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SMART INHALERS AND METHODS AND SYSTEMS THEREOF

Abstract

Disclosed herein are apparatuses for monitoring user health via an inhaler as well as systems and methods thereof. The apparatus can include the inhaler as well as a power source, sensors, and a computing system. The sensors can include a first sensor configured to capture expiratory flow data from within the inhaler and a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler. The computing system can be configured to process the data captured by the sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information. The apparatus can also include an electronics board, configured to communicatively couple the power source, the sensors, and the computing system.

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Background/Summary

TECHNICAL FIELD

[0001] The present disclosure relates to inhalers and systems and methods thereof.

BACKGROUND

[0002] An inhaler is a device that provides medicine to the lungs or trachea of a person by the person inhaling the medicine when dispensed by the device. The inhalation of the medicine dispensed by the device allows the medicine to be absorbed by tissue proximate to or within the lungs, which provides targeted delivery of the medicine to a specific region while reducing the side effects of orally taken medications. There are many types of inhalers to treat various conditions such as asthma, chronic obstructive pulmonary disease (COPD), and other diseases and disorders related to a person's airways.

SUMMARY

[0003] Disclosed herein are smart inhalers. In other words, disclosed herein are variations on an inhaler that include at least part of a computing system as well as one or more sensors to capture, process, and provide information about a user using the inhaler. The inhaler and variations of the inhaler can provide feedback information from its use—such as feedback including flow data related to a user's breathing, pulse oximetry data of the user, heart rate data of the user, and other types of feedback information related to a condition or health status of the user. Such information in the form of feedback from the inhaler can be used to assess a disease or disorder experienced by the user, such as asthma.

[0004] Also, disclosed herein are apparatuses for monitoring user health via an inhaler as well as systems and methods thereof. Such an apparatus can include the inhaler as well as a power source, sensors, and a computing system. The sensors can include a first sensor configured to capture expiratory flow data from within the inhaler and a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler. The computing system can be configured to process the data captured by the sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information. The apparatus can also include an electronics board, configured to communicatively couple the power source, the sensors, and the computing system. Such a method or system can include such an apparatus in some embodiments.

[0005] The inhalers shown in the drawings are metered-dose inhalers (MDIs); however, it is to be understood that the inhalers of some embodiments are dry powder inhalers (DPIs) or Soft mist inhalers (SMIs). Also, in some cases, embodiments can include a nebulizer.

[0006] These and other important aspects of the invention are described more fully in the detailed description below. The invention is not limited to the particular assemblies, apparatuses, methods, and systems disclosed herein. Other embodiments can be used and changes to the described embodiments can be made without departing from the scope of the claims that follow the detailed description.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present disclosure will be understood more fully from the detailed description given below and from the accompanying drawings of various example embodiments of the disclosure.

[0008] FIGS. **1** to **5** illustrate different views of an example inhaler, in accordance with some embodiments of the present disclosure. In the views, some portions of the inhaler are broken away to reveal internal details of the construction of the inhaler.

[0009] FIG. **6** illustrates a block diagram of example aspects of a computing system, which can include computing components, sensors, and a communications interface of the inhaler shown in FIGS. **1** to **5**, in accordance with some embodiments of the present disclosure.

[0010] FIG. **7** shows a method related to an example inhaler (such as the inhaler shown in FIGS. **1** to **5**) and an example computing system (such as the computing system shown in FIG. **6**), in accordance with some embodiments of the present disclosure.

[0011] FIG. **8** illustrates a second example inhaler in which the flow rate information and other health-related information are captured and processed by a separate attachable system, in accordance with some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0012] The present disclosure will be understood more fully from the detailed description given below and from the accompanying drawings of various example embodiments of the disclosure.

[0013] Disclosed herein are smart inhalers. In other words, disclosed herein are variations on an inhaler that include at least part of a computing system as well as one or more sensors to capture, process, and provide information about a user using the inhaler. The inhaler and variations of the inhaler can provide feedback information from its use—such as feedback including flow data related to a user's breathing, pulse oximetry data of the user, heart rate data of the user, and other types of feedback information related to a condition or health status of the user. Such information in the form of feedback from the inhaler can be used to assess a disease or disorder experienced by the user, such as asthma.

