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(54) **AUTOMATIC DRUG ADMINISTRATION DEVICE AND METHOD**

(71) Applicant: **Hays, Inc.**, Onsted, MI (US)

(72) Inventor: **Gregory Hays**, Onsted, MI (US)

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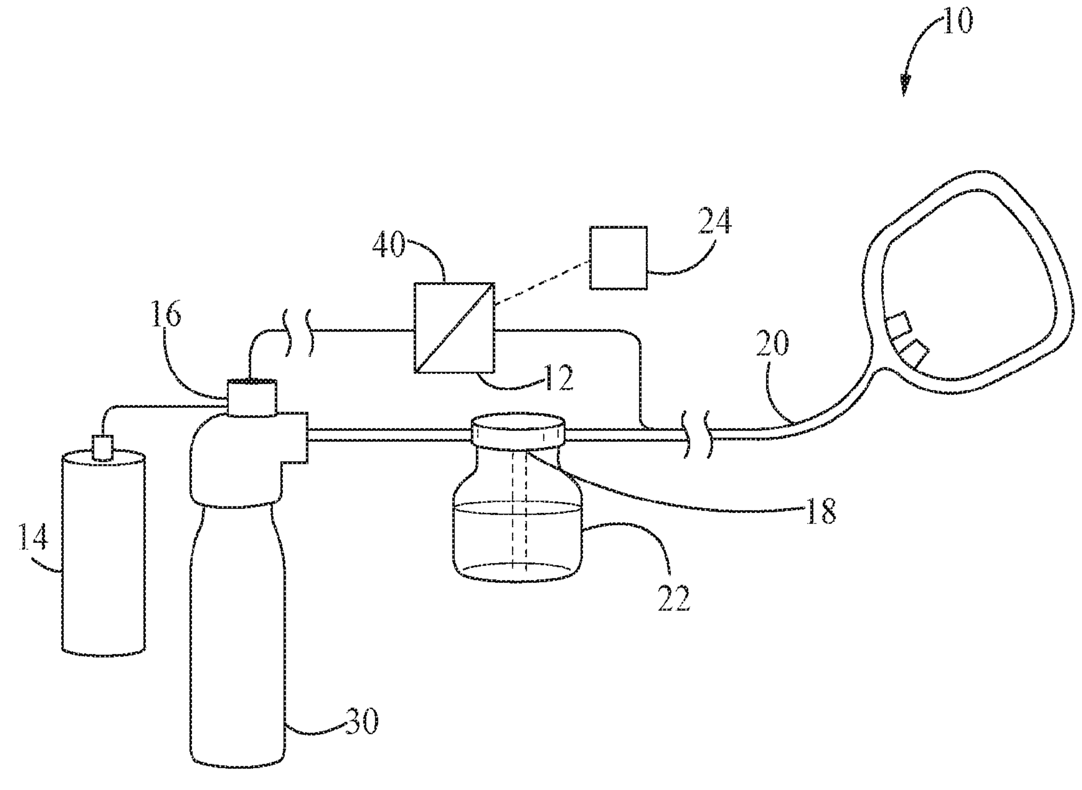
(57) **ABSTRACT**

A device for detecting an overdose and automatically administering a drug includes a sensor configured to measure a condition of a user indicative of overdose. The device includes a container that retains the drug and a drug delivery device fluidly connected to the sensor and the container. The device includes a pressurized gas container retaining pressurized gas. The pressurized gas container is configured to release the pressurized gas to expel the drug from the container into the drug delivery device. The device includes a controller electrically coupled to the sensor and the pressurized gas container. The controller is configured to determine whether to release the pressurized gas. The device is wearable by the user and is portable such that movement and location of the user is not restricted



