TITLE

A nasal medication delivery device.

FIELD OF INVENTION

This invention relates to a device for delivering medication to the nasal cavity of a human patient.

BACKGROUND

Devices which deliver medication to the nasal cavities are known. In some cases they create an aerosol from liquid medication using compressed gas or piezoelectric energy. They are often referred to as “nebulisers” and they typically have a chamber in which the medication is energised. The medicament is then caused to contact a mesh, or to move through a jet nozzle, to enter the nasal cavities as an aerosol. The mesh may be vibrated directly via a piezo-oscillating element, or indirectly as a result of acoustic energy. The acoustic energy may also be used to drive the medication to the mesh.

Some nebulisers have a drawback in that their delivery mechanism requires an undesirably large minimum volume of medication before they can do their work. When the medication falls to below that volume a relatively large residual amount is wasted. It is an object of a preferred embodiment of the present invention to go at least some way towards alleviating this problem. However this and any other objects of the preferred embodiment should not be taken as a limitation on the scope of the invention or claims. The object of the invention in its broadest form is simply to provide a useful choice.

SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided a delivery device for nasal medication, having:

- an ultrasonic energy generator adapted to create an ultrasonic focal zone;
- a feeder chamber holding medication;
- an energising chamber smaller than the feeder chamber;
- a mesh; and
- an exit;

the device formed so that when it is activated the feeder chamber continuously fills the energising chamber with medication (until the feeder chamber has insufficient

medication left to achieve this) so that there is a substantially constant supply of medication within the focal zone able to be energised and forced from the energising chamber so as to contact the mesh, become an aerosol, and leave the device by way of the exit.

Optionally the device has a mouthpiece adapted for a human user to blow into and sensing means which, in response to such blowing, causes the medication to be energised and the aerosol to form.

Optionally the energising chamber has a volume of 0.1 cm^3 to 0.8 cm^3, and preferably a volume of 0.2 cm^3 to 0.4 cm^3.

Optionally the ultrasonic generator comprises a concave transducer adapted to focus ultrasonic energy on the focal zone when activated, such that the medication in the energising chamber becomes acoustically energised and moves towards the mesh.

Optionally the device is formed such that it causes the mesh to vibrate as the medication contacts it so as to assist in creating the aerosol.

Optionally the device has a nasal prong and the exit is part of the prong.

Optionally the mesh is integral with the prong.

Optionally the mesh is immediately adjacent to the exit so as to prevent or minimise condensation of the aerosol inside the device.

Optionally the activation chamber, the generator and exit are at an angle of about 40º to about 80º, and preferably about 50º to about 70º, with respect to the mouthpiece.

Optionally the medication is a pharmaceutical or saline solution prior to being energised.

Optionally the feeder chamber has a funnel or flume formed to naturally encourage the medication into the energising chamber.

Optionally the energising chamber has a tapered floor to urge medication to gather at the focal zone.

Optionally the energising chamber has a well to urge medication to gather at the focal zone.

Optionally the energising chamber is symmetrical.

Optionally the energising chamber is asymmetrical.

Optionally the feeder chamber plus the energising chamber collectively have sufficient medication for:

- only 5 or fewer patient doses;
- only 4 or fewer patient doses;
- only 3 or fewer patient doses;
- only 2 or fewer patient doses; or
- only 1 patient dose;

(a dose in this context is the amount of medication per administration event, as opposed to, for example, the number of acoustic pulses needed to dispense that amount)(the energising chamber may, in some embodiments, be initially empty).

According to a further aspect of the invention there is provided a delivery device for nasal medication, having:

- a mouth piece;
- sensing means;
- an ultrasonic energy generator in the form of a concave transducer adapted to focus ultrasonic energy on a focal zone;
- a feeder chamber holding medication;
- an energising chamber smaller than the feeder chamber;
- a mesh; and
- a nasal prong;

the device formed so that when it is activated the feeder chamber continuously fills the energising chamber with medication (until the feeder chamber has insufficient medication left to achieve this) so that there is a substantially constant supply of medication within the focal zone able to be energised and forced from the energising chamber so as to contact the mesh, become an aerosol, and leave the device by way of the nasal prong;

the sensing means arranged to detect when a user blows into the mouth and to then cause the medication to be energised while the mesh oscillates to produce a pumping action to assist in creating the aerosol;

the feeder chamber having a funnel or flume formed to encourage the medication into the energising chamber; and

the energising chamber having a tapered floor and/or well arranged to urge the medication into the focal zone.