[0014] Also, disclosed herein are apparatuses for monitoring user health via an inhaler as well as systems and methods thereof. Such an apparatus can include the inhaler as well as a power source, sensors, and a computing system. The sensors can include a first sensor configured to capture expiratory flow data from within the inhaler and a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler. The computing system can be configured to process the data captured by the sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information. The apparatus can also include an electronics board, configured to communicatively couple the power source, the sensors, and the computing system. Such a method or system can include such an apparatus in some embodiments.

[0015] The inhalers shown in the drawings are metered-dose inhalers (MDIs); however, it is to be understood that the inhalers of some embodiments are dry powder inhalers (DPIs) or Soft mist inhalers (SMIs). Also, in some cases, embodiments can include a nebulizer.

[0016] FIGS. **1** to **5** illustrate different views of an example inhaler **100**, in accordance with some embodiments of the present disclosure. In the views, some portions of the inhaler **100** are broken away to reveal internal details of the construction of the inhaler.

[0017] FIG. **1** shows a front-side perspective view of the inhaler **100** with broken-away portions of the inhaler. For example, parts of the housing and actuator (such as a plastic actuator) are broken away to reveal an inhaler medication cartridge **101** (also referred to herein as a canister) and the spray nozzle **112** of the cartridge. The medication aerosolizer **102** is not depicted in FIG. **1**, but an arrow is pointing to a position under a spray nozzle plate **107**, which is where the aerosolizer is located (e.g., see FIGS. **2**, **3**, and **5** for a depiction of the aerosolizer **102**). Also, revealed is a power source of the inhaler **100**. And, in the illustration, battery **103** is shown as the power source. Also revealed is a microcontroller **104** which can include or be a part of some of the computing systems described herein. Also revealed is a first integrated circuit **105** that can include an accelerometer, gyroscope, or a combination thereof. The inhaler **100** also includes a mouthpiece **106**. As revealed by the breakaway of the housing of the inhaler **100**, the inhaler also includes the spray nozzle plate **107**. The plate **107** causes the spray nozzle **112** to spray medicine contained in the cartridge **101** when the actuator is pushed downward by a user pressing the front end of the canister on the plate **107**. The spray nozzle **107** releases the medicine from the cartridge **101** and the medicine is aerosolized by the medication aerosolizer **102**. Also, FIG. **1** reveals a second integrated circuit **108** that can include a pulse oximeter, a heart rate sensor, or a combination thereof. Furthermore, FIG. **1** reveals a differential pressure sensor **109**. FIG. **1** also shows electronics housing **110** and main body housing **111**. As depicted, the electronic housing **110** can house the battery **103**, the microcontroller **104**, the first integrated circuit **105**, and the second integrated circuit **108**. In some examples, the electronics housing houses the differential pressure sensor **109** too. In some other examples, the main body housing **111** houses the differential pressure sensor **109**. The cartridge **101** fits into a reusable medication cartridge holder and interface which is a part of the main body housing **111** of the inhaler **100**. The actuator of the inhaler **100** includes the main body housing **111**.

[0018] FIG. **2** shows a front perspective view of the inhaler **100** such that the medication aerosolizer **102**, the microcontroller **104**, and the first integrated circuit **105** are shown through the opening provided by the mouthpiece **106**. Also, FIG. **2** illustrates a top portion of the inhaler medication cartridge **101** and a front portion of an external wall of the main body housing **111**. As shown, the medication aerosolizer **102** is in front of the first integrated circuit **105**, which is in front of the microcontroller **104**. Through the opening of the mouthpiece **106**, an internal wall of the electronics housing **110** is shown behind the medication aerosolizer **102**, the first integrated circuit **105**, and the microcontroller **104**.

