedback interface includes a timer, the method further comprising activating the timer responsive to one or both of the apparatus being removably adhered to the subject's chest or an adhesive cover being removed from the enclosure.

19. The method of claim **18**, wherein generating the real-time feedback based on the information in the signals from the sensor bank comprises determining time elapsed since collapse of the subject, the time elapsed since collapse determined to be at least one minute responsive to the information in the signals from the sensor bank indicating ventricular fibrillation and no respiratory movement.

20. The method of claim **19**, wherein the real-time feedback comprises a recommendation to begin chest compressions on the subject, the recommendation to begin chest compressions on the subject determined responsive to the time elapsed since collapse of the subject being at least one minute, the information in the signals from the sensor bank indicating no respiratory movement, and the information in the signals from the sensor bank indicating no pulse in the subject.

21. The method of claim **20**, wherein the real-time feedback comprises a recommendation to shock or defibrillate the subject, the recommendation to shock or defibrillate the subject determined responsive to a time elapsed since a start of chest compressions being at least three minutes, the information in the signals from the sensor bank indicating ventricular fibrillation, and the information in the signals from the sensor bank indicating no pulse in the subject.

22. The method of claim **20**, wherein the real-time feedback comprises a recommendation to inject the subject with epinephrine, the recommendation to inject the subject with epinephrine determined responsive to a time elapsed since a start of chest compressions being at least five minutes, the information in the signals from the sensor bank indicating ventricular fibrillation, and the information in the signals from the sensor bank indicating no pulse in the subject.

23. The method of claim **13**, wherein the subject is receiving positive pressure ventilation during the code blue scenario, and wherein the real-time feedback comprises a recommendation to adjust a ventilation pressure and/or a ventilation rate, the recommendation to adjust the ventilation pressure and/or the ventilation rate determined based on information in the signals related to a rate and depth of chest rise in the subject.

24. The method of claim **13**, further comprising:

generating, with a heart rate sensor of the sensor bank, a signal conveying information associated with a heart rate of the subject during resuscitation;

generating, with a cardiac rhythm sensor of the sensor bank, a signal conveying information associated with a cardiac rhythm of the subject during resuscitation;

generating, with a respiration sensor of the sensor bank, a signal conveying information associated with a respiration of the subject during resuscitation;

generating, with a chest movement sensor of the sensor bank, a signal conveying information associated with chest movements caused by artificial respiration provided to the subject during resuscitation;

generating, with a temperature sensor of the sensor bank, a signal conveying information associated with a temperature of the subject during resuscitation;

generating, with a blood pressure sensor of the sensor bank, a signal conveying information associated with a blood pressure of the subject during resuscitation;

generating, with an oxygen saturation sensor of the sensor bank, a signal conveying information associated with an oxygen saturation of the subject during resuscitation;

generating, with a chest compression sensor of the sensor bank, a signal conveying information associated with chest compressions performed on the subject during resuscitation;

generating, with a cardioversion and/or defibrillation sensor of the sensor bank, a signal conveying information associated with cardioversion procedures and/or defibrillation procedures performed on the subject during resuscitation; and

generating, with a verbal communication sensor of the sensor bank, a signal conveying information associated with verbal communication in an environment of the subject during resuscitation.

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专利名称(译)	用于记录代码蓝色场景的系统，装置和方法		
公开(公告)号	US20180250519A1	公开(公告)日	2018-09-06
申请号	US15/974367	申请日	2018-05-08
[标]申请(专利权)人(译)	洛杉矶生物医学RES INST在港湾UCLA医仙		
申请(专利权)人(译)	洛杉矶生物医学研究所在港湾，加州大学洛杉矶分校医学中心		
当前申请(专利权)人(译)	洛杉矶生物医学研究所在港湾，加州大学洛杉矶分校医学中心		
[标]发明人	CHANG RUEY KANG		
发明人	CHANG, RUEY-KANG		
IPC分类号	A61N1/39 A61B5/0205 A61B5/021 A61B5/08 A61B5/00 G16H40/63 A61H31/00		
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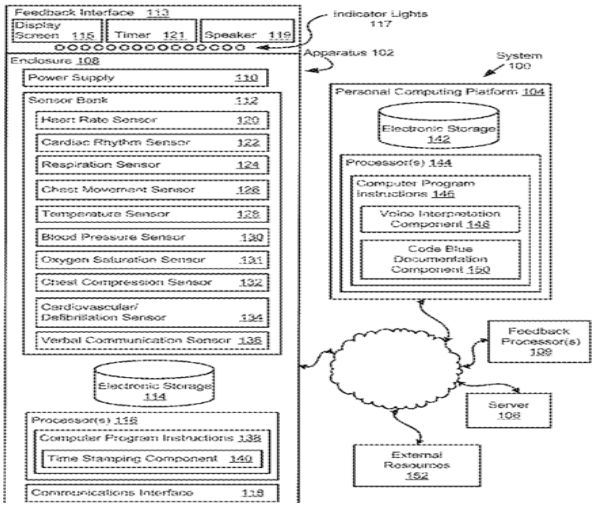
外部链接	Espacenet USPTO		

摘要(译)

装置可以被配置用于通过感测和发送与代码蓝色情景相关联的信息，在代码蓝色情景期间当通过感测和发送经历复苏的对象的胸部时向护理者提供反馈。这样的信息可以包括在复苏期间受试者的生命体征中的一个或多个，与复苏期间受试者的胸部运动相关联的信息，以及在复苏期间来自受试者的环境的音频信息。一个或多个处理器可以基于所感测和传输的信息生成用于在代码蓝场景期间与护理人员通信的实时反馈。