SUMMARY

[0005] Described here are devices and methods for dispensing therapeutic gases to the nasal mucosa of a patient.

[0005a] According to a first aspect, there is provided a device for dispensing a therapeutic gas to a patient comprising: a compressed gas cylinder, a first valve and a second valve, a first pressure regulator and a second pressure regulator, a measurement chamber that has a defined volume of therapeutic gas at a predetermined pressure set by the first pressure regulator, and a sequencing mechanism that is coupled to the first valve and the second valve, wherein the sequence mechanism alternately opens and closes the first valve and second valve, wherein the compressed gas cylinder is coupled to input of the first valve, and output of the first valve is coupled to input on the first pressure regulator, and output of the first pressure regulator is coupled to input of the second pressure regulator and to the measurement chamber, wherein output of the second pressure regulator is coupled to input of the second valve and output of the second valve is coupled to the patient, wherein the therapeutic gas passes from the compressed gas cylinder through the first pressure regulator to the measurement chamber, then the therapeutic gas passes from the measurement chamber through the second pressure regulator to provide the patient a constant volume of therapeutic gas. In general, the devices are configured to include a compressed gas cylinder, a first valve and a second valve, a first pressure regulator and a second pressure regulator, a measurement chamber that has a defined volume of therapeutic gas at a predetermined pressure set by the first pressure regulator, and a sequencing mechanism that is coupled to the first valve and the second valve. The sequence mechanism may alternately open and close the first valve and second valve. The aforementioned components may be viewed as being operatively connected to each other in a manner that dispenses consistent doses of a therapeutic gas to patients.

[0006] In some variations, the compressed gas cylinder is coupled to the input of the first valve, and output of the first valve is coupled to the input on the first pressure regulator, and output of the first pressure regulator is coupled to the input of the second pressure regulator and to the measurement chamber. Here output of the second pressure regulator may be coupled to input of the second valve and output of the second valve may be

coupled to the patient. In use, a therapeutic gas typically passes from the compressed gas cylinder through the first pressure regulator to the measurement chamber. The therapeutic gas then passes from the measurement chamber through the second pressure regulator to provide the patient a constant volume of a therapeutic gas.

[0007] Variations of the device may further include an orifice to control the rate of gas flow, wherein the output of the second valve is coupled to one end of the orifice and another end of the orifice is coupled to the patient. The sequence mechanism of the devices may comprise either a mechanical or an electronic apparatus.

[0008] With respect to the measurement chamber, this component of the device may store a volume of therapeutic gas at a controlled pressure of approximately 200 psi. The patient here may receive a constant flow rate of gas of approximately 0.5 standard liters per minute at a controlled pressure of approximately 1 atmosphere. The therapeutic gases that may be dispensed include without limitation, carbon dioxide, nitric oxide, oxygen, gaseous acids, helium, and combinations thereof.

[0009] Methods for intranasally delivering a therapeutic gas to a patient are also described herein.

[0009a] According to a second aspect, there is provided a method for delivering intranasally a therapeutic gas to a patient comprising the steps of: obtaining the above device, activating the sequence mechanism to open the first valve and close the second valve to allow the therapeutic gas to flow from the compressed gas cylinder to the measurement chamber, activating the sequence mechanism to close the first valve and open the second valve to allow the therapeutic gas to flow from the measurement chamber to the patient, wherein the patient receives the therapeutic gas at a constant flow rate and pressure. In general, the methods include the steps of obtaining a device comprising a compressed gas cylinder, a first valve and a second valve, a first pressure regulator and a second pressure regulator, a measurement chamber that has a defined volume of therapeutic gas at a predetermined pressure set by the first pressure regulator, and a sequencing mechanism that is coupled to the first valve and the second valve; activating the sequence mechanism to open the first valve and close the second valve to allow the therapeutic gas to flow from the compressed gas cylinder to the measurement chamber; and activating the sequence mechanism to close the first valve and open the second valve to allow the therapeutic gas to flow from the measurement chamber to the patient. The methods are devised so that the patient receives the therapeutic gas at a constant flow rate and pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 schematically illustrates the components of an exemplary therapeutic gas dispenser.

[0011] Fig. 2 illustrates an exemplary flow rate performance of a therapeutic gas dispenser.

[0012] Fig. 3 illustrates the major subsystems of one variation of a therapeutic gas dispenser.

[0013] Fig. 4 shows a more detailed view of the dispenser in Fig. 3.

[0014] Fig. 5 depicts three layouts of common piston regulators.

[0015] Fig. 6 illustrates a diaphragm regulator analogous to Layout 2a of Fig. 5.

[0016] Fig. 7 shows a carbon dioxide phase diagram.

DETAILED DESCRIPTION

[0017] Described here are devices and methods for dispensing therapeutic gases to the nasal mucosa of a patient. The devices typically comprise a combination of a measurement chamber, pressure regulators and a sequencing mechanism that controls valves associated with the pressure regulators. More specifically, the devices are generally configured to include a compressed gas cylinder, a first valve and a second valve, a first pressure regulator and a second pressure regulator, a measurement chamber that has a defined volume of therapeutic gas at a predetermined pressure set by the first pressure regulator, and a sequencing mechanism that is coupled to the first valve and the second valve. When the