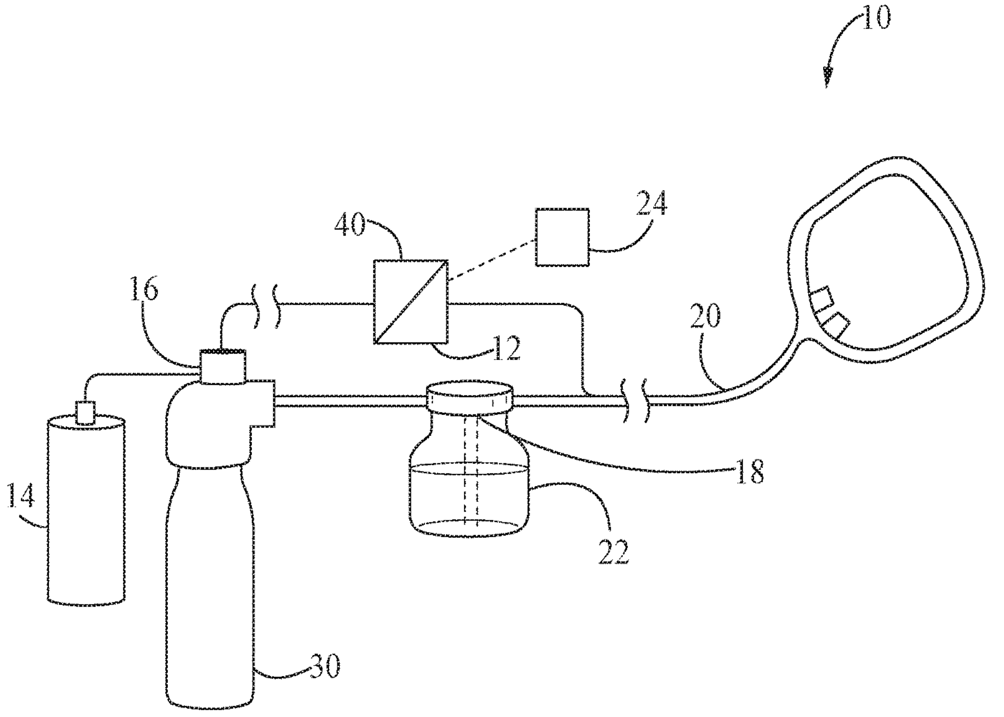



FIG. 1

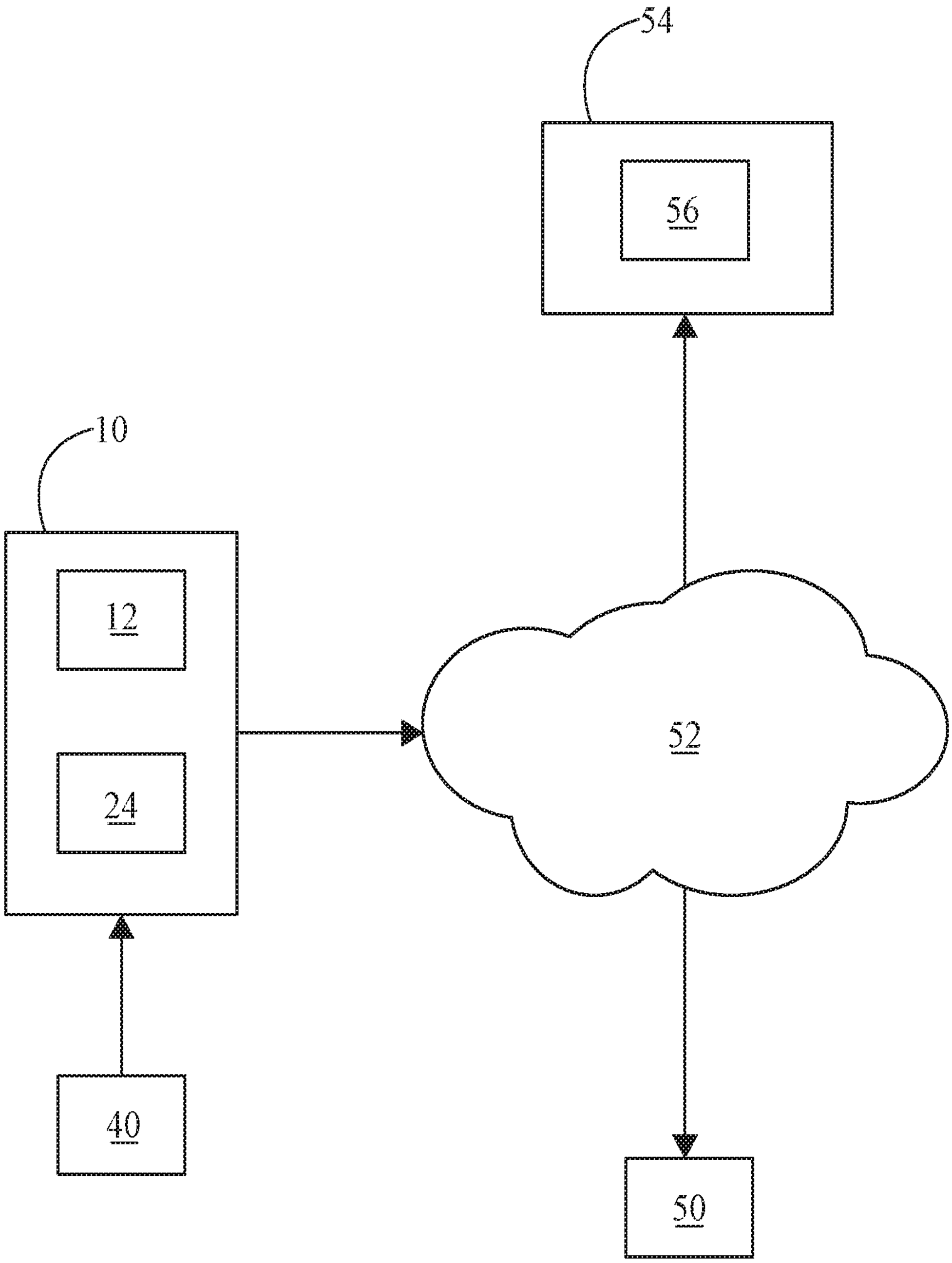



FIG. 2

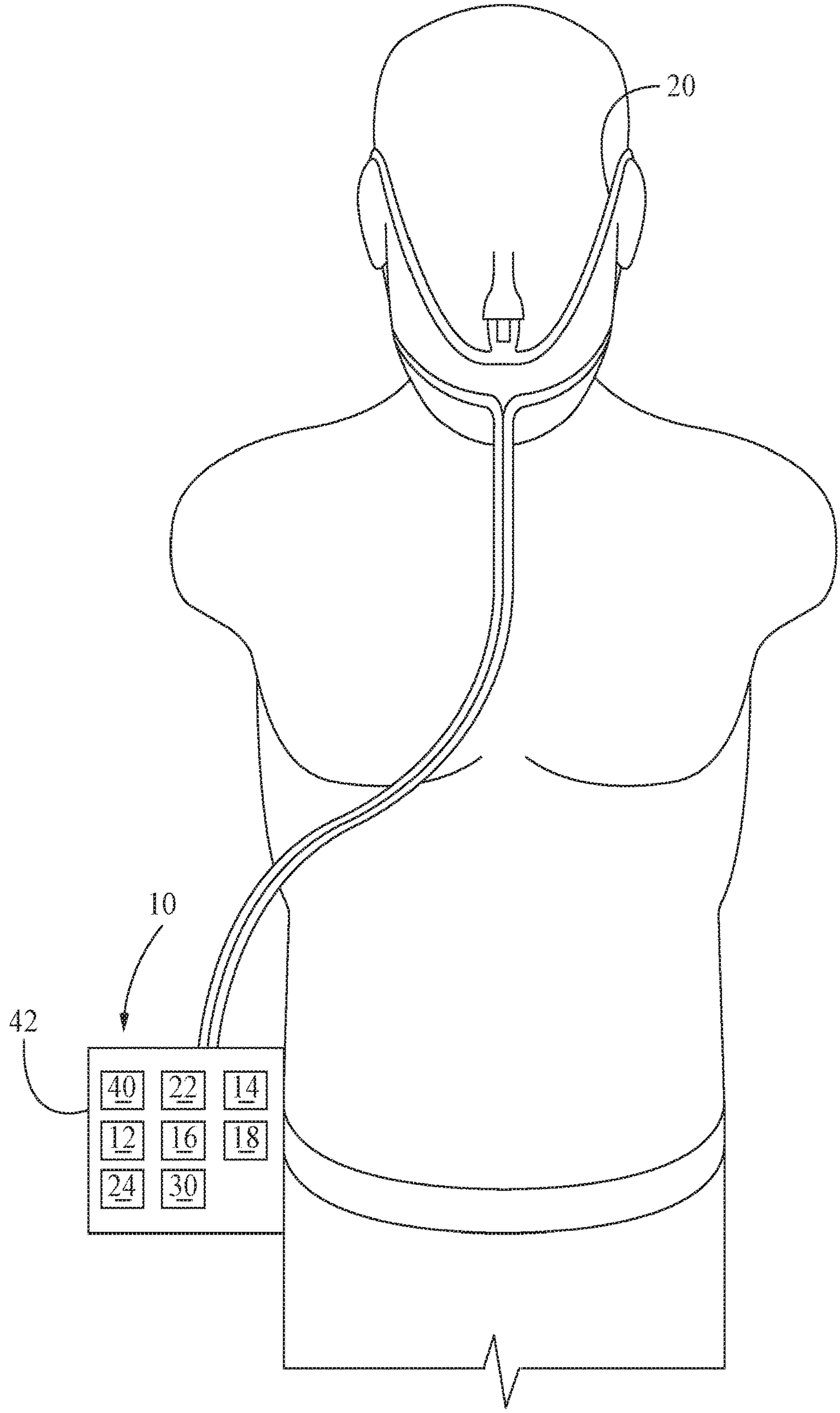



FIG. 3

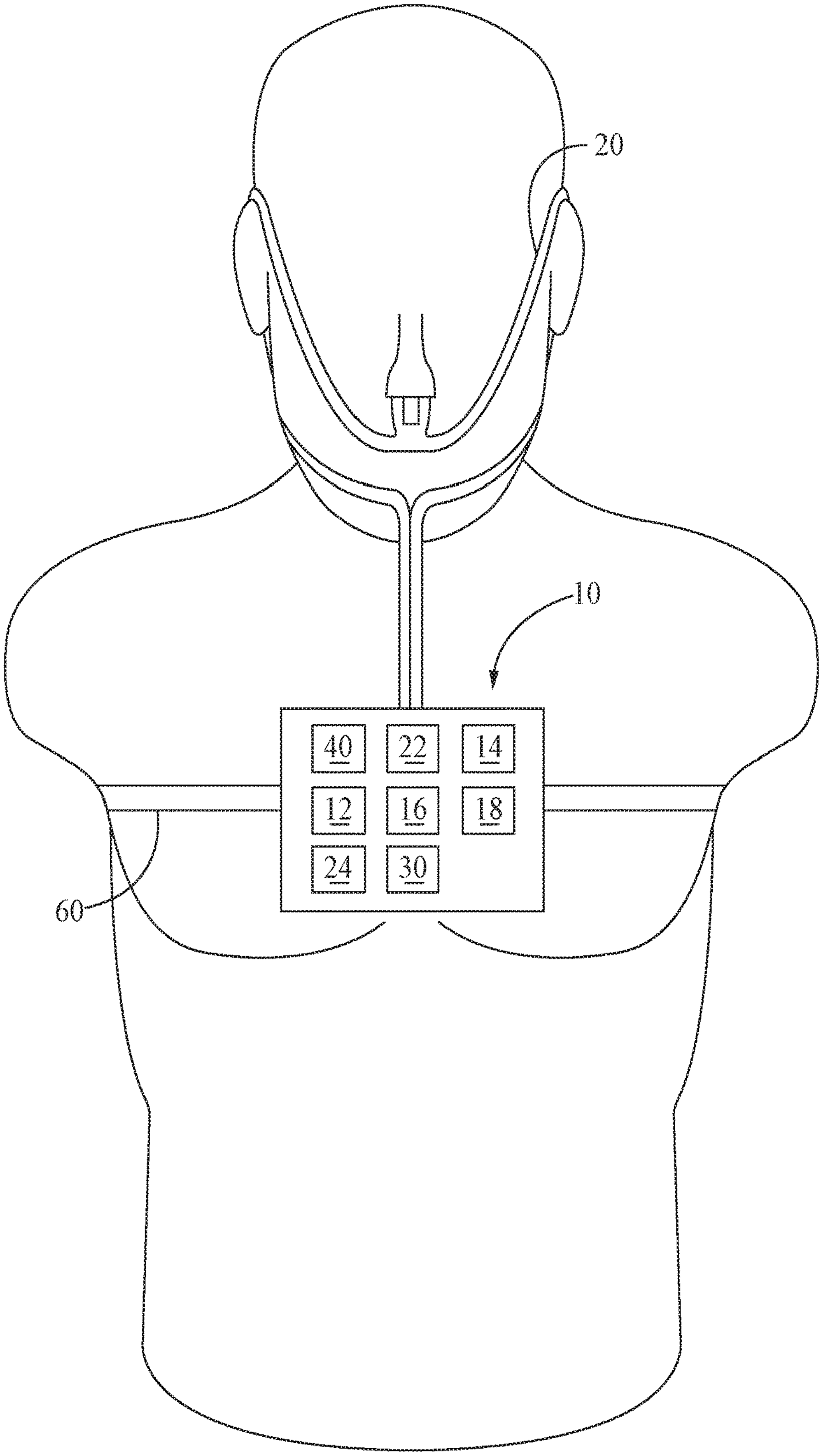



FIG. 4

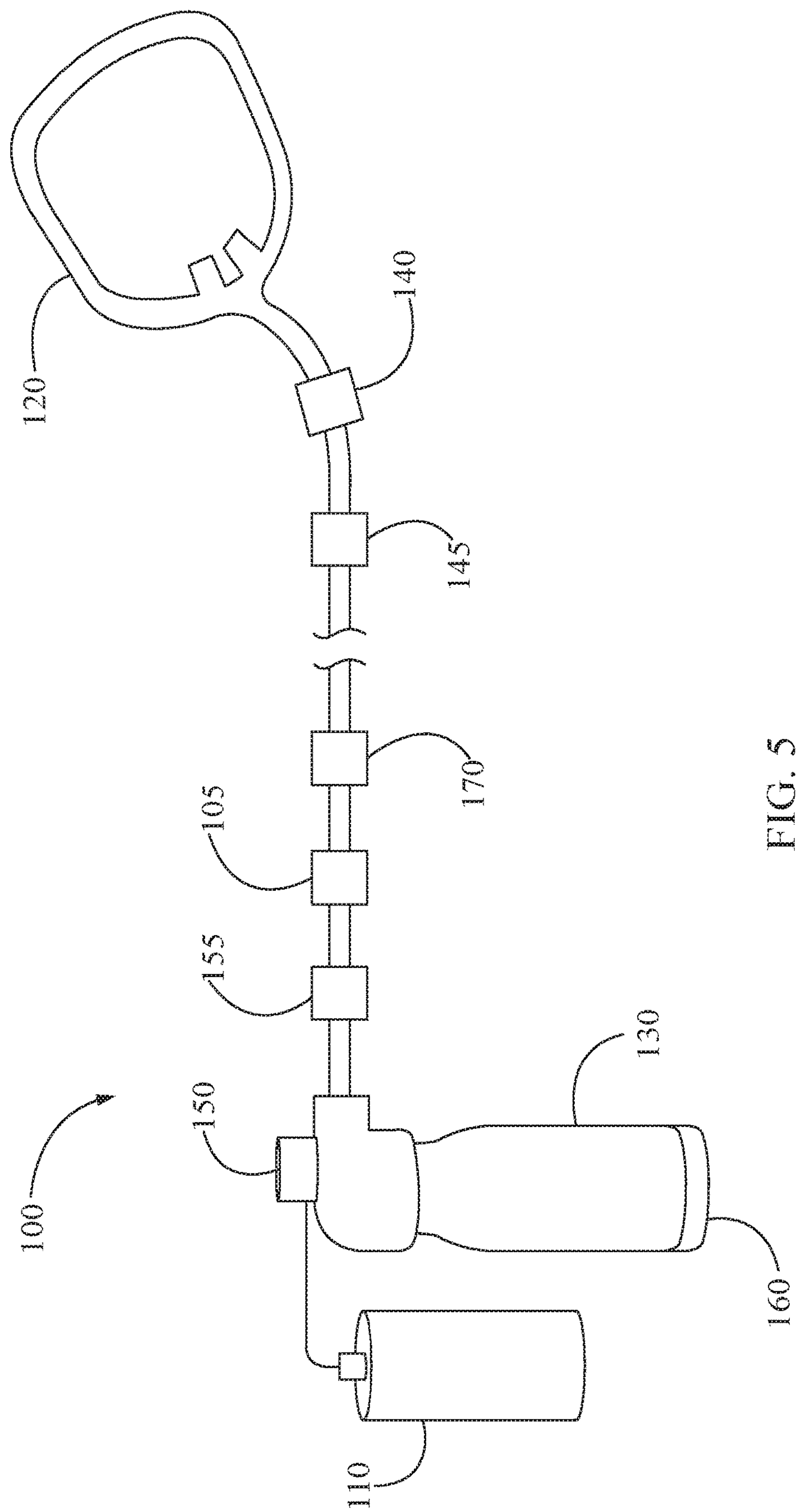



FIG. 5

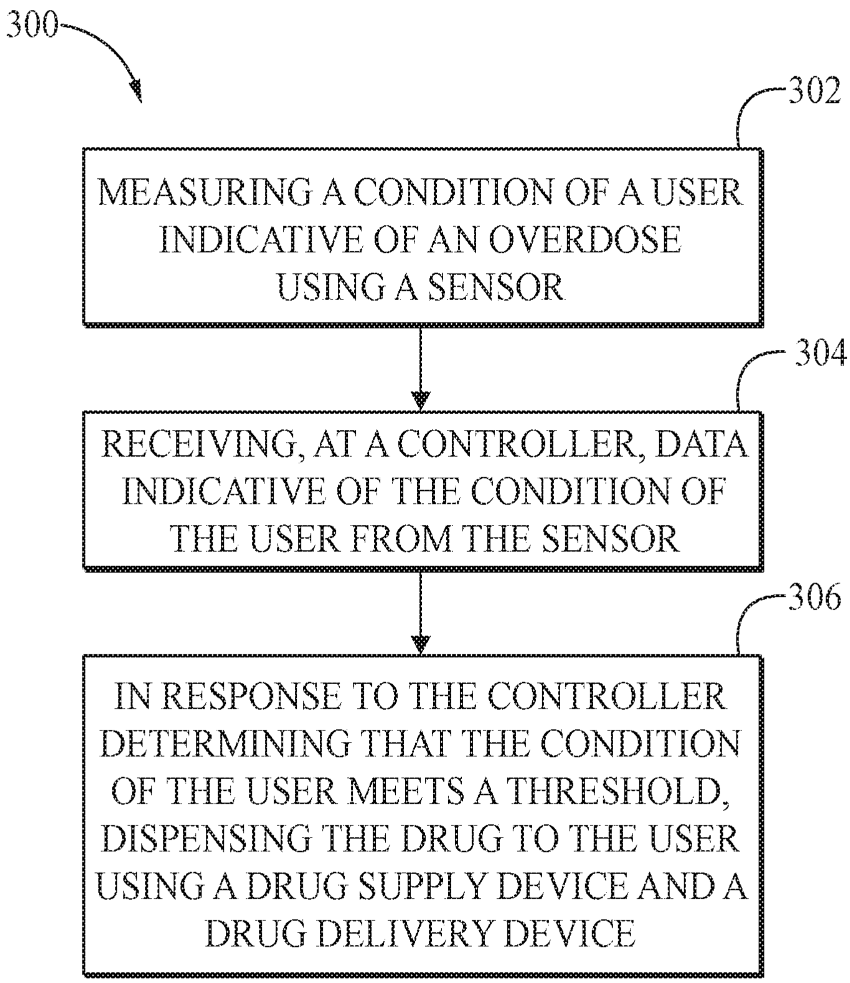

300
302
MEASURING A CONDITION OF A USER INDICATIVE OF AN OVERDOSE USING A SENSOR
304
RECEIVING, AT A CONTROLLER, DATA INDICATIVE OF THE CONDITION OF THE USER FROM THE SENSOR
306
IN RESPONSE TO THE CONTROLLER DETERMINING THAT THE CONDITION OF THE USER MEETS A THRESHOLD, DISPENSING THE DRUG TO THE USER USING A DRUG SUPPLY DEVICE AND A DRUG DELIVERY DEVICE

FIG. 6

# AUTOMATIC DRUG ADMINISTRATION DEVICE AND METHOD

## CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/578,689, filed on Oct. 30, 2017, the content of which is hereby incorporated by reference in its entirety for all purposes.

## TECHNICAL FIELD

[0002] This disclosure generally relates to the field of automatic drug administration devices and methods. The disclosure has a non-exclusive use with pharmaceutical compounds to treat narcotic overdose.

## BACKGROUND

[0003] The use of prescription opioid drugs has been on the rise since the mid-2000s resulting in the current opioid epidemic. Nearly half of all opioid related deaths have been attributed to prescriptions. Drug overdoses have since become the leading cause of death of Americans under 50, with two-thirds of those deaths caused by opioids.