[0019] FIG. **3** shows a front and cross-sectional perspective view of the inhaler **100** with broken-away portions of the inhaler. For example, a front portion of the housing **111** and actuator (such as a plastic actuator) are broken away to reveal an entire front-side portion of the inhaler medication cartridge **101**, the spray nozzle **112**, and the medication aerosolizer **102**. As shown the nozzle **112** interfaces the aerosolizer **102** via an interface portion of a reusable medication cartridge holder of the inhaler **100**. By having the parts broken away, FIG. **3** also reveals a front view of the aerosolizer **102**, the microcontroller **104**, the first integrated circuit **105**, the spray nozzle plate **107**, the second integrated circuit **108**, the differential pressure sensor **109**, and the spray nozzle **112**. An internal wall of the electronics housing **110** is also shown behind the medication aerosolizer **102**, the first integrated circuit **105**, and the microcontroller **104**.

[0020] FIG. **4** shows a side perspective view of the inhaler **100**. FIG. **4** depicts external walls of respective side portions of the mouthpiece **106**, the electronics housing **110**, and the main body housing **111**. Also, a top portion of the inhaler medication cartridge **101** is shown.

[0021] FIG. **5** shows a side and cross-sectional perspective view of the inhaler **100** with broken-away portions of the inhaler. For example, respective side portions of the main body housing **111** and the electronics housing **110** as well as the actuator (such as a plastic actuator) are broken away to reveal portions of the inhaler medication cartridge **101**, the spray nozzle **112** attached to the cartridge, and medication aerosolizer **102**, the battery **103**, the microcontroller **104**, the first integrated circuit **105**, the spray nozzle plate **107**, and the differential pressure sensor **109**. Also, shown is a part extending from the second integrated circuit **108** (which can include a pulse oximeter, a heart rate sensor, or a combination thereof) that is configured to be pressed upon by a thumb of a user when the user holds and activates the inhaler **100**. Wherein the circuit **108** includes a pulse oximeter, the pulse oximeter can capture and measure, such with a computing system, the saturation of oxygen carried in red blood cells of a user. The capturing of the saturation of oxygen can occur via the thumb of the user pressed upon the part extending from the second integrated circuit **108**.

[0022] As shown by FIGS. **1** to **5**, some embodiments of an apparatus can include an inhaler (e.g., see inhaler **100**) that includes a plurality of inhaler components including a power source (e.g., see battery **103**), a plurality of sensors including a first sensor configured to capture expiratory flow data from the inhaler (e.g., see the differential pressure sensor **109** as well as such as via the opening in the mouthpiece **106**) as well a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler (e.g., see circuit **108**), and a computing system (e.g., see microcontroller **104**) configured to process the data captured by the plurality of sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information. Also, the inhaler can include an electronics board, configured to communicatively couple the power source, plurality of sensors, and the computing system (e.g., see microcontroller **104**, first circuit **105**, and second circuit **108**).

[0023] In some embodiments of the apparatus, the plurality of inhaler components include a reusable-medication-cartridge holder and interface (e.g., see cartridge **101**, housing **111**, and plate **107**), wherein the holder is configured to secure a medication cartridge within the inhaler housing, and wherein the interface is configured to connect the medication cartridge with a hand-operated actuator and a metering valve of the inhaler (e.g., see medication aerosolizer **102** which can include a metering valve in some embodiments). In some embodiments of the apparatus, the metering valve is a part of or in electromechanical communication with the first sensor. In some embodiments of the apparatus, the second sensor is configured to capture the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler to activate the hand-operated actuator of the inhaler to activate the inhaler and release medication from the inhaler (e.g., see the part extending from the circuit **108**). In some embodiments of the apparatus, the inhaler includes a pressurized metered-dose inhaler (MDI) including the actuator and the metering valve and the medication cartridge includes a metal canister and medication within the canister. In some examples, the medication includes a propellant or suspension and the actuator and the metering valve are configured to be reused with replacements of the medication cartridge. In some cases, the actuator is configured to receive and attach to the canister. In some cases, the apparatus includes an aerosolizer nozzle and plate (e.g., see nozzle **112** and plate **107**) configured to release and spray medication from the medication cartridge, and beneath a base of the nozzle and plate a part of the first sensor (such as a digital differential pressure sensor, e.g., see sensor **109**) is pointed upward and a part of the second sensor (such as a pulse oximeter) is pointed downward such that a thumb of a user is placed underneath the second sensor and on a data capturing portion of the second sensor (e.g., see the part extending from circuit **108** shown in FIG. **5**).

