Turning now to Figs. 1-5 of the drawings, there is illustrated a dry powder pediatric nebulizer in accordance with the present invention. The nebulizer 10 comprises a housing or body 12 sized and shaped to fit comfortably within the hand of a human adult. Body 12 houses a dry powder aerosol engine, battery power and controls all as will be discussed below. Referring in particular to Figs. 2 and 3, the hand held nebulizer 10 is connected at its outlet 14 to a facemask 16. Facemask 16 is sized and shaped to fit over the mouth and nose of a patient, and is formed of a resiliently deformable material such as silicon rubber. Facemask 16 may comprise a single wall construction or, if desired may comprise a soft partially air-filled cuff 18 at its distal end, and optionally may include a one-way filter valve 19 to allow the patient's exhale breath to escape. Facemask 16 is friction fitted to the outlet end of nebulizer device 12 so that it may be removed for cleaning and/or disposal and a fresh facemask placed thereon. Also, if desired, facemask 16 may come in different sizes, e.g. for adults, children and infants. The face mask may incorporate a pressure sensor 17 to measure the quality of fit and seal over the patient or the sensor may be incorporated into the inhaler housing. A good seal is preferred to ensure high efficiency of delivery of the drug to the patient and to protect the care-giver from exposure to the drug and the patient from exposure of the drug to the eyes.

Body 12 includes a movable panel ~~48~~20 for permitting one or more blister packs or molded bodies 22 containing a powdered medication to be introduced into a chamber 23 (shown in phantom) -defined within the interior of body 12. A body, comprising ~~B~~blister pack 22, is guided by guides 24 to locate in contact with the top surface of an aerosolization engine in the form of a vibratory element 26. ~~Alternatively, body 22 may be a~~ A molded body that is reused over a number of dosings, or a capsule, may be used as an alternative to the blister pack. The blister pack, molded body or capsule, in this case provides a way for introducing the drug into the chamber. Vibratory element 26 preferably comprises a piezo activator or piezo transducer or a mechanical vibrator, an electro-mechanical vibrator or a magnetostrictive element or other vibratory mechanism. Preferred are aerosolization engines and aerosolization

published U.S. Application Nos. 2005/0172962 and 2008/0202514, the contents of which are incorporated herein by reference.

Blister pack 22 preferably comprises a domed dry powder drug package made of cold formed or thermal formed film, and includes a conical, semi-spherical, elliptical, pyradidal or similar top part 34 and flat base 28 such as described in U.S. 7,080,644, assigned to the common assignee. Blister pack 22 has at least one drug ejection aperature 32 substantially opposite base 28 and serving primarily for injection of drug particles. Aperatures 32 may be pre-formed integrally with ~~capsule~~ blister pack 22, or formed as puncture holes when the blister pack~~capsule~~ 22 is inserted into body 12.

Blister pack 22 carries a supply of a drug substance or substances which preferably are provided as a dry powder. A single component or several drug combinations may be used, or, the drug substance or substances combined with excipients, such as lactose or combinations thereof. Other additives such as pharmaceutically inactive ingredients, de-aggregation agents, etc., also may be added.

Body 12 carries a battery 25 for powering the vibratory element 26, as well as a microprocessor or electronic controller 27 for controlling operation of the vibratory element ~~36~~26, sensor signal processing for inhalation and/or exhalation detection,etc. Body 12 also includes a control panel 38 including one or more activation buttons 40, 42, and a display 44. The display 44 may incorporate active dose feedbacks to indicate such things as device readiness, face mask seal integrity, activation of the aerosol engine during inhalation or tidal breathing and dosing complete, such as described in U.S. Published Application No. US-2005-0183725-A1, the contents of which are incorporated herein by reference. Body 12 also includes one or more side walled aperatures 46 which permit air to enter chamber (shown in phantom at 23) from the outside.

Operation of the nebulizer is as described below.

A caregiver places the facemask over the mouth and nose of the patient. Thereafter, the caregiver presses the start button 40 which activates the vibrating element 26 for a predetermined time, e.g. 1-2 seconds. The vibrating element engages with the base of blister pack 22 whereupon powdered medication is deaggregated and ejected out

of blister pack ~~34~~ 22 into chamber 23 as a cloud or powder plume ~~46~~50 where it is then inhaled by the patient.

The present invention has several advantages over the prior art. For one, the ability to aerosolize dry powders and deliver same in a nebulizer permits much higher dose concentrations than are possible with liquid carried drugs. Thus, administration time for a dose may be significantly reduced over those of a liquid nebulizer. Also, many drugs are insoluble in water and can't be delivered using conventional nebulizers, or are soluble only in organic solvents which create other problems.

Another feature and advantage of the present invention is that the generation of powder plume is independent of inhalation rate and inhalation timing. Thus, the nebulizer of the present invention is particularly useful in the case of infants and small children, respiratory compromised patients, and unconscious patients. The above described invention provides controlled, reproducible and recordable pulmonary doses from pre-measured blister packs. Alternatively, a plurality of blister packs may be mounted in the body 12 as a cartridge, and advanced, as necessary. Alternatively the dose amount may be controlled by the number and duration of the delivery 'pulses', or aerosol activation cycles.

The invention is susceptible to modification. For example, facemask 16 may be removed, or the nebulizer mounted directly to a pre-existing ventilator/nebulizing system where it may be run continuously or semi-continuously or intermittedly. The nebulizer also may be triggered to turn on and off by sensing tidal breathing of a patient as illustrated in Fig. 6 and 7, and operate over one or several breaths. As shown in Figure 7 the inhalation and/or exhalation cycle is sensed and the aerosol generator is turned on for a short duration followed by an amount of chase air to carry or follow the particles into the patient. A sufficient quantity of chase air is necessary to ensure lung deposition when inhalation volumes are low and inhalation cycles are short. Any sensor or combination of sensors that can be used to measure or identify the difference in properties between an inhalation and exhalation manuever can be used to synchronize and turn the aerosol generator on and off. Example of sensors that may be used to detect the patients