[0004] A popular treatment for opioid addiction is naloxone (NARCAN®) that is primarily used as an emergency treatment for acute opioid overdose. Naloxone must be administered within minutes of the overdose to prevent brain damage or death.

## SUMMARY

[0005] One aspect of the disclosure is a device for detecting an overdose and automatically administering a drug. The device includes a sensor configured to measure a condition of a user indicative of overdose. The device includes a container that retains the drug and a drug delivery device fluidly connected to the sensor and the container. The device includes a pressurized gas container retaining pressurized gas, the pressurized gas container being configured to release the pressurized gas to expel the drug from the container into the drug delivery device. The device includes a controller electrically coupled to the sensor and the pressurized gas container, wherein the controller is configured to release the pressurized gas upon a predetermined event.

[0006] Another aspect of the disclosure is a device for detecting an overdose and automatically administering a drug. The device includes a sensor configured to monitor breathing of a user and a container retaining the drug. The device includes a nasal cannula fluidly connected to the container and the sensor. The device includes a drug supply device configured to carry the drug through the nasal cannula and to the user. The device includes a mobile alert device and a controller electrically coupled to the mobile alert device, the sensor, and the drug supply device. The controller is configured to the drug supply device to supply the drug to the user through the nasal cannula upon a predetermined event, such as undetectable respiration. The controller is configured to use the mobile alert device to send a notification to an external device in response to supplying the drug to the user.

[0007] Another aspect of the disclosure is a method for detecting an overdose and automatically administering a drug. The method includes measuring a condition of a user indicative of an overdose using a sensor. The method includes receiving, at a controller, data indicative of the condition of the user from the sensor. The method includes in response to the controller determining that the condition of the user meets a threshold, dispensing the drug to the user using a drug supply device and a drug delivery device.

