Nebulizer

Nebulizers use a variety of techniques to convert a liquid solution of the drug into a fine mist, which again contains a wide range of particle sizes.

From: Nunn's Applied Respiratory Physiology (Eighth Edition), 2017

Related terms:

Inorganic Ions, Dry Powder Inhaler, Chronic Obstructive Pulmonary Disease, Salbutamol, Sodium Chloride

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Treatment Delivery Systems

Bruce K. Rubin, James B. Fink, in Clinical Asthma, 2008

Jet Nebulizer Maintenance

JNs should be rinsed and air dried between treatments and routinely washed. Nebulizers should not be stored between treatments still containing medication, as this can be a reservoir for bacteria or fungus. The nebulizer should be routinely checked for leaks and cracks. Nebulizer performance tends to degrade over time; however the newer ones seem to perform more consistently.

Medication should be placed in the nebulizer cup either in unit doses or kept in the refrigerator and discarded once the expiration date is reached. Nebulizers should be inhaled generally from an upright position as tilting the nebulizer cups can cause spillage, loss of medication, and ineffective nebulization. Nebulization should stop once the cup begins to sputter. The fill volume of the cup is particularly important for nebulizers that have a large residual volume.

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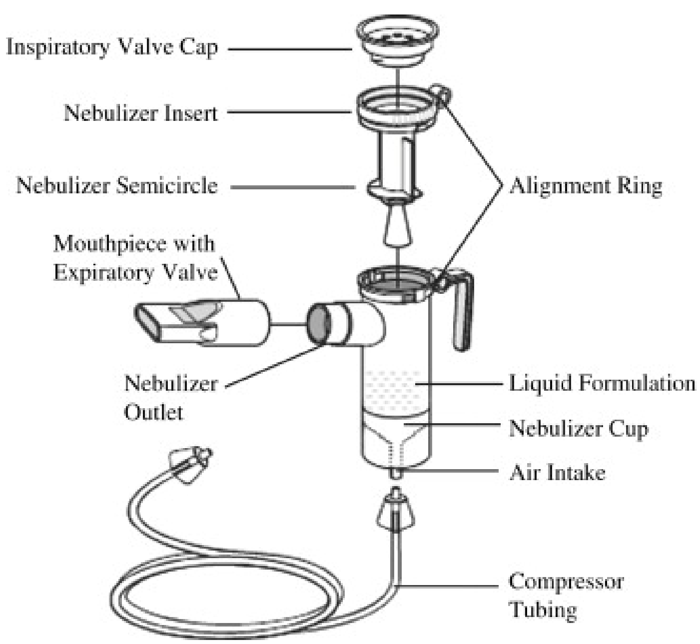
Pulmonary Drug Delivery

Mohammed Ali, in Handbook of Non-Invasive Drug Delivery Systems, 2010

9.3.3 Nebulizers

Nebulizers have been available since the beginning of the twentieth century. Nebulization from a drug solution is a common method of medical aerosol generation. To deliver a drug by nebulization, the drug must first be dispersed in a liquid (usually aqueous) medium. After application of a dispersing force (either a jet of gas or ultrasonic waves), the drug particles are contained within the aerosol droplets, which are then inhaled. At present all commercially available nebulizers can be categorized into two types: (i) jet (or pneumatic) small-volume nebulizers and (ii) ultrasonic nebulizers. Jet nebulizers are based on the venturi principle, whereas ultrasonic nebulizers use the converse piezoelectric effect to convert alternating current to high-frequency acoustic energy (Rau, 2002). The major features of both types of nebulizer are duration of treatment at each time of use, particle size distributions produced, and aerosol drug output.

The formulation of drug solution is usually designed to optimize drug solubility and stability; small changes in formulation may also affect inhaled mass, particle size distribution, and treatment time. The differences between nebulizer brands probably has a greater impact than differences in formulation (O'Riordan, 2002). There are several advantages to jet nebulization, including the fact that effective use requires only simple, tidal breathing, and that dose modification and dose compounding are possible. Disadvantages include the duration of treatment time and equipment size. Design modifications to the constant-output nebulizer have resulted in breath-enhanced, open-vent nebulizers such as the Pari LC Plus and the dosimetric AeroEclipse. Figure 9.8 shows the design of the primary functional parts of a jet nebulizer.



IPR2021-00406

Figure 9.8. Design of primary functional parts of a classic jet nebulizer.Courtesy of PARI Respiratory Equipment Inc., Midlothian, VA, USA.