[0024] In some examples of the apparatus, the first sensor includes a peak flow meter. The first sensor can include a digital differential pressure sensor to measure the peak expiratory flow (e.g., see sensor **109**). In some examples of the apparatus, the second sensor is configured to capture the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler to activate a hand-operated actuator of the inhaler to activate the inhaler and release medication from the inhaler (e.g., see the part extending from circuit **108** shown in FIG. **5**). In some cases, the second sensor includes pulse oximeter.

[0025] In some examples of the apparatus, the plurality of sensors includes a motion sensor configured to detect movement of the apparatus and the motion sensor includes a gyroscope or an accelerometer (e.g., see the first integrated circuit **105**). In some examples of the apparatus, the power source is communicatively coupled to a charging system, and the charging system is connected to the electronics board (e.g., see battery **103** which can be communicatively coupled to the microcontroller **104**, which in some cases includes a charging system). In some examples of the apparatus, the electronics board includes a printed circuit board (PCB).

[0026] FIG. **6** illustrates a block diagram of example aspects of a computing system **200**, which can include computing components, sensors, and a communications interface of the inhaler shown in FIGS. **1** to **5**, in accordance with some embodiments of the present disclosure. Also, FIG. **5** illustrates parts of the computing system **200** within which a set of instructions are executed for causing a machine (such as a computer processor or processing device **202**) to perform any one or more of the steps of the methodologies discussed herein performed by a computing system (e.g., see the method steps of the method **300** shown in FIG. **6**). In some embodiments, the computing system **200** operates with additional computing systems to provide increased computing capacity in which multiple computing systems operate together to perform any one or more of the methodologies or processes discussed herein that are performed by a computing system.

[0027] In some embodiments, the computing system **200** corresponds to a host system that includes, is coupled to, or utilizes memory or is used to perform the operations performed by any one of the computing systems described herein. In some embodiments, the machine is connected (e.g., networked) to other machines in a LAN, an intranet, an extranet, or the Internet. In some embodiments, the machine operates in the capacity of a client device in a client-server network environment, as a peer machine in a peer-to-peer (or distributed) network environment, or as a client in a cloud computing infrastructure or environment. In some embodiments, the machine is a computer or microcomputer or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while a single machine is illustrated, the term “machine” shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies or processes discussed herein performed by computing systems.

[0028] The computing system **200** includes a processing device **202**, a main memory **204** (e.g., read-only memory (ROM), flash memory, dynamic random-access memory (DRAM), etc.), a static memory **206** (e.g., flash memory, static random-access memory (SRAM), etc.), and a data storage system **210**, which communicate with each other via a bus **218**. The processing device **202** represents one or more general-purpose processing devices such as a microprocessor, a central processing unit, or the like. More particularly, the processing device can include a microprocessor or a processor implementing other instruction sets, or processors implementing a combination of instruction sets. Or, the processing device **202** is one or more special-purpose processing devices such as an application-specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), a network processor, or the like. The processing device **202** is configured to execute instructions **214** for performing the operations discussed herein performed by a computing system. In some embodiments, the computing system **200** includes a network interface device **208** to communicate over a communications network such as network **224**. Such a communications network can include one or more local area networks (LAN(s)), such as a WIFI network or a BLUETOOTH network, and/or one or more wide area networks (WAN(s)). In some embodiments, the communications network includes the Internet and/or any other type of interconnected communications network. The communications network can also include a single computer network or a telecommunications network. In the case of communications network **224** including the Internet, the inhaler **100** or another embodiment of the inhaler can be considered Internet of Things (IoT) device.

[0029] The data storage system **210** includes a machine-readable storage medium **212** (also known as a computer-readable medium) on which is stored one or more sets of instructions **214** or software embodying any one or more of the methodologies or functions described herein performed by a computing system. The instructions **214** also reside, completely or at least partially, within the main memory **204** or within the processing device **202** during execution thereof by the computing system **200**, the main memory **204** and the processing device **202** also constituting machine-readable storage media. While the machine-readable storage medium **212** is shown in an example embodiment to be a single medium, the term “machine-readable storage medium” should be taken to include a single medium or multiple media that store the one or more sets of instructions. The term “machine-readable storage medium” shall also be taken to include any medium that is capable of storing or encoding a set of instructions for execution by the machine and that causes the machine to perform any one or more of the methodologies of the present disclosure performed by a computing system. The term “machine-readable storage medium” shall accordingly be taken to include solid-state memories, optical media, or magnetic media.