[0008] Another method for detecting an overdose and automatically administering a drug comprises providing to a user a portable device including a nasal cannula connected to a sensor and a drug delivery means to be worn by the user during opioid use; monitoring using the sensor respiration of the user through the nasal cannula; when the sensor detects a respiration event, automatically activating the drug delivery means to propel a drug to the user through the nasal cannula to reestablish respiration.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention is best understood from the following detailed description when read in conjunction with the accompanying drawings. It is emphasized that, according to common practice, the various features of the drawings are not to-scale. On the contrary, the dimensions of the various features are arbitrarily expanded or reduced for clarity.

[0010] FIG. **1** is a diagram of a device configured to detect an overdose and automatically administer a drug according to one embodiment.

[0011] FIG. **2** is a block diagram of an example of communication between the device and one or more external devices.

[0012] FIG. **3** is a diagram of the device connected to the user according to one embodiment.

[0013] FIG. **4** is a diagram the device according to one embodiment where the detection means includes an RIP band.

[0014] FIG. **5** is a diagram of a device configured to detect an overdose and automatically administer a drug according to another embodiment.

[0015] FIG. **6** is a flowchart of a process for detecting an overdose and automatically administering a drug.

## DETAILED DESCRIPTION

[0016] When a drug user overdoses, medical assistance often arrives too late to prevent brain damage or death of the drug user. Accordingly, there is a need for a portable device that can be worn or carried by the drug user that detects a potential overdose and automatically administers an antidote, such as naloxone, without the intervention of the drug user, to save the life of the drug user during an acute opioid overdose. Devices disclosed herein are configured to be portable and worn by the drug user, to monitor the user for conditions indicative of drug overdose, to determine whether an indicator of drug overdose exists, and to deliver a drug such as naloxone to the user in response to determining that the indicator exists. In some embodiments, the devices may send a notification and the user's location to one or more external devices.

[0017] FIG. **1** is a diagram of a device **10** configured to detect an overdose and automatically administer a drug without human intervention according to one embodiment. The device **10** is meant to be portable and is worn or carried by a user who is taking harmful substances with a potential for overdosing, such as opioid or heroin. In some embodiments, the device **10** can be connected to the user. For example, the device **10** can be connected to the user around the user's waist using a belt clip (not shown), around the user's chest using an elastic band, or can be attached to any other portion of the user in any other suitable manner. In some embodiments, the device **10** can be carried by the user. For example, the device **10** can be carried in a pocket of a shirt, jacket, pants, or any other article of clothing. The device **10** can also be disposed in a housing, bag, purse, fanny pack, or any other container.

**[0018]** The device **10** includes a detection means **40** for measuring one or more conditions of the user. For example, the detection means **40** may measure conditions indicative of user overdose (e.g. a hypoxic state or an imminent hypoxic state). The detection means **40** can include a respiration sensor, a carbon dioxide ($CO_2$) sensor, a Respiratory Inductance Plethysmography (RIP) band, a pulse oximeter, one or more other sensors, or a combination thereof. In the illustrated example, the detection means **40** is a $CO_2$ sensor.

**[0019]** The device **10** also includes a drug delivery device **20**. The drug delivery device **20** facilitates delivery of the drug from the device **10** to the user. The drug delivery device **20** can include any nasal cannula, breathing mask, or any other suitable medical device allowing the user to inhale the drug into the user's respiratory system. In the illustrated example, the drug delivery device **20** includes a high-flow nasal cannula having one end connected to the device **10** and an opposing end portion configured to be retained in the nostrils of the user. In some embodiments, the detection means **40** may be fluidly connected to the drug delivery device **20**. For example, the drug delivery device **20** may include a nasal cannula and the detection means **40** may include a respiration sensor disposed inside the nasal cannula. In some embodiments, the detection means **40** may not be fluidly connected with the drug delivery device **20**.

**[0020]** In some embodiments, the drug delivery device **20** may include a needle, syringe, intravenous line (IV) or any other injection device that injects the drug into the user. A container retaining the drug can be positioned on or near the user's body at a location in which, when activated, the injection device would penetrate the user's skin and inject the drug into the user.

**[0021]** The device **10** includes a container **22** fluidly connected with the drug delivery device **20** such that the drug delivery device **20** can facilitate transportation of the drug from the container **22** to the user. The container **22** retains (e.g. holds) the drug. The drug can include any medication, antidote, or any drug including but not limited to naloxone.

**[0022]** The device **10** includes a drug supply device **30** for supplying the drug to the user. For example, the drug supply device **30** may transport the drug from the container **22**, through the drug delivery device **20**, and to the user. In one embodiment, the drug supply device **30** is configured to aerosolize or atomize the drug. The drug supply device **30** can include, for example, a pressurized gas container, a plunger, a fan, any other suitable device, or combination thereof.

**[0023]** In FIG. **1**, the drug supply device **30** is illustrated as being a pressurized gas container. The pressurized gas container retains pressurized gas including air, oxygen, $CO_2$, or any other gas. In some embodiments, the pressurized gas container is configured to release the pressurized gas to expel the drug from the container **22**, through the drug delivery device **20**, and to the user. In some embodiments, the drug supply device **30** may include a pressure sensor adapted to measure the pressure of the pressurized gas inside the pressurized gas container. The pressure sensor can be used to measure remaining doses of the drug, or to confirm that there is adequate gas left in the pressurized gas container to deliver the drug to the user if needed. In some embodiments, the device **10** may not include the drug supply device **30** and the drug may be retained in a pressurized container that is configured to deliver the drug to the user.

**[0024]** In some embodiments, the controller **12** may activate an electronically activated valve **16** fluidly connected to the drug supply device **30** to supply the drug to the user. For example, in response to engaging the electronically activated valve **16**, the pressurized gas inside the pressurized gas container may be released into the drug delivery device **20** to deliver the drug to the user. In some embodiments, the container **22** of the drug may include a venturi valve **18** to assist in the administration of the drug by increasing its velocity while exiting the container **22**.

**[0025]** Once the device **10** is connected to the user, the device **10** is intended to be in continuous use. That is, once connected to the user, the device **10** can, as further described below, monitor the user and deliver the drug to the user in response to detection of an adverse medical condition, such as overdose. In some embodiments, the drug delivery device **20** (e.g. the nasal cannula or the breathing mask) is the only part of the device **10** that is viewable by others.