The second type, ultrasonic nebulizers, usually generates a higher output rate than jet nebulizers; however, the average particle size is larger (Rau, 2002). Ultrasonic nebulizers can substantially increase reservoir solution temperature, which is the opposite of jet nebulizer cooling. Drug concentration in the reservoir does not increase with ultrasonic nebulization as it does with jet nebulization. Although ultrasonic nebulizers have the same advantages as jet nebulizers, the former is more expensive and fragile than the latter type; in addition, the ultrasonic nebulizer may cause drug degradation and may not nebulize suspensions well. It has been shown that neither type of nebulizer meets the criteria of an ideal inhaler, which would generate efficient and quick dose delivery with reproducibility, cost-effectiveness, and no ambient contamination by escaped aerosols during administration (Rau, 2002). However, the electrostatic charge per mass of the nebulized aerosols is negligible, which extensively reduces OPL deposition of drug particles and enhanced deposition into the deeper lung (Ali et al., 2008a). Another study showed that nebulized terbutaline aerosol, 1.8, 4.6, and 10.3 μm particles, deposited 80%, 60%, and 44% of drug respectively in the lung (Clay and Clarke, 1987).

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Asthma and chronic obstructive pulmonary disease

Derek G. Waller BSc (HONS), DM, MBBS (HONS), FRCP, Anthony P. Sampson MA, PhD, FHEA, FBPhS, in Medical Pharmacology and Therapeutics (Fifth Edition), 2018

Nebulisers

Nebulisers are devices used with a facemask or mouthpiece to deliver the drug from a reservoir solution. There are two types:

- Jet nebulisers use compressed air or oxygen passing through a narrow orifice at 6–8 L/minute to suck drug solution from a reservoir into a feed tube. There are fine ligaments in this tube, and the impact of the solution on these ligaments generates droplets (Venturi principle). Baffles trap the larger droplets.
- Ultrasonic nebulisers use a piezoelectric crystal vibrating at high frequency to create the aerosol, and do not require gas flow. The vibrations are transmitted through a buffer to the drug solution and form a fountain of liquid in the

nebulisation chamber. Ultrasonic nebulisers produce a more uniform particle size than jet nebulisers, but are less widely used due to cost.

Up to 10 times the amount of drug is required in a nebuliser to produce the same degree of bronchodilation achieved by a metered-dose inhaler. Drug delivery is more efficient via a mouthpiece than via a mask from which drug can be deposited in the nasal passages.

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Therapeutic nanostructures for pulmonary drug delivery

Yousef Javadzadeh, Shadi Yaqoubi, in Nanostructures for Drug Delivery, 2017

6.1 Nebulizer

Nebulizers are classic pulmonary drug delivery devices. Glass nebulizers were an innovation of the late 19th century as the first inhaler devices (Labiris and Dolovich, 2003). These types of pulmonary drug delivery devices require liquid formulations to produce polydispersed particles in the range of an inhalable size. There are two main types of nebulizers available: the first and most common type is jet nebulizer that works based on changes in air pressure. The liquid formulation containing drug particles along with the compressed air within the inhaler chamber pass through a very narrow tube and enter a wide area; the increase in the volume of compressed air leads to reduction of its pressure and atomizes the liquid into micron size droplets. In order to catch large and noninhalable particles there is a baffle within the inhaler. Finally, small inhalable particles of drug will be sucked into the respiratory track to reach the site of action or the site of systemic absorption.

The other type of nebulizer utilizes ultrasonic power in order to produce micron-scaled inhalable particles; ultrasonic nebulizers break down the drug solution into small droplets via piezoelectric vibration. There is a baffle within the inhaler, as well as jet nebulizers, to remove large droplets and return them to the main chamber of device.

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Humidification and Filtration

Benjamin M. Hyers, ... James B. Eisenkraft, in Anesthesia Equipment (Third Edition), 2021

Nebulizers

Nebulizers work by creating a mist of droplets that are suspended in a gas which can be useful for airway hydration and medication delivery. Different types exist such as jet, spinning disc, and ultrasonic nebulizers. Jet nebulizers take high pressure gas and use a venturi to cause a pressure differential, which draws liquid from the reservoir to the gas. This causes the liquid to be broken apart into a spray. Spinning disc nebulizers use centrifugal forces to produce microdroplets by drawing water onto a rotating disc. Ultrasonic nebulizers use high-frequency vibrations to create a mist. The size of the droplets that are created dictate where in the respiratory system they will reach. For example, greater than 5-μm droplets are likely to be deposited in the main airways, which can increase resistance to flow. Sterile water must always be used because these droplets are ideal carriers for microbes.[42,43]

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Aerosols and Aerosol Drug Delivery Systems

Beth L. Laube, Myrna B. Dolovich, in Middleton's Allergy (Eighth Edition), 2014

Ultrasonic Nebulizers

Ultrasonic nebulizers incorporate a piezoelectric crystal, which is vibrated at a high frequency with sufficient intensity to create standing waves on the surface of the liquid overlying the crystal. Droplets are formed that remain within the nebulizer until they are swept out by a fan or the patient's inspiratory breath.

Most current ultrasonic nebulizers operate at frequencies above 1 MHz, producing aerosols with MMADs between 2 and 12 μm, with an output that is two to three times higher than with most jet nebulizers.[41] Heat is produced along with the aerosol, however, because the ultrasonic nebulizer solution is sonicated, and the temperature can rise 10° to 15 °C over a 10-minute treatment period, which may adversely affect heat-sensitive components of formulations, such as proteins. Ultrasonic nebulizers also are not suitable for nebulizing suspensions.

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