[0030] Also, as shown, the computing system **200** includes a user interface **216**. A UI, such as UI **216**, or a UI device described herein includes any space or equipment where interactions between humans and machines occur. A UI described herein allows the operation and control of the machine from a human user, while the machine simultaneously provides feedback information to the user. Examples of a user interface, or UI device include the interactive aspects of computer operating systems (such as GUIs) and inhaler operator controls such as the actuator of an inhaler (e.g., the plastic actuator on an MDI). Also, as shown, the computing system **200** includes electronics **220** that are a part of the computing system or interact directly with the computing system such as any one of the sensors described herein (such as the sensor of circuit **108** shown in FIG. **1** and sensor

408 shown in FIG. **8**.

[0031] FIG. **7** shows a method **300** related to an example inhaler (such as the inhaler **100** shown in FIGS. **1** to **5** and FIG. **8**) and an example computing system (such as the computing system **200** shown in FIG. **6**), in accordance with some embodiments of the present disclosure. The method **300** starts with delivering medicine to a user via an inhaler at step **302**. At step **304**, the method continues with activating the electronics of the inhaler by use or motion of the inhaler by the user sensed by a motion sensor of the inhaler. At step **306**, the method continues with receiving, via the inhaler, an exhaled breath from the user. At step **308**, the method continues with capturing, via a first sensor of the electronics, expiratory flow data of the exhaled breath. In some cases, the first sensor is located within the inhaler and beneath an aerosolizer nozzle of the inhaler. At step **310**, the method continues with recording, by a computing system of the electronics, the captured flow data as peak expiratory flow information. At step **312**, the method continues with capturing, via a second sensor of the electronics that is integrated with the inhaler, pulse oximetry or heart rate data from a user of the inhaler. At step **314**, the method continues with recording, by the computing system, the captured flow data as pulse oximetry or heart rate information.

[0032] At step **316**, the method continues with communicating, by the computing system, the peak expiratory flow information and the pulse oximetry or heart rate information to a remote computing system for analysis or use by an application running through the remote computing system. At step **318**, the method continues with the application generating and providing health information via a user interface based on the peak expiratory flow information and the pulse oximetry or heart rate information. In some cases, the method further includes the application providing a periodic or daily message to the user via the user interface based at least partially on the peak expiratory flow information and the pulse oximetry or heart rate information.

[0033] In some cases of the method, the second sensor captures the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler to activate a hand-operated actuator of the inhaler to activate the inhaler and release medication from the inhaler. And, in some examples, the method includes the second sensor capturing the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler after breathing into the inhaler to measure expiratory flow data.

[0034] FIG. **8** illustrates a second example inhaler **400** in which the flow rate and other health-related information is captured and processed by a separate attachable system (see the clip-on system **402**). As shown in FIG. **8**, some embodiments include an apparatus that includes an inhaler (such as inhaler **400**), in which the inhaler includes a plurality of inhaler components (such as medicine cartridge **401**) as well as a separate attachable system (see clip-on system **402**), configured to removably attach to the inhaler. Similarly, the inhaler components also include a mouthpiece **406**. The separate attachable system includes a power source, a plurality of sensors, and a computing system. The sensors include at least a first sensor configured to capture expiratory flow data from the inhaler as well as a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler (e.g., see the thumb sensor **408** at the lower part **403** of the clip-on system **402**). The computing system is configured to process the data captured by the plurality of sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information. The separate attachable system also includes an electronics board, configured to communicatively couple the power source, plurality of sensors, and the computing system. In summary, the inhaler **400** has similar components to the inhaler **100** but the electronics of the inhaler **400** are part of a separate module (see clip-on system **402**). As the name implies, the clip-on system **402** clips onto the outside wall of an inhaler or the actuator of an inhaler.