**[0026]** In some embodiments, the device **10** can be set up on a user who may not be able to physically and/or consciously engage with (e.g. set up, wear, turn on and off, etc.) the device **10**. In other words, the drug delivery device **20** can be placed on the user by a third party such that the third party does not have to monitor the user to prevent the user from overdosing. For example, the third party may place the nasal cannula in the user's nostrils, place the breathing mask over the user's nose and/or mouth, or place the injection device in or near the user. In some embodiments, the user can himself or herself place the drug delivery device **20** in an operable position prior to and/or during the use of harmful substances so the device **10** can be used to prevent potential overdoses.

**[0027]** The device **10** includes a controller **12** electrically coupled to any described component including but not limited to the detection means **40**, the drug supply device **30**, the drug delivery device **20**, and a power source **14**. The power source **14** may include one or more batteries of any type or any other suitable power source. In some embodiments, the power source **14** may include multiple power sources, each powering one or more described components.

**[0028]** In some embodiments, the device **10** can include one or more indicators configured to communicate information to the user and/or third parties. For example, the one or more indicators may indicate the occurrence of an overdose, battery life remaining in the power source **14**, an amount of drug remaining in the device **10**, the detected $CO_2$ level of the breach of the user, and/or the respiration rate of the user. The indicator can be powered by the power source **14** and can be electrically coupled to the controller **12**. The indicator can include, for example, a digital screen display, a speaker, or lights. In some embodiments, the indicator can automatically generate a notification in response to the controller **12** determining that the user has overdosed based on signals sent by the detection means **40**. For example, the lights may flash or the display may generate a notification. In some embodiments, as further described below, the device **10** may be capable of networked communication. As such, notifications can be sent to one or more external devices such as a cloud-based server, a mobile device, an email system, other networked devices or systems, or a combination thereof.

**[0029]** In some embodiments, the controller **12** may include a timer configured to track the amount of time that elapses since the drug was last administered to the user (e.g. dispensed). The time may be displayed on the indicator, for example to assist a medical professional treating the user. In some embodiments, the device **10** may administer the drug to the user based on the time elapsed since the drug was last administered. For example, the device **10** can administer the drug to the user in response to the detection means **40** measuring a condition of the user indicative of overdose. The detection means **40** can continue to monitor the condition of the user after administration of the drug. Based on a determination by the controller **12** that the user's condition is not improving (e.g. the user's respiration rate and/or $CO_2$ level do not meet respective thresholds) and based on the expiration of a predetermined time period since the previous administration of the drug, the device can administer the drug again to the user.

**[0030]** In some embodiments, the device **10** may prevent administration of the drug to the user based on the time elapsed since the drug was last administered. For example, if a minimum time period has not elapsed since the last administration of the drug, the controller **12** may prevent administration of the drug to the user even if the detection means **40** measures a condition of the user indicative of overdose (e.g. the user's respiration rate and/or $CO_2$ level do not meet respective thresholds). The indicator may produce a notification indicative of the user's condition if the controller **12** determines that the measured condition indicates an overdose and the device **10** does not administer the drug.

**[0031]** The detection means **40** can include a respiration sensor that is configured to monitor the respiration rate of the user. The respiration rate sensor can transmit a signal indicative of the respiration rate to the controller **12**. The detection means **40** can include a $CO_2$ sensor that is configured to monitor the $CO_2$ level in the user's breath and to transmit a signal indicative of the $CO_2$ level to the controller **12**. The detection means **40** can include the RIP band configured to measure the movement of the chest and abdominal wall and to transmit a signal indicative of the movement to the controller **12**. The detection means **40** can include a pulse oximeter to measure oxygen level and heart rate and to transmit a signal indicative of the oxygen level and heart rate to the controller **12**. The controller **12** is configured to determine if the user has entered, or is about to enter, a hypoxic state based on at least one of the measured conditions indicative of overdose. The measured conditions may include $CO_2$ level, chest movement, abdominal movement, respiration rate, other conditions, or any combination thereof. For example, if the controller **12** determines that the $CO_2$ level is above a first threshold and/or determines that the respiration rate, oxygen level, chest movement, and/or abdominal movement is below a second threshold, the controller **12** transmits a signal to the drug supply device **30** to supply the drug to the user through the drug delivery device **20**.

**[0032]** The device **10** can include a mobile alert device **24**. The device **10** can also include a GPS device configured to determine a location of the device **10**. The GPS device may be included in the mobile alert device **24**. The mobile alert device **24** sends a notification (including, for example, an alert message, information indicative of the user's condition measured by the detection means **40**, and/or the user's location) to one or more external devices **50** or to emergency services. For example, the mobile alert device **24** can send the notification to a mobile phone in response to the device **10** determining that the user's respiratory rate is lower than a threshold. The mobile alert device **24** may include software programmed into a processor, integrated circuit, or may be otherwise executed by the device **10**. In some embodiments, the mobile alert device **24** is included in the controller **12**. The mobile alert device **24** can be integrated into the device **10** such that the mobile alert device **24** is included in the same housing, carrier, or any other container as the device **10**. In some embodiments, the mobile alert device **24** can be included in hardware separate from the device **10** that is in communication with the device **10**. For example, the mobile alert device **24** can be worn separately from the device **10**, such as on a lanyard around the user's neck or carried in a pocket.

**[0033]** In some embodiments, the mobile alert device **24** can be activated using a command generated by the user. In some embodiments, the mobile alert device **24** can be in electronic communication with the controller **12** such that the controller **12** activates the mobile alert device **24**. For example, the controller **12** can activate the mobile alert device **24** when the drug has been delivered to the user and/or when the detection means **40** measures a condition of the user indicative of an overdose. In some embodiments, the mobile alert device **24** can periodically or constantly update one or more external devices **50** with notifications.

**[0034]** In some embodiments, the GPS device may be enabled or disabled by an administrator having access to the GPS device. The administrator can include the user and/or a designated person other than the user. Access to the GPS device (e.g. the ability to turn the GPS device on and off) by the administrator may be password protected or otherwise secured.

**[0035]** The controller **12** may be in communication (e.g., using a network interface of the controller **12**) with one or more of the external devices **50** including but not limited to a mobile phone, a tablet computer, a laptop computer, a notebook computer, a desktop computer, or a server computer, a cloud-based server, other networked devices or systems, or a combination thereof. In some embodiments, the user or the administrator may define specified recipients or specified external devices to which notifications may be sent. The communication may be wired or wireless (e.g., WiFi, Bluetooth, USB, HDMI, Wireless USB, Near Field Communication (NFC), Ethernet, a radio frequency, and/or other interfaces for communicating data between one or more external devices).

**[0036]** In some embodiments, the mobile alert device **24** will send the notification through a cellular network, for example, over 3G, 4G, 5G, CDMA, or GSM. The mobile alert device **24** can use the cellular network to send the notification to emergency services or an emergency contact. For example, the mobile alert device **24** can use the cellular network to send the notification to a monitoring center which will in turn send the notification to emergency services.