DESCRIPTION OF THE DRAWINGS

Some preferred embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, of which:

Figure 1 is an exploded isometric view of a nasal medication delivery device;

Figure 2 is a side cross-sectional view of the supply unit;

Figure 3 is a side view of the exterior of the supply unit;

Figure 4 is an expanded side cross-sectional view showing detail of the supply unit;

Figure 5 is an isometric view of the supply unit;

Figure 6 is an opposite isometric view of the supply unit;

Figure 7 is schematic part cross-sectional view, and exterior view, of the device illustrating angled placement of various parts;

Figure 8 is a side cross-sectional view showing detail of the medicine supply unit of an alternative embodiment of the invention showing a tapered medicine energising chamber; and

Figure 9 is a side cross-sectional view of the medicine supply unit of an alternative embodiment of the invention showing an energising chamber which incorporates a well.

DETAILED DESCRIPTION

Referring to figure 1, the delivery device is used for the administration of therapeutic agents to the nasal cavity of a human patient. It has a main body 1, a breath receptor 2, and a medicine supply unit 3.

The Main Body

The main body 1 has an LCD screen 4 to display messages to the user, for example the name of the medicine to be delivered, the time at which the next dose is due to be taken, etc. The main body 1 also has a battery, a USB port 5 for charging the battery or for receiving input generally, an on/off power switch 6, an RFID reader 7 and a breath sensor. All of the electronics for the delivery device are part of the main body 1.

The RFID reader 7 is able to read electronically stored prescription details kept on a tag on the medicine packaging. Those details are used to automatically set the device to deliver the prescribed amount of medicine.

The Breath Receptor

The breath receptor 2 is detachable from the main body 1 with a click-fit arrangement, and has a detachable replaceable mouthpiece 8. The mouthpiece 8 can be gripped between the lips of the user and blown into. As the breath moves through the receptor 2 it is acoustically detected by the sensor in the main body 1, and, as a consequence, the device is triggered to deliver medicine to the user. The breath then passes out the back 9 of the device, having served its purpose. The device only releases medicine while the user is blowing/exhaling. This is because the act of exhaling causes the user's pharynx to close, so that medicine is only delivered to the nose, and not the throat or lungs.

The Medicine Supply Unit

Referring to Figures 2 to 6, the medicine supply unit 3 has a concave piezo-ceramic ultrasonic transducer 10, ultrasonic energy transmission fluid 11 (optionally water), an ultrasonic transparent membrane 12 (which may be formed from a material such as polyetheretherketone (PEEK)), a medicine (liquid) feeder chamber 13, a liquid energising chamber 14, a mesh 15 and a nasal prong 16. The energising chamber 14 may or may not be asymmetrical or angled. The nasal prong 16 and a sub-assembly of the mesh engage the rest of the supply unit 3 by way of a twist lock mechanism to enable it to be easily cleaned or replaced.

With particular reference to Figure 4, the transducer 10 is concave and emits ultrasonic energy that travels through the transmission fluid 11, through the membrane 12 and into a charge of medicine 18a in the energising chamber 14. The charge 18a becomes acoustically energized within an acoustic focal zone 19 created by the transducer,

which produces an acoustic radiation pressure on the inner face of the mesh 15. As a result the mesh 15 oscillates and produces a micro-pumping action of the medicine as it moves through the pores of the mesh 15. Such contact with the mesh 15 causes the medicine to become an aerosol 20, ie at the outer face of the mesh 15. The aerosol 20 then passes out of the nasal prong 16 via the exit 17. If the prong is held in the user's nose the aerosol enters his or her nasal cavity to give therapeutic relief.

With further reference to Figure 4, the concave nature of the transducer 10 concentrates ultrasonic energy at the focal zone 19 within the energising chamber 14 so that the charge of medicine 18a becomes acoustically activated. The dotted lines in Figure 4 illustrate an ultrasonic energy pathway resulting from the concavity of the transducer 10. The area referred to as the focal zone 19 is a small region of concentrated ultrasonic energy. As indicated, the focal zone preferably incorporates the focal point 19a, the position of which is dependent on the curvature of the transducer. In some embodiments of the invention the focal zone may be equivalent to the focal point.

In the preferred embodiment the energising chamber 14 is approximately 0.2 cm^3 to 0.4 cm^3 in size. The small size of the energising chamber 14 with respect to the liquid storage chamber 13 means that the size of the focal zone 19 is minimised. This helps to minimise or substantially limit the amount of residual medicine (wastage) in the energising chamber 14 when the feeder chamber is exhausted.

The liquid medicine 18a in the energising chamber 14 is replenished with a new charge of medicine 18b under normal gravity from the feeder chamber 13. This ensures that there is always a charge of medicine 18a ready to be acoustically energized, that is until the medicine in the liquid storage chamber is emptied. When there is insufficient volume of medicine in the energising chamber 14 there will not be enough acoustic radiation pressure to effectively oscillate the mesh 15.