[0035] An example problem faced in asthma control is that asthma levels are assessed once or a couple of times a year, making it very difficult to assess the status of asthma in a patient. And, this is especially a problem since asthma can change seasonally. As a result, many people become ill enough to be taken to the emergency room or they become disabled further with pneumonia (which could lead to hospitalization). This can occur because of a false sense of security in thinking their asthma is well controlled when in actuality it is not. The apparatuses, inhalers, and system and methods thereof described herein address these problems by having a sensor built in (such as a digital differential pressure sensor, e.g., see sensor **109**). Such a sensor can capture daily peak flow data. Also, a second sensor (e.g., see circuit **108** or thumb sensor **408**) can capture pulse oximetry or heart rate, both of which can be used to assess the state of asthma of a user. This way health status is known more readily by the patient and the doctor of the patient potentially and action can be taken more immediately to prevent hospital and emergency room visits as well as further disease that can occur from neglect. Another major problem is that current inhalers are not reusable. In some embodiments, the apparatuses, inhalers, and systems and methods thereof described herein are reusable. For example, medicine cartridges can be replaced while keeping the body of the inhaler intact for another cartridge.

[0036] In some examples, the inhaler or apparatus including the inhaler uses a relatively normal inhaler body shape with some modifications. Also, the inhaler or apparatus can include an electronic board, gyroscope, and battery in a chamber behind the main chamber of the inhaler. Such an apparatus can also have a pulse oximeter placed under the thumb grip of the inhaler, and a digital differential pressure sensor to measure the peak expiratory flow.

[0037] In some examples, a pulse oximeter, heart rate monitor, or combination thereof and a differential flow meter are in the inhaler body, as well as a gyroscope or accelerometer, a PCB, and a rechargeable battery can be part of the inhaler. When the inhaler is used (such as daily), after daily medication, the smart features would be awakened via the gyroscope (e.g., shake to awake), and a user can blow into the inhaler, which would record peak flow data via the digital differential pressure sensor and collect pulse oximetry and heart rate data from a sensor under the thumb rest area where the user would grip the inhaler naturally during use (e.g., see method **300**). Such captured data can then be transmitted to an application, where trends can be analyzed to view how controlled and severe the asthma is (e.g., see method **300**). The application can also send daily reminders to a user's phone to remind the user of the inhaler. In some cases, as mentioned, the inhaler body is reusable, and when the medication cartridge is empty, the user can remove the previous cartridge, and insert a new one. In some examples, the electronics of the apparatus are designed so that none of the integrated sensors affect the function of the inhaler medication administering system. In some cases, the disclosed technologies aim to keep them as similar to a regular inhaler as possible to limit the change in patients' workflow or routine for using inhalers. With that in mind, the sensors can be built into the inhaler body. After the patient takes their inhaler, they would then blow into the inhaler body, which would collect the peak flow data. The flow sensor is on the inside, under the inhaler nozzle. The pulse oximeter data and heart rate data are recorded from a sensor on the thumb pad under the inhaler, which is where a user would hold it to use the inhaler correctly. As shown as an example in FIG. **8**, an alternative system can have a clip-on system that contains the sensors rather than having them built into the inhaler (contrary to the inhaler shown in FIGS. **1** to **5**).

[0038] In the foregoing specification, embodiments of the disclosure have been described with reference to specific example embodiments thereof. It will be evident that various modifications can be made thereto without departing from the broader spirit and scope of embodiments of the disclosure as set forth in the following claims. The specification and drawings are, accordingly, to be regarded in an illustrative sense rather than a restrictive sense.

Claims

1. An apparatus, comprising: an inhaler, comprising a plurality of inhaler components; power source; a plurality of sensors, comprising: a first sensor configured to capture expiratory flow data from the inhaler; and a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler; a computing system configured to process the data captured by the plurality of sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information; and an electronics board, configured to communicatively couple the power source, plurality of sensors, and the computing system.