**[0037]** FIG. **2** is a block diagram of an example of communication between the device **10** and one or more external devices **50**. In some embodiments, the controller **12**

may collect data for transfer and/or storage. The data may include but is not limited to occurrence of an overdose, the user's respiration rate, the user's $CO_2$ level, the user's chest movement, the user's abdominal movement, time the device **10** has been in use, medication dosage delivered to the user, time since the last dosage was delivered to the user, the user's location, or any other user information described herein. The data may be transmitted to a server used to implement a software as a service product at which records of the user's data are stored. In the illustrated example, the detection means **40** transmits the data to the controller **12** and/or the mobile alert device **24** of the device **10**. The device **10** transmits the data to a network **52**. The data is transmitted from the network **52** to a server **54** optionally including a database **56** and/or one or more of the external devices **50**. The one or more external devices **50** may include a server. The server **54** may include a hardware component or a software component (e.g. a web server).

**[0038]** FIG. **3** is a diagram of the device **10** connected to the user according to one embodiment. Any of the described components of the device **10**, including but not limited to, the controller **12**, the detection means **40**, the drug delivery device **20**, the mobile alert device **24**, the container **22**, the venturi valve **18**, the activated valve **16**, the drug supply device **30**, and the power source **14** may be disposed inside a housing **42**. The housing **42** can include a bag, box, carrier, or any other container. The housing **42** can be connected to the user's belt, belt clip, belt loop, or any other article of clothing. In some embodiments, the housing **42** can be connected to the user using any fastener.

**[0039]** FIG. **4** is a diagram the device **10** according to one embodiment where the detection means **40** includes an RIP band **60**. The RIP band **60** may include an adjustable band (e.g. a band having elastic portions or hook and loop fasteners) worn around the user's torso. In some embodiments, any other described detection means **40** can also be included, such as the $CO_2$ sensor. The RIP band **60** is in communication with the controller **12**. Any of the described components of the device **10**, including but not limited to the controller **12**, the detection means **40**, the drug delivery device **20**, the mobile alert device **24**, the container **22**, the venturi valve **18**, the activated valve **16**, the drug supply device **30**, and the power source **14** may be connected to the RIP band **60**. In some embodiments, the components of the device **10** may be connected to a housing, carrier, or any other container connected to the RIP band **60**.

**[0040]** FIG. **5** is a diagram of a device **100** configured to detect an overdose and automatically administer a drug according to another embodiment. The device **100** may include features similar to those of device **10** except as otherwise described. The device **100** is a portable device that can be attached to a user, for example, by way of a belt clip (not shown) or in a pocket of a shirt, jacket or pants. Referring to FIG. **5**, the device **100** includes a controller **105** and a power source **110**. The device **100** also includes a nasal cannula **120** that is fluidly connected to a pressurized canister **130** that contains an antidote, for example, naloxone. The pressurized canister **130** is configured to aerosolize the drug and may be removable and/or refillable.

**[0041]** The nasal cannula **120** is fluidly connected to a respiration sensor **140**, a carbon dioxide ($CO_2$) sensor **145**, a pressure sensor **150**, and an optional fan **155**. The respiration sensor **140** and the $CO_2$ sensor **145** may be combined into a single sensor. The device may include only the respiration sensor **140** or only the $CO_2$ sensor **145**, or both sensors. The pressure sensor **150** is configured to measure the pressure of the pressurized canister **130** to estimate the volume of its contents. The pressure sensor **150** may also act as a dose counter.

**[0042]** The controller **105** is electrically coupled to the respiration sensor **140**, $CO_2$ sensor **145**, pressure sensor **150**, optional fan **155**, plunger **160**, and one or more indicator lights **170**. The respiration sensor **140** is configured to monitor the respiration rate of the user and to transmit a signal indicative of the respiration rate to the controller **105**. The $CO_2$ sensor **145** is configured to monitor the $CO_2$ level in the user's breath and to transmit a signal indicative of the $CO_2$ level to the controller **105**. The controller **105** is configured to determine if the user has entered, or is about to enter, a hypoxic state based on the $CO_2$ level and/or respiration rate. If the controller **105** determines that the $CO_2$ level is above a first threshold and/or determines that the respiration rate is below a second threshold, the controller signals the plunger **160** to deploy.

**[0043]** The deployment of the plunger **160** causes a predetermined dose of aerosolized antidote to be expelled from the pressurized canister **130** into the nasal cannula **120**. The antidote travels through the nasal cannula and into the nasal cavity of the user where the antidote is administered. In one example, the controller may activate the optional fan **155** to aid in drug delivery and ensure that the full dose is administered.

**[0044]** The pressure sensor **150** monitors the pressure of the pressurized canister **130** and/or monitors the number of doses administered. The pressure sensor **150** signals the pressure and/or number of doses administered to the controller **105**. When the controller **105** determines that the pressure falls below a threshold or that a maximum number of doses have been administered, the controller **105** signals one or more indicator lights **170** to illuminate, alerting that the antidote is low or depleted. The indicator lights **170** are also configured to receive a signal from the power source **110** to indicate a low power level.

**[0045]** The device (i.e. device **10** or device **100**) monitors the $CO_2$ level in the nasal cannula and/or the respiration rate of the user and/or the respiration movement of the user with the detection means **40**. The device determines whether a threshold parameter relating to the detected parameter is above or below a predetermined threshold. If, for example, the $CO_2$ level is above a threshold, or whether the respiration rate of the user is below a threshold, the device dispenses the aerosolized antidote. If not, the device will continue to monitor the user. In addition, upon dispensing the aerosolized antidote, the device can continue to monitor the user through the nasal cannula to determine if another dose of antidote is needed.

**[0046]** FIG. **6** is a flowchart of a process **300** for detecting an overdose and automatically administering a drug without the need for human intervention or assistance. Because the device is portable, the process **300** is performed wherever the drug user is located, such as outdoors, in a house, in a park, in an abandoned building, in his or her own bedroom or bathroom, or in a medical or treatment setting where that person cannot be monitored by a person at all times. The process **300** can be used in or by any of the devices described herein (e.g. device **10** or device **100**) is described. Operation **302** of the process **300** includes measuring a condition of the user indicative of an overdose. In some embodiments, measuring the condition of the user can include measuring the $CO_2$ level of the user's breath, measuring the respiration rate of the user, and/or measuring the movement of the user's chest/and or abdominal wall. The respiration of the user may be measured by the detection means **40**.

**[0047]** The operation **304** of the process **300** includes receiving data indicative of the condition of the user. Receiving the data indicative of the condition of the user may include receiving data indicative of the user's $CO_2$ level, respiration rate, chest movement, and/or abdominal wall movement. In some embodiments, the controller **12** may receive the data indicative of the condition of the user.