Referring to Figure 2, the mesh 15 is located within and is integral with the nasal prong 16, and the exit is an opening 17 at the end of the prong. The pore size of the mesh 15 determines, in part, the size of the aerosol droplets.

Referring to Figure 1, the medicine supply unit 3 can be readily detached from the main body 1 for cleaning, disinfection or replacement altogether. It connects to the body 1 via a cavity in the breath receptor 2. With particular reference to Figure 7, the

medicine supply unit is angled slightly upwards to help the medicine flow more easily into the energising chamber 14 and to prevent bubbles forming in either the energising chamber or the transmission media 11. The angle also assists one to better align the path of aerosol leaving the mesh with targeted areas within the nasal cavity.

Other Features

In some embodiments of the invention the device will only run if the user has purchased sufficient electronic ‘credits’, which are communicated to the device wirelessly or by hardwire.

Referring to Figures 8 and 9, in some embodiments the energising chamber 14 has a tapered floor or a well provided by the membrane 12, designed to urge medicine 18a to gather centrally in the focal zone so as to prevent or reduce undelivered residues.

While some preferred forms of the invention have been described by way of example, it should be appreciated that modifications and improvements can occur without departing from the scope of the following claims.

CLAIMS

1. A device delivering for nasal medication, having:

- an ultrasonic energy generator, being a concave ultrasonic transducer, adapted to create a tapered ultrasonic focal zone of concentrated ultrasonic energy;
- ultrasonic energy transmission medium;
- a feeder chamber holding medication;
- an energising chamber smaller than the feeder chamber arranged to hold medication at the focal zone, and further arranged such that the transmission medium is between the transducer and the energising chamber;
- a mesh; and
- a nasal prong;

the device formed so that when it is activated:

- ultrasonic energy travels through the transmission medium and into a charge of the medication such that the charge becomes acoustically energised within the focal zone; and
- the feeder chamber continuously fills the energising chamber with medication, until the feeder chamber has insufficient medication left to achieve this so that there is a substantially constant supply of medication within the focal zone able to be energised and forced from the energising chamber so as to contact the mesh, as a consequence become an aerosol, and leave the device by way of the prong.

2. A device according to claim 1, having a mouthpiece adapted for a human user to blow into and sensing means which, in response to such blowing, causes the medication to be energised and the aerosol to form.

3. A device according to claim 1 or 2, wherein the energising chamber has a volume of 0.1 cm^3 to 0.8 cm^3.

4. A device according to claim 1, 2 or 3, wherein the transmission medium comprises a fluid and there is a membrane between the fluid and the energising chamber.

5. A device according to any one of the preceding claims, wherein the ultrasonic generator is adapted to focus ultrasonic energy on the focal zone when activated, such that medication in the energising chamber becomes acoustically energised and moves towards the mesh.

6. A device according to any one of the preceding claims, formed such that when activated it causes the mesh to vibrate as the medication contacts the mesh so as to assist in creating the aerosol.

7. A device according to any one of the preceding claims, having an exit which is part of the prong.

8. A device according to claim 7, wherein the mesh is integral with the prong.

9. A device according to claim 7 or 8, wherein the mesh is immediately adjacent to the exit so as to prevent or minimise condensation of the aerosol inside the device.

10. A device according to claim 7, 8 or 9, in each case when read as dependent on claim 2, wherein the energising chamber, the generator and exit are at an angle of about 40º to about 80º upwards with respect to the mouthpiece.

11. A device according to claim 7, 8, or 9 in each case when read as a dependent on claim 2, or according to claim 10, wherein the energising chamber, the generator and exit are at an angle of about 50º to about 70º upwards with respect to the mouthpiece.

12. A device according to any one of the preceding claims, wherein the medication is a pharmaceutical or saline solution.

13. A device according to any one of the preceding claims, wherein the feeder chamber has a funnel or flume formed to naturally encourage the medication into the energising chamber.

14. A device according to any one of claims 1 to 13, wherein the energising chamber has:

a. a tapered floor and/or

b. a well;

to urge medication to gather at the focal zone.

15. A delivery device for nasal medication according to claim 1, wherein:

- the ultrasonic energy acoustically energises a charge of the medication within the focal zone to produce an acoustic radiation pressure on an inner face of the mesh so that the mesh oscillates to cause a micro-pumping action of the medication; and
- the feeder chamber is at one side of the device only, and cantilevers outwardly from a location between the nasal prong and the ultrasonic energy generator.