2. The apparatus of claim 1, wherein the plurality of inhaler components comprise a reusable-medication-cartridge holder and interface, wherein the holder is configured to secure a medication cartridge within the inhaler housing, and wherein the interface is configured to connect the medication cartridge with a hand-operated actuator and a metering valve of the inhaler.

3. The apparatus of claim 2, wherein the metering valve is a part of or in electromechanical communication with the first sensor.

4. The apparatus of claim 2, wherein the second sensor is configured to capture the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler to activate the hand-operated actuator of the inhaler to activate the inhaler and release medication from the inhaler.

5. The apparatus of claim 2, wherein the inhaler comprises a pressurized metered-dose inhaler comprising the actuator the metering valve, wherein the medication cartridge comprises a metal canister and medication within the metal canister, wherein the medication comprises a propellant or suspension, wherein the actuator and the metering valve are configured to be reused with replacements of the medication cartridge, and wherein the actuator is configured to receive and attach to the canister.

6. The apparatus of claim 2, comprising an aerosolizer nozzle and plate configured to release and spray medication from the medication cartridge, and beneath a base of the nozzle and plate a part of the first sensor is pointed upward and a part of the second sensor is pointed downward such that a thumb of a user is placed underneath the second sensor and on a data capturing portion of the second sensor.

7. The apparatus of claim 1, wherein the first sensor comprises a peak flow meter.

8. The apparatus of claim 7, wherein the first sensor comprises a digital differential pressure sensor to measure the peak expiratory flow.

9. The apparatus of claim 1, wherein the second sensor is configured to capture the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler to activate a hand-operated actuator of the inhaler to activate the inhaler and release medication from the inhaler.

10. The apparatus of claim 1, wherein the second sensor comprises a pulse oximeter.

11. The apparatus of claim 1, wherein the plurality of sensors comprises a motion sensor configured to detect movement of the apparatus, and wherein the motion sensor comprises a gyroscope or an accelerometer.

12. The apparatus of claim 1, wherein the power source is communicatively coupled to a charging system, and wherein the charging system is connected to the electronics board.

13. The apparatus of claim 1, wherein the electronics board comprises a printed circuit board (PCB).

14. A method, comprising: delivering medicine to a user via an inhaler; activating electronics of the inhaler by use or motion of the inhaler by the user sensed by a motion sensor of the inhaler; receiving, via the inhaler, an exhaled breath from the user; capturing, via a first sensor of the electronics, expiratory flow data of the exhaled breath, wherein the first sensor is located within the inhaler and beneath an aerosolizer nozzle of the inhaler; recording, by a computing system of the electronics, the captured flow data as peak expiratory flow information; capturing, via a second sensor of the electronics and integrated with the inhaler, pulse oximetry or heart rate data from a user of the inhaler; and recording, by the computing system, the captured flow data as pulse oximetry or heart rate information.

15. The method of claim 14, further comprising communicating, by the computing system, the peak expiratory flow information and the pulse oximetry or heart rate information to a remote computing system for analysis or use by an application running through the remote computing system.
16. The method of claim 15, further comprising the application generating and providing health information via a user interface based on the peak expiratory flow information and the pulse oximetry or heart rate information.
17. The method of claim 16, further comprising the application providing a periodic or daily message to the user via the user interface based at least partially on the peak expiratory flow information and the pulse oximetry or heart rate information.
18. The method of claim 14, wherein the second sensor captures the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler to activate a hand-operated actuator of the inhaler to activate the inhaler and release medication from the inhaler.
19. The method of claim 14, wherein the second sensor captures the pulse oximetry or heart rate data via a thumb of a user of the inhaler when the user holds the inhaler after breathing into the inhaler to measure expiratory flow data.
20. An apparatus, comprising: an inhaler, comprising a plurality of inhaler components; and a separate attachable system, configured to removably attach to the inhaler and comprising: power source; a plurality of sensors, comprising: a first sensor configured to capture expiratory flow data from the inhaler; and a second sensor configured to capture pulse oximetry or heart rate data from a user of the inhaler; a computing system configured to process the data captured by the plurality of sensors and record the data as corresponding peak expiratory flow information and pulse oximetry or heart rate information; and an electronics board, configured to communicatively couple the power source, plurality of sensors, and the computing system.