**[0048]** Operation **306** of the process **300** includes dispensing the drug to the user in response to determining that the condition of the user does not meet a threshold. In some embodiments, determining that the condition of the user does not meet a threshold includes determining that the $CO_2$ level of the breath of the user is above a first threshold and/or that the respiration rate is below a second threshold. The controller **12** may determine that the condition of the user does not meet the threshold. The device may dispense the drug to the user using the drug supply device **30** and the drug delivery device **20**. If the controller **12** determines that the condition of the user does not meet the threshold, the process **300** may return to operation **302**.

**[0049]** In some embodiments, the process **300** may further include sending a notification to one or more of the external devices **50** in response to determining that the condition of the user does not meet the threshold. The mobile alert device **24** and/or the controller **12** may send the notification.

**[0050]** Implementations of the controller **12** and/or the mobile alert device **24** (and the algorithms, methods, instructions, etc., stored thereon and/or executed thereby) can be realized in hardware, software, or any combination thereof. The hardware can include, for example, computers, intellectual property (IP) cores, application-specific integrated circuits (ASICs), programmable logic arrays, optical processors, programmable logic controllers, microcode, microcontrollers, servers, microprocessors, digital signal processors or any other suitable circuit. In the claims, the term "controller" should be understood as encompassing any of the foregoing hardware, either singly or in combination. The terms "signal" and "data" are used interchangeably. Further, portions of the controller **12** and the mobile alert device **24** do not necessarily have to be implemented in the same manner.

**[0051]** Further, in one aspect, for example, the controller **12** and/or the mobile alert device **24** can be implemented using a general-purpose computer or general-purpose processor with a computer program that, when executed, carries out any of the respective methods, algorithms and/or instructions described herein. In addition, or alternatively, for example, a special purpose computer/processor can be utilized which can contain other hardware for carrying out any of the methods, algorithms, or instructions described herein.

**[0052]** Further, all or a portion of implementations of the present disclosure can take the form of a computer program product accessible from, for example, a computer-usable or computer-readable medium. A computer-usable or computer-readable medium can be any device that can, for example, tangibly contain, store, communicate, or transport the program for use by or in connection with any processor. The medium can be, for example, an electronic, magnetic, optical, electromagnetic, or a semiconductor device. Other suitable mediums are also available.

**[0053]** While the invention has been described in connection with certain embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications, combinations, and equivalent arrangements included within the scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law. One or more elements of the embodiments disclosed may be combined with one or more elements of any other embodiment disclosed.

What is claimed is:

**1**. A device for detecting an overdose and automatically administering a drug, the device comprising:
- a sensor configured to measure a condition of a user indicative of overdose;
- a container that retains the drug;
- a drug delivery device fluidly connected to the container;
- a pressurized gas container retaining pressurized gas, the pressurized gas container being configured to release the pressurized gas to expel the drug from the container into the drug delivery device; and
- a controller electrically coupled to the sensor and the pressurized gas container, wherein the controller is configured to activate release of the pressurized gas based on a signal from the sensor, wherein the device is wearable by the user and is portable such that movement and location of the user is not restricted.

**2**. The device of claim **1**, wherein:
- the sensor includes a $CO_2$ sensor configured to measure a $CO_2$ level in a breath of the user;
- the condition includes the $CO_2$ level; and
- the controller is further configured to release the pressurized gas in response to a determination that the $CO_2$ level is above a predetermined threshold.

**3**. The device of claim **1**, wherein:
- the sensor includes a respiration sensor configured to measure a respiration rate of the user;
- the condition includes the respiration rate; and
- the controller is further configured to expel the drug from the container into the drug delivery device in response to a determination that the respiration rate is below a predetermined threshold.

**4**. The device of claim **1**, wherein the drug delivery device includes a nasal cannula.

**5**. The device of claim **1**, wherein the drug delivery device includes a breathing mask.

**6**. The device of claim **1**, wherein the pressurized gas is configured to aerosolize or atomize the drug.

**7**. The device of claim **1**, further comprising a pressure sensor configured to measure a pressure of the pressurized gas.

**8**. The device of claim **7**, wherein the pressure sensor is further configured to measure remaining doses of the drug.

**9**. The device of claim **1**, wherein the sensor is one or more of a respiration rate sensor, a $CO_2$ sensor, and an RIP band.

**10**. The device of claim **1** further comprising:
- a mobile alert device including a GPS device, wherein the mobile alert device sends a notification to an external device in response to the controller determining to release the pressurized gas.

**11**. The device of claim **10**, wherein the mobile alert device sends a notification to an external device in response to a command generated by the user.

**12**. A device for detecting an overdose and automatically administering a drug, the device comprising:

a nasal cannula worn by a user;

a sensor configured to monitor breathing of the user using gas exhaled by the user to the nasal cannula;

a container retaining the drug;

a drug supply device configured to carry the drug through the nasal cannula and to the user;

a mobile alert device; and

a controller electrically coupled to the mobile alert device, the sensor, and the drug supply device, the controller configured to activate the drug supply device to supply the drug to the user through the nasal cannula based on output of the sensor, and configured to use the mobile alert device to send a notification to an external device in response to supplying the drug to the user, wherein

the device is wearable by the user and is portable such that movement and location of the user is not restricted.

**13**. The device of claim **12**, wherein the sensor is one or both of a respiration rate sensor and a $CO_2$ sensor.

**14**. The device of claim **12**, where in the drug supply device is a pressurized gas container holding a pressurized gas.

**15**. The device of claim **14**, wherein the pressurized gas container includes an electronically activated valve that is actuated using a battery in response to receiving a signal from the controller.

**16**. The device of claim **12**, further comprising:

a housing retaining the device, wherein the nasal cannula extends through at least a portion of the housing, and wherein the housing is portable with the user.

**17**. The device of claim **12**, wherein the mobile alert device includes a GPS device and the notification sent by the mobile alert device includes a location of the device.

**18**. A method for detecting an overdose and automatically administering a drug, comprising:

providing to a user a portable device including a nasal cannula connected to a sensor and a drug delivery means to be worn by the user during opioid use;

monitoring using the sensor respiration of the user through the nasal cannula;

when the sensor detects a respiration event, automatically activating the drug delivery means to propel a drug to the user through the nasal cannula to reestablish respiration.

**19**. The method of claim **18**, wherein the sensor monitors one of respiration rate or carbon dioxide level.

**20**. The method of claim **18**, further comprising sending a notification using a mobile alert device to an external device in response to drug delivery means being activated.

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摘要(译)

一种用于检测过量并自动施用药物的装置包括传感器，该传感器被配置为测量指示过量的用户的状况。该装置包括保持药物的容器和流体连接到传感器和容器的药物输送装置。该装置包括保持加压气体的加压气体容器。加压气体容器配置成释放加压气体以将药物从容器排出到药物输送装置中。该装置包括电耦合到传感器和加压气体容器的控制器。控制器配置成确定是否释放加压气体。该设备是用户可穿戴的并且是便携式的，使得用户的移动和位